CONSERVATION OF WOODEN MONUMENTS
PROCEEDINGS OF THE ICOMOS WOOD COMMITTEE
IV INTERNATIONAL SYMPOSIUM
CANADA, JUNE 1982

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COMPTE RENDU DES TRAVAUX DU COMITÉ
DU BOIS DE L'ICOMOS
IVe COLLOQUE INTERNATIONAL
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PREFACE

This was the first time that a specialised international committee of ICOMOS met in Canada. That it was the Wood Committee could not have been more appropriate, for Canada is the land of wood "par excellence". Yet, as specialists in the restoration of our architectural heritage, we are well aware of the problems connected with the exploitation of our forests, the utilization of our lumber, the woodworking trades and wooden buildings. All these problems are present and even magnified in Canada.

Practically all our oaks have disappeared. A few years ago, I was directing the restoration of the buildings at Lower Fort Garry near Winnipeg when I discovered that the original roofs were oak shingles. People assured me this was impossible because there are no oaks near Winnipeg. However, only a few kilometres away is the site of the Battle of Seven Oaks. Unfortunately, they didn't replant then, and we don't replant now the wood species that served in the construction of our historic buildings. The pretext today is that there is no demand for these woods. In fact, they are so rare and so expensive that nobody can use them.

The industrialization of the construction process has brought about the use of wood often in modified form; for example, as particle board or as plywood, or better yet in the standardization of the inevitable 2" by 4" in spruce (a 5 cm x 10 cm board that serves as the structural base for most of the residential construction in North America). In a general way, wood is first of all the foremost materials for making paper pulp, and to produce it our forests are harvested like so many fields of wheat. The tree species which are used in reforestation today are those which can be utilized for these products.

The quick reactions of some governments to the energy crisis have encouraged a new industry: the retro-insulation of existing buildings. During a certain period in Canada generous grants permitted home owners to install additional insulation. Frequently urea formaldehyde foam was used. This material now presents health problems on one hand, while on the other it is not well-adapted to

PRÉFACE

C'était la première fois qu'un Comité International Spécialisé de l'ICOMOS se rencontrait au Canada. Que ce fût le Comité du bois, rien ne pouvait être plus approprié. Le Canada est par excellence le pays du bois. Et pourtant! En tant que spécialistes de la sauvegarde du patrimoine architectural nous sommes conscients que tous les problèmes qui concernent l'exploitation de la forêt, l'utilisation des bois, les métiers du bois et les bâtiments en bois sont présents au Canada et y sont même magnifiés.

Pratiquement tous nos chênes ont disparu. A tel point qu'il y a quelques années alors que je dirigeais la restauration de bâtiments au Petit Fort Garry près de Winnipeg et que j'avais découvert qu'à l'origine les toitures étaient en bardeaux de chênes, on m'affirmait que c'était impossible, qu'il n'y avait pas eu de chênes dans la région. Alors qu'à quelques kilomètres se trouve le site de la bataille de "Seven Oaks" (sept chênes). En effet, on n'a pas replanté alors et on ne replante pas maintenant ces espèces de bois qui ont servi à tant de nos constructions dans le passé. Le prétexte aujourd'hui est qu'il n'y a pas de demande pour ces bois, en fait ils sont si rares et si dispendieux que personne ne peut maintenant les utiliser.

L'industrialisation de la construction a amené une utilisation du bois souvent dans des formes modifiées, contreplaqués agglomérés ou bien encore sous des formes standardisées tel l'inévitable 2" par 4" en épinette (pièce de bois d'environ 5 cm par 10 cm du section qui sert de base structurale à la plupart des constructions résidentielles en Amérique du Nord). Mais d'une façon générale le bois est avant tout matière première pour la pâte à papier et les forêts sont moissonnées comme autant de champs de blé. Et les essences d'arbres qui ont fait l'objet de reforestration sont uniquement celles qui conviennent à ces utilisations.

La réaction vive de certains gouvernements à la crise de l'énergie a vu l'encouragement de toute une nouvelle industrie: "l'isolement après coup des bâtiments existants". Au many buildings since it introduces condensation problems inside the wood frame walls, which in the long term (and sometimes even in the short term) destroy the building's structure itself.

Concerning the woodworking trades, the last generation of fine joiners and carpenters capable of working in historic traditional methods is rapidly disappearing, and the replacement of these skills is far from being assured.

In Canada, as elsewhere, stone buildings are considered more prestigious than wooden ones. In a small town not far from Ottawa, Ontario all the original wooden buildings were demolished, while at the same time the restoration of the stone buildings was encouraged because they were thought to be more significant vestiges of our heritage.

Although our symposium did not find solutions to all these problems, each participant contributed his own expertise and ideas. I would like to take this opportunity to thank both the participants and the organizers.

In order to give meaning to our discussions, one task remains: making available our deliberations to as many people as possible. The publication of these proceedings will assure the dissemination of this work and will contribute to our existing knowledge about the conservation of wooden monuments, upon which, others will continue to build.

Jacques Dalibard,
President, ICOMOS CANADA

Canada, pendant une certaine période, des octrois généreux permettent aux propriétaires de faire installer cette isolation. On a injecté parfois de la mousse "urée formaldéhyde", matériel dangereux pour la santé d'une part et d'autre part complètement inadapté puisque on introduit des problèmes de condensation à l'intérieur des murs qui, à la longue, et parfois à courte échéance, détruit la structure même des bâtiments.

En ce qui concerne les métiers du bois, la dernière génération de menuisiers et charpentiers capables de travailler le bois à l'ancienne, disparait rapidement, et la relève est loin d'être assurée.

Au Canada comme ailleurs les bâtiments de pierres sont considérés commes plus nobles que les bâtiments en bois. Dans le centre d'une petite ville non loin d'Ottawa, on a récemment démoli tous les bâtiments en bois qui avaient servi aux premiers habitants de la ville, tout en encourageant la restauration de bâtiments de pierres comme étant plus significatifs de notre héritage.

Notre colloque n'a pas trouvé de solution à tous ces problèmes mais chacun a contribué son expérience et ses idées et j'en profite pour remercier tous les participants et la organisateurs.

Il restait une chose à faire pour donner un sens à notre débat et c'était d'en faire profiter le plus grand nombre. La publication du présent ouvrage assurera la diffusion de notre travail et contribuera à l'édifice de connaissance sur lesquelles d'autres pourront continuer à bâtir.

Jacques Dalibard,
Président, ICOMOS CANADA

FOREWORD

As Chairman of the fourth symposium of the ICOMOS "Wood Structures Committee", I was delighted that we in Canada could have the opportunity to act as hosts for the first meeting of this committee to be held outside Europe. As the develoment and organization of the symposium proceeded, I was deeply gratified by the enthusiastic support which I received from all my staff at the Heritage Canada Foundation, our colleagues in Québec under the dynamic leadership of André Robitaille, and the generous Canadian federal and provincial agencies and other institutions whose assistance is most gratefully acknowledged elsewhere in this publication.

I trust that this publication will serve as a worthy reminder of the success of the symposium and that it will also make a useful contribution to the literature in this field.

Martin E. Weaver,
Chairman, IVth Symposium

AVANT-PROPOS

En ma qualité de président de la IVe conférence du "Comité des structures en bois" du Conseil international des Monuments et des Sites, je suis enchanté que le Canada ait eu l'opportunité d'agir en tant qu'hôte à la première conférence de ce comité à l'extérieur de l'Europe.

Au fur et à mesure que l'organisation de la conférence se développait, j'ai eu le plaisir de recevoir le support enthousiaste du personnel de la Fondation canadienne pour la protection du patrimoine, ainsi que celui de nos collègues au Québec sous la direction dynamique d'André Robitaille. J'aimerais souligner l'aide généreuse apportée par les agences du gouvernement canadien, des gouvernements provinciaux et autres institutions.

J'espère que cette publication servira de souvenir digne du succès de la conférence et qu'elle sera aussi une contribution utile à la littérature de ce domaine.

Martin E. Weaver,
Président de la IVe Conférence

ACKNOWLEDGEMENTS

In order to prepare these conference proceedings for publication, an editorial board was established at the Heritage Canada Foundation. Martin E. Weaver and Dean Jones edited the English papers. Richard O. Byrne served as the production editor. Jacques Lemire, Michel Moreau and Annik Virot edited the French papers and Judy Oberlander provided abstracts for all the papers. Gail Sussman researched and compiled the information on Canada's wood preservative industry. And a special thank you to Deidre Jones-Nishimura, who handled the difficult task of mounting this work into a helpful word-processor.

We would like to acknowledge the assistance of Jacques Dalibard, President of ICOMOS CANADA, and Rany Keo-Kosal of the ICOMOS Secretariat in Paris, who were actively involved along with members of the Heritage Canada Foundation staff, in the preparations for the June 1982 symposium. André Robitaille, Vice-president of the Francophone Committee, Ernest Martin and Laszlo Demeter, President and Canadian member of the ICOMOS Wood Committee, respectively, and Paul Stumes of Parks Canada were also responsible for organizing various aspects of the meeting. Our thanks must also be extended to the following organizations who contributed so generously in order to make the symposium and this publication possible.

Of particular note is the grant from the Department of Industry, Trade and Commerce, that not only assisted with the publication of the papers presented at the Symposium, but also enabled us to provide the international community with information on Canadian expertise in the field of wood preservation.

Bank of Montreal
Canada Mortgage and Housing Corporation
Canadian Wood Council
City of Québec
La Corporation du Moulin de la Chevrotière, Deschambault, Québec
French-Speaking Committee of ICOMOS CANADA
Heritage Canada Foundation
Ministry of Citizenship and Culture, Ontario
Ministry of Cultural Affairs, Québec
Ministry of Industry, Trade and Commerce
Ministry of Inter-governmental Affairs, Québec

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Afin de préparer les textes des conférenciers pour cette publication, un comité de rédaction fut créé par la Fondation canadienne pour la protection du patrimoine. Martin E. Weaver et Dean Jones révisèrent les textes anglais, Richard O. Byrne agit comme chef de la production, J.Jacques Lemire, Michel Moreau et Annik Virot révisèrent les textes français et Judy Oberlander écrivit l'introduction et un sommaire pour tous les textes. Gail Sussman fit la recherche de l'annexe au sujet de l'industrie canadienne pour la conservation du bois. Et merci à Deidre Jones-Nishimura pour son aide général avec les textes.

Nous remercions M. Jacques Dalibard, président d'ICOMOS CANADA, M. André Robitaille, vice-président du Comité francophone, Paul Stumes de Parcs Canada, et Rany Keo-Kasal du Secrétariat de l'ICOMOS à Paris qui ont participé, avec la Fondation canadienne pour la protection du patrimoine, aux préparatifs de la rencontre internationale de juin 1982 à Ottawa et à Québec. M. Ernest Martin, président du Comité international sur les structures en bois et M. Laszlo Demeter, membre canadien du même Comité, ont contribué également à l'organisation de ce colloque. Finalement, sans la générosité des organismes suivants le colloque international et cette publication n'auraient pu être réalisés.

Et tout particulièrement, soulignons la contribution financière accordée par le ministère de l'Industrie et du Commerce qui non seulement a rendu possible la publication des communications du colloque, mais qui aussi nous a permis de diffuser à la communauté internationale cette information spécialisée sur la conservation du bois.

Banque de Montréal
Comité francophone de l'ICOMOS CANADA
Conseil du bois du Canada
Conseil des monuments et sites du Québec
Corporation du Moulin Lachevrotière à Deschambault (Québec)
Fondation canadienne pour la protection du patrimoine
Ministère des Affaires civiques et culturelles (Ontario)
Ministère des Affaires culturelles (Québec)
Ministère des Affaires intergouvernementales (Québec)

Ministry of Energy, Mines and Resources, Québec
Monuments and Sites Board of Québec
National Museums of Canada
Parks Canada
Samuel and Saidye Bronfman Family Foundation
Seminary, Québec City

The fourth symposium of the International Specialized Committee for the Conservation of Structures and Buildings in Wood of the International Council on Monuments and Sites (ICOMOS) was held from June 14 to 19, 1982 in Ottawa and Québec City. Upon the invitation of the ICOMOS CANADA National Committee, the meeting brought together participants from Canada, the United States and other nations.

Four themes were selected for discussion during the visit to Canada:

1. The energy crisis; heating and insulation of buildings.
2. Damage to monuments and methods of intervention.
3. The Canadian forest and its exploitation.
4. Dendrochronological research.

A total of 18 papers were presented during the working sessions in Ottawa and Québec City. Study tours to laboratories at Parks Canada, the Canadian Conservation Institute and Forintek completed the Ottawa segment of the meeting. A visit to the outdoor architectural museum, Upper Canada Village near Morrisburg, Ontario, enabled the participants to see living examples of 19th century wood production in Canada. En route to Québec City, the group visited the School of Forestry in Duchesnay and a pressure treatment plant at St-Raymond de Portneuf. Following additional presentations in Québec City, there was a walking tour of the historic urban core and preservation projects involving wooden and stone structures.

RESOLUTIONS PASSED AT THE MEETING

The members would like to express their gratitude to the Canadian National Committee and the other sponsoring organizations for their hospitality and the excellent organization of the symposium.

The Committee's deliberations and discussions resulted in the following resolutions:

- THAT since inappropriate use of certain energy conservation measures might damage buildings, the Committee recommended that IN ALL COUNTRIES

Ministère de l'Energie et de Ressources (Québec)
Ministère d'Industrie et Commerce (Québec)
Musées Nationaux du Canada
Parcs Canada
Samuel and Saidye Bronfman Family Foundation
Séminaire de Québec
Société canadienne d'hypothèque et de logement
Ville de Québec

Les membres du Comité international spécialisé dans la conservation des structures et des constructions en bois du Conseil international des monuments et des sites (ICOMOS) se sont réunis du 14 au 19 juin 1982 à Ottawa et à Québec, pour leur quatrième colloque. A l'invitation du Comité national canadien de l'ICOMOS, le colloque a réuni de nombreux participants du Canada, des Etats-Unis et de divers autres pays.

Quatre thèmes ont été choisis pour cette rencontre au Canada:

1. La crise de l'énergie, le chauffage et l'isolation des bâtiments.
2. Les atteintes aux monuments et les moyens d'interventions.
3. La forêt canadienne et son exploitation.
4. Les recherches dendrochronologiques.

Dix-huit communications ont été données pendant ces rencontres à Ottawa et à Québec. Des visites aux laboratoires de Parcs Canada, à l'Institut canadien de conservation, et au Forintek ont été incluses lors du séjour à Ottawa. Par la suite, on a visité le musée architectural Upper Canada Village, près de Morrisburg (Ontario) afin de voir les méthodes du XIXe siècle utilisées dans la production du bois et dans la construction des maisons à l'époque. En route vers Québec, le groupe a visité l'Ecole forestière à Duchesnay et une usine pour le traitement du bois à St-Raymond-de-Portneuf. Après les discussions à Québec, il y eu des tours de ville, dans les quartiers historiques où se trouvent des bâtiments en bois et en pierre.

RESOLUTIONS ADOPTEES LORS DU COLLOQUE

Les membres du Comité expriment leur reconnaissance au Comité canadien pour l'accueil qu'il leur a réservé et pour la parfaite organisation de ce colloque, de même qu'à

WHERE SUCH MEASURES ARE ADVOCATED, IN-DEPTH STUDIES BE UNDERTAKEN BEFOREHAND IN ORDER TO GUARANTEE THEIR SUCCESS TO PRESERVE BUILDINGS AND TO AVOID ALTERING THE INTEGRITY OF OUR ARCHITECTURAL HERITAGE.

- THAT the disappearance of certain species of trees used in buildings, hardwoods in particular, led the Committee to recommend that THE EXPLOITATION OF FORESTS BE COMPENSATED BY REFORESTATION OF THE IDENTICAL SPECIES AND THE FORESTS BE LEFT INTACT UNTIL THE TREES REACH MATURITY.

Québec, Canada, June 19, 1982.

toutes les institutions qui l'ont soutenu.

Au terme de leurs travaux et de leurs délibérations, les membres du Comité:

- CONSTATANT qu'une application inconsidérée de certaines mesures d'économie d'énergie peut conduire à des dégâts dans les bâtiments, RECOMMANDENT QUE, DANS TOUS LES PAYS OU DE TELLES MESURES SONT PRECONISEES, DES ETUDES APPROFONDIES SOIENT ENTREPRISES AU PREALABLE EN VUE DE GARANTIR LEUR EFFICACITE, D'ASSURER LA CONSERVATION DES STRUCTURES ET D'EVITER TOUTE ALTERATION DE LA SUBSTANCE DU PATRIMOINE ARCHITECTURAL.

- CONSTATANT également la disparition de certaines essences forestières de bois de construction, plus particulièrement de bois dur, RECOMMANDENT QUE LES EXPLOITATIONS DE CES BOIS SOIENT COMPENSEES PAR DES REPLANTATIONS D'ESSENCES IDENTIQUES ET QUE LES COUPES NE SOIENT PAS ENTREPRISES AVANT MATURITE.

A Québec (Canada), le 19 juin 1982.

ICOMOS WOOD COMMITTEE - COMITE BOIS
INTERNATIONAL MEETING - REUNION INTERNATIONALE
Ottawa, Canada
June 14-18 Juin 1982

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QUATRIEME COLLOQUE DU COMITE SUR LE BOIS A OTTAWA: MOT DE BIENVENUE

M. Laszlo Demeter

"Ladies and gentlemen, I have the honour to welcome on behalf of the Wood Committee of ICOMOS, and in my own name as the Canadian member of this Committee, all those who accepted our invitation to participate on this 4th Symposium of this Committee."

Je suis particulièrement heureux de saluer M. Ernest Martin, président de notre comité et Madame Martin, ainsi que nos membres titulaires ici présents: M. Berry de France, Panu Kaila de Finlande et tous les autres membres qui ont répondu à notre invitation. Je salue tous les anciens amis avec qui, mon épouse et moi avons eu le plaisir de participer aux séances d'étude sur la conservation du bois lors des trois précédents colloques tenus en Suède, en France et en Suisse. Je souhaite donc à tous la plus cordiale bienvenue à cette quatrième rencontre de notre comité, en terre canadienne. J'exprime aussi notre sincère regret pour les membres qui n'ont être avec nous aujourd'hui.

"I would like to take this opportunity to present my sincere thanks to the organizers of this Symposium, namely Mr. Martin Weaver, Chairman of the organizing committee, Mr. Richard Byrne, Paul Stumes, Judy Oberlander from Ottawa and Rany Keo-Kosal from Paris, as well as Paul Arès and André Robitaille for their indefatigably efficient way of managing the obstacles and arranging everything to make possible our Symposium this week."

"I especially thank Mr. Jacques Dalibard, President of ICOMOS CANADA, for having accepted the idea to have our Committee meet here and for having accepted also the accompanying responsibilities."

Mesdames et messieurs, voici les quatre thèmes choisis pour ce colloque:

- la crise de l'énergie, le chauffage et l'isolation des bâtiments en bois,
- les atteintes aux structures et les moyens d'intervention,
- la forêt canadienne et son exploitation,
- la recherche dendrochronologique, de nature technique et scientifique.

Au sujet de ces faits, j'aimerais souligner quelques points. Bien que notre comité soit à la fois technique et scientifique par sa vocation, il considère sans cesse la réalité historique, le lien entre le passé et le présent. L'Homme se situe dans cet environnement historique, entouré par l'oeuvre du passé, qui est sa création; il s'identifie à cela qui l'amène ensuite à la conservation. Suivant l'évolution de la pensée critique, l'on assure aux oeuvres leur identité historique et culturelle, tout en les considérant comme éléments actifs de l'environnement en évolution dans l'intérêt de leur utilisation, mais sans jamais oublier ou même sacrifier les principes fondamentaux de la conservation.

"Is every building able to receive any kind of modernisation without losing its architectural or historical values? The insulation and heating of buildings are economic problems; they are not historical, esthetic or cultural ones. But their introduction in the old buildings must not affect their fundamental values."

"Today one speaks about the second Industrial Revolution. About 'les systèmes informatisés de conception de dessin technique' (computerized systems for the conception of technical drawings), or about computerized fabrication (la fabrication informatisée). What will be the influence of all these systems on the evolving interest in heritage conservation?"

Si le robot de l'informatisation ne prévoit pas de nuances pour la protection des valeurs traditionnelles, comment pouvons-nous mieux protéger le patrimoine qu'en suivant dans chacun de nos gestes les principes établis et défendus par les théoriciens? Il faut alors trouver le bon passage depuis la tendance abstraite et les exigences strictes des théories jusqu'à l'application pratique. Nous devrions donc ne pas perdre de vue ces idées, car il ne s'agit pas de faire passer le confort, l'avantage économique ou technique avant la vérité ou l'authenticité historique et culturelle.

Dans l'optique, "ladies and gentlemen", de ces quelques remarques, je souhaite à tous encore une fois la plus cordiale bienvenue. "I express again the warmest welcome to everybody - and wish for productive sessions during the whole week," et je prie M. Ernest Martin d'adresser la parole aux participants ainsi que de bien vouloir ouvrir le colloque.

ALLOCUTION DE BIENVENUE A QUEBEC

Bernard Ouimet

Monsieur le président d'ICOMOS CANADA, monsieur le président du Conseil des monuments et sites du Québec, monsieur le président du Comité sur le bois de l'ICOMOS, mesdames, messieurs: le ministère des Affaires culturelles, que j'ai l'honneur de représenter, a accepté avec enthousiasme de s'associer à la tenue du quatrième colloque du Comité international spécialisé pour la conservation des structures et des constructions en bois, et dès à présent, je voudrais souligner l'apport de nos colleègues du ministère de l'Energie et des Ressources et celui du ministère des Affaires intergouvernementales grâce auxquels votre séjour au Québec a été rendu possible.

Je me dois également de souligner le dévouement de monsieur André Robitaille, qui a présidé à l'organisation des travaux techniques du colloque et a vu à la bonne coordination des activités qui s'y sont déroulées et qui doivent se poursuivre demain matin par la visite des bâtiments de l'Assemblée Nationale du Québec.

Vous avez pu constater à l'occasion de vos déplacements sur le territoire québécois ou lors des exposés qui vous ont été faits, que le patrimoine du Québec, comparé à celui des pays européens ou asiatiques, est relativement récent et traduit en cela la jeunesse de notre histoire.

Jeune par rapport au patrimoine mondial, le nôtre n'en est pas moins un des plus anciens lorsqu'on le compare aux autres richesses patrimoniales que recèle l'espace canadien, du moins pour la période postérieure au contact euro-amérindien.

Cette situation particulièere n'est sans doute pas étrangère au fait que le Québec fut le premier gouvernement de la fédération canadienne à adopter la première pièce de législation visant à conserver, au nom de l'intérêt national, les objets ayant une valeur historique ou artistique. La Loi de 1922 prévoyait le classement des biens meubles et immeubles. En 1952, s'ajoutaient le concept de vestige archéologique, celui du site historique ainsi que l'idée naissante de protéger les abords des monuments ou des sites historiques classés.

Modifiée à plusieurs reprises en 1963, en 1972 puis en 1978, la législation du Québec en matière de patrimoine a bénéficié d'un appui général de la part des élus ainsi que des différents partis politiques.

Sans doute l'affirmation de la spécificité du Québec en Amérique du Nord et l'identification de la population aux valeurs que représente son patrimoine culturel ont-elles tenu des places importantes dans la gamme des motivations qui ont permis l'adoption des mesures législatives et administratives visant à la sauvegarde et à la mise en valeur des biens culturels.

Ces motifs expliquent dans une large mesure pourquoi les interventions gouvernementales en faveur du patrimoine ont souvent reposé sur l'intuition et la valeur symbolique plutôt que sur des connaissances rigoureuses dont on connaît, aujourd'hui, les exigences méthodologiques. Nos universités s'intéressent à l'étude des phénomènes de notre culture matérielle depuis à peine une quinzaine d'années si bien, qu'en l'absence d'une longue tradition universitaire, d'une documentation suffisante sur le sujet, le rattrapage des connaissances a dû, de façon supplétive, être assumé par la Direction générale du patrimoine du ministère des Affaires culturelles.

Dans ce contexte, les voies traditionnelles de l'inventaire des oeuvres d'art ou d'architecture se sont révélées trop lentes et peu opérationnelles pour répondre aux demandes croissantes d'intervention qui nous assaillaient. D'autre part, l'absence d'une perspective d'ensemble empêchait une planification intelligente des études et des inventaires à réaliser. Nous avons innové, je crois, en lançant en 1977 une opération dite de macro-inventaire qui visait à recueillir sur l'ensemble du territoire québécois, toute l'information accessible.

Cette importante opération comprend cinq approches réalisées en séquence pour chacun des soixante-quatorze comtés municipaux du Québec:
- un résumé historique relatant les faits marquants de l'évolution du comté est réalisé;
- une couverture photographique aérienne oblique est réalisée: à haute altitude, elle permet une vue d'ensemble de chaque village; à moyenne altitude, elle révèle les ensembles les plus intéressants alors que les photographies prises à basse altitude révèlent les détails significatifs;
- des équipes se rendent sur le terrain pour réaliser une étude ethnologique sommaire des caractéristiques matérielles témoignant d'activités humaines propres aux régions;
- à l'aide des fiches de pré-inventaire, on procède à une analyse sommaire des églises et de leur contenu, sur la base du comté;
- après analyse de la photographie aérienne, on choisit des sites où on procède à l'analyse des paysages architecturaux et de la typologie architecturale.

Cette opération, terminée en 1982, a permis de constituer un trésor de connaissance et a facilité la compréhension des grand phénomènes qui ont marqué le développement de nos régions et qui ont façonné les traits caractéristiques du patrimoine encore visibles dans l'aménagement des agglomérations, dans l'architecture, dans les us et coutumes de la population, dans le développement des métiers et de l'artisanat local.

Ainsi, le phénomène du bois occupe une place centrale dans le développement de notre culture matérielle. Le bois a doublement marqué le paysage architectural québécois: d'une part, comme matériau de construction et d'autre part, comme ressource forestière.

Comme matériau de construction, il fut utilisé dès les premiers temps de la colonie. Jacques Cartier remonta le fleuve Saint-Laurent en 1535 et établit des quartiers dans l'embouchure de la rivière Saint-Charles, à l'emplacement de l'actuel Parc Cartier-Brébeuf qu'il nomma "havre de Sainte-Croix" où ses hommes construisirent un fort "tout clos de grosses pièces de bois plantées debout, joignant les unes contre les autres, et tout à l'entour garni d'artillerie, et bien en ordre pour se défendre contre tout le pays."[1]

Toujours utilisé pour les charpentes, le bois des premières cabanes est remplacé par la pierre, matériau plus permanent, dès que les maçons européens s'installent en Nouvelle-France apportant avec eux leurs façons de bâtir qu'ils adaptent aux rigueurs du climat. De ces temps anciens, nous comptons encore des témoins remarquables, vieux de deux siècles, tels la maison à colombages pierrotés (Maison Lamontagne à Rimouski) ou les constructions en pièce sur pièce, ou faites de poteaux sur sol. D'architecture humble, marquant surtout le paysage rural ou villageois, ces constructions domestiques son d'avantage importantes par leur valeur d'évocation et pour la compréhension de notre histoire plutôt que pour leur contribution au développement d'une technologie constructive du bois.

Comme ressource forestière, le bois représente, tout au long du XIXe siècle, le principal produit d'exportation du Québec et occupe une place de premier rang dans son économie. Linteau, Durocher et Robert, dans leur Histoire de Québec contemporain, distinguent trois grandes étapes bien caractérisées:

Celle du bois équarri pour l'approvisionnement de la construction navale. Les plus belles pièces de bois sont équarries sur le lieu d'abattage, puis assemblées en radeaux et flottées jusqu'a Sillery et embarquées vers l'Angleterre sur des navires construits à Québec.

La deuxième étape est celle du bois scié qui apparaît ver 1850 et qui est surtout liée aux besoins du marché américain au prise avec l'urbanisation rapide. Les arbres de moins grande taille et les essences négligées par les besoins de la construction navale peuvent être utilisés pour la production de planches et de madriers. Cette exploitation de la forêt donne naissance à des agglomérations installées à l'embouchure des principales rivières et crée une culture matérielle axée sur les gestes et les rites du travail forestier.

A la fin du XIXe siècle, un nouveau besoin naît pour la production de la pâte à papier. Une coupe systématique de la forêt, utilisant les conifères et les arbres de petites dimensions néligés jusque-là, caractérise cette période. Des entrepreneurs, d'origine étrangère, s'installent dans les régions périphériques du Québec et se taillent de véritables empires. Avec eux démarra la troisième étape qui est celle de l'industrie papetière encore florissante aujourd'hui. Cette activité a généré la création de petites villes industrielles sur les lieux du traitement de la pâte ou de la fabrication du papier.

De l'exploitation industrielle de la forêt s'est constitué un patrimoine unique dont la valeur fut consacrée par la Loi sur les biens culturels. Ajoutés aux autres biens culturels classés, ces vestiges et témoins du passé industriel récent méritent d'être protégés, sauvegardés et mis en valeur car ils présentent un intérêt majeur pour l'interprétation des grands courants socio-économiques ayant caractérisé l'évolution de ces régions. C'est ainsi que la mise en valeur du bateau-remorqueur T.E. Draper, datant de 1929 ou le classement du site d'Opémican datant de 1883, prennent de l'intérêt dans la mesure où ils témoignent des activités reliées au flottage du bois dans la région du Témiscamingue. Dans le même ordre d'idées, et puisqu'il est question de l'exploitation industrielle de la forêt, le classement en 1978 de la goélette Saint-André comme monument historique peut être évoqué. Les goélettes, dès le début de notre histoire et jusqu'à tout récemment, furent largement utilisées, entre autres choses, pour le transport du bois sous toutes ses formes.

Ces mesures de protection, accordées à des bâtiments qui étaient encore en activité il y a quelques années, ne peuvent pas s'expliquer ni être comprises en dehors du contexte que je viens d'évoquer. La tramme particulière de notre développement conditionne et personnalise notre démarche culturelle.

Permettez-moi en terminant de vous exprimer la joie et l'honneur que nous avons eus de vous accueillir dans la belle ville de Québec qui est le berceau de la civilisation française en terre d'Amérique.

Nous attachons beaucoup d'importance à des réunions internationales comme celle-ci car nous savons que nous avons beaucoup à retirer de la confrontation de nos expériences réciproques. Humblement, nous croyons aussi pouvoir apporter le témoignage de notre démarche à ceux qui ont pour partage un patrimoine relativement jeune.

Le Québec est fier d'apporter sa contribution à la communauté internationale et dans la mesure de nos moyens, nous continuerons à jouer un rôle actif tant auprès de l'ICOMOS qu'auprès du Comité international sur le Bois, ainsi qu'auprès du Comité international pour les inventaires du Patrimoine dont mon collègue de la Direction générale du patrimoine, monsieur Michel Cauchon, fait partie.

BERNARD OUIMET est le Directeur general du patrimone, Province du Québec.

SOURCES

(1) "Voyages de découverte au Canada entre les années 1534 et 1542", cité dans Québec trois siècles d'architecture, Noppen, Paulette Tremblay.

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ENERGY-SAVING IN BUILDINGS - A THREAT TO ARCHITECTURAL HERITAGE? SWEDISH EXPERIENCES IN THE LAST FIVE YEARS

Kerstin Alexandersson and Christina Sandström

POLITICAL DECISIONS

Since the energy crisis in 1973, questions about how to save energy have been amongst the hottest political topics in Sweden. Even more so as the discussion about the use of future energy sources was very intense at the end of the 1970's, when the use of nuclear power above all was the main topic. The discussion led to a popular vote in 1980, where the decision was that nuclear sources should be used for 25 years and thereafter they were to be successively abandoned.

The government has formulated the goals and aims of their energy policy in a series of documents and government bills. One important part of the government programme is to save energy in the existing building stock through a variety of measures, especially concentrated on the stock of dwelling houses. The structure of this is shown in Diagram 1, where it is striking to see that the majority of our dwelling houses were built after 1940. One would also see that 40% of the single-family houses were built before 1940, while only 22% of the multi-family houses are from that time. Among these, however, you will find the main part of the building in our town and city centers.

The energy-consumption growth from 1800 till today is shown in Diagram 2. Around 1800, the Swedish population was 2.3 million and today it is around 8 million. The energy-consumption growth during the 19th century was approximately from 15 Twh. per year to around 60 Twh. per year, while the growth during this century, and then especially after World War II, has been increasing immensely. The total consumption today is around 450 Twh. per year. Most of this is due to the growth of energy consumption for industry and transport, as shown in the diagram.

Diagram 3 shows the use of energy for different purposes in 1982. The heating of buildings today takes 30% of our energy consumption, which is quite a large part. This, of course, is due to our climate.

In 1977, the government presented a plan for the saving of energy in the existing building stock. There, it was stated that within a period of ten years (1978 - 1988), the amount of energy used for heating buildings would be cut down by 25 to 30%, which means a cut in the energy consumption of 39 to 48 Twh. To obtain this goal, 31 to 48 billion SwCr (5.6 to 8.7 billion US$) would be allocated during the ten-year period. The major part of it would be incentive money - which means favourable loans and federal contributions to owners of buildings for energy-saving measures.

As the political idea of the government was to reach its purposes through voluntary efforts, quite a large sum of money was allocated to information to the public. Funds were also allocated to the local authorities, to enable them to set up an organization of 'energy-saving advisors', which would serve house owners. The money also would enable the communities to get started with programming work on a local level, to plan how to handle the current and future situation. During 1978-79, 1,285 million SwCr was allocated to subsidies and loans for energy-saving purposes in buildings - a sum which has been increasing since, and in 1981, was 2,365 million SwCr. The amount of money for the planning and information work on a local level was, in 1979-80, 95 million SwCr and in 1981, 130 million SwCr.

(To get comparable figures, it would be useful to know that the Gross National Product in Sweden in 1979 was 459,000 million SwCr in purchase value at current prices and that the sum allocated to ordinary housing loans guaranteed by the state was 6,000 million SwCr [US $1.00 = approximately 5.40 SwCr].)

In the plan of 1977, it was also pointed out by the government that an increase in the employment of construction workers was to be expected, from 20,000 to 30,000 men per year, due to energy-saving measures in buildings.

It was quite clear that energy-saving efforts along the lines laid out by the government would be a

threat to the architectural heritage. In this plan of 1977, it therefore stated that approximately 30% of the buildings should be excluded from measures that had an impact on their exteriors, e.g. exterior thermal insulation and changed windows.

This political statement was based on reports and inventories made by the Central Board of National Antiquities to the Minister responsible for the energy-saving work, before and during the period when the plan of 1977 was worked out. The statement has no implementation in the sense of financing, but has thereafter been the political ground on which protection work could be based.

It was also said that the plan and the results obtained should be evaluated after a three-year period and that the measures thereafter may be altered.

As presented above, the aim of the government was not (and still is not) to use coercive measures at any level, but to rely merely on voluntary efforts. Therefore, no rules have been worked out on how to guide the process through compulsory measures on national, regional or local levels.

PREPARATORY SURVEYS AND RESEARCH WORK AS A BASIS FOR THE ENERGY-SAVING PLAN, 1977

In the very beginning of this process, a project was carried out by the National Building Research Institute as a basis for the plan of 1977. This project aimed at a description of the building stock by technical aspects. The authorities responsible for the architectural heritage, through their own initiative and with the help of personal contacts with the Building Research Institute, succeeded in putting in force a parallel evaluation of the same objects from a cultural and historical point of view.

To finance this project, the Central Board of National Antiquities received a research grant from the National Board of Building Research. This grant, though, covered only part of the costs. The main effort was made by the regional body responsible for the architectural heritage - the county museums.

In this study, it was stated that approximately one-fifth of our building stock has such qualities that it should be handled carefully and with respect towards its architectural values, when trying to improve its energy status.

The study also presented possibilities of combining the technical evaluation made by the Building Research Institute and the cultural historical one. Then it could be shown clearly that the technical status of the building stock of cultural historical value was, in fact, much better than was the general opinion at that time.

THE PRINCIPAL WAYS AND MEANS OF ACTION FOR THE AUTHORITIES RESPONSIBLE FOR THE ARCHITECTURAL HERITAGE

In the political decisions, the authorities responsible for the architectural heritage have been given no special commission to fulfil, although other authorities responsible for physical planning and construction, housing loans, etc. have been commissioned with direct work on programming, information, implementation, and so on. All the same, the question of saving energy has been of high priority for the work within the conservationist field.

The working method has been, so to speak, "to try to catch any train that is running." Which has meant, above all, to try to be well-informed about what is going on and to work out and offer basic statistical, technical and historical information about the older building stock, so that this knowledge can be considered in both the work done by others and in political decisions on all levels.

A heavy emphasis has been put on information about the quality and value of the older buildings, and on ways in which they could be properly handled from the aspect of energy-saving.

THE IMPLEMENTATION OF THE ENERGY-SAVING PLAN ON A LOCAL LEVEL

The administrative features of Sweden are based on a balance between the local authorities and the State government, which has both a central and a regional level.

The implementation of physical planning and building construction is merely a responsibility of the local authorities. It is also on this level that the main outlines for programmes for energy-saving ought to be worked out. On a central level lies merely the responsibility for guidelines, pilot studies and research of different kinds.

The political decisions concerning energy-saving have naturally led to a wide range of measures on all levels.

On the central level, one of the first steps was to work out consultative guidelines for the programming work of the local authorities. The responsibility for this work was tied to the Swedish National Board of Physical Planning and Building. However, the Central Board for National Antiquities was invited to join the work and to give guidelines on how to handle the architectural heritage.

The question here was merely to work out a principal time schedule, an analytical decision system and an inventory system, which could be used in the integrated planning process.

In 1979, the National Board of Physical Planning and Building and the Central Board of National Antiquities, together with the National Association of Local Authorities, presented their method for programming work on energy-saving in local communities.

The Central Board of National Antiquities thereafter worked out a pilot study, demonstrating how the inventory system concerning the architectural heritage could be carried out. This was due to the fact that not all the existing inventories were usable as basic information for the new types of questions that energy-saving puts forward. The question is no longer whether a single building or monument shall be maintained, but to what extent the maintenance, as such, can cope with façade alterations of different kinds.

To be able to carry out the task of advising house owners and implementing the energy-saving work on a local level, the local authorities have the possibility of asking for State financial subsidies. Most communities have made use of this possibility and, by now, energy advisory staff are tied to the work on a local level, to quite a large extent.

TRAINING OF LOCAL COMMUNITY OFFICIALS

Special education and training for community officials started in order to effect the energy-saving plan on the local level. Local officials already working with housing and developments, as well as the newly recruited energy-saving advisors and surveyors, needed special training. The Swedish National Board of Physical Planning and Building and the National Association of Local Authorities were made responsible for the education. Within the education programme, the Central Board of National Antiquities was invited to say what demands had to be fulfilled in order to preserve the cultural historical values. The Board took this opportunity to engage actively and intensively in the education effort. This, at first, caused some doubts among the responsible authorities - doubts that gradually changed into a more moderate view on the need for knowledge and information.

The Central Board of National Antiquities (hereafter referred to as the CBNA) was aware that the aim of this education was to influence attitudes towards the built environment, as well as to increase knowledge. The common view at the time was that only very few buildings were of cultural historical value, e.g. churches, castles and certain very old houses. The consciousness of the risk that values of cultural historical interest might be in conflict with the measures for energy-saving was, therefore, very rare. Thus, one of our main purposes became to reveal and call attention to all the buildings and environments that we today consider as having great cultural historical qualities.

The second main educational task was to supply knowledge about old construction techniques. From the 1950's, there had been a period when almost no reconstruction work in older houses took place. This means that all practicing building technicians, architects, etc. are lacking a knowledge of old building methods, and without this knowledge, it will be impossible to accomplish effective measures of energy-saving in older buildings.

Thirdly, the CBNA wanted to prove that energy-saving measures can be carried out on most buildings without the cultural historical value being lost.

At the same time as the CBNA engaged in training programmes for building technicians, its own organization was being educated as well. This training programme was directed mainly towards the conservationists at the county museums. These museums are the regional institutions with which the communities collaborate on questions of the cultural historical value in the built environment. The museums could thereafter more actively take part in the safeguarding of cultural historical values involved in energy planning on a local level. They performed inventories and evaluations of the built environment and were also engaged in giving advice and recommendations directly to owners of old buildings.

INFORMATION TO HOUSE OWNERS AND THE GENERAL PUBLIC

In order to carry out the very extensive information campaign about energy-saving measures, a special State committee was appointed - the so-called Energy Conservation Committee. Its work is aimed at house owners, tenants and the general public. Information brochures, posters, exhibitions and advertising campaigns were used to inform the public about the necessity for saving energy and how to accomplish that. Main slogans in the campaign were appeals to lower the indoor temperature and to make technical improvements, such as thermal insulation of walls and installation of triple-glazed windows. Since no coercive measures had been enforced, the favourable loan and subsidy systems became the only incitement used.

The building material industry, especially manufacturers of façade materials and insulating windows, were also running a big advertising campaign, heavily stressing the favourable loans and subsidies being given.

The CBNA was strongly aware of the need for information about cultural historical values to be a part of this extensive campaign. However, it turned out to be very difficult to get through with this message and no financing was available for this purpose. The CBNA, nevertheless, prepared information material that could be used within the exhibits which toured all the communities in Sweden. A special screen-exhibit on energy-saving measures in older buildings was also made in collaboration with the Museum of Architecture in Stockholm. This exhibit was originally made for the county museums. However, due to the limited means available at the CBNA, it proved difficult to get enough attention paid to the cultural historical values in this energy-saving campaign.

At this point, the CBNA found it necessary to produce a special information brochure, aiming at the owners of culturally and historically valuable houses. This brochure, called "Save and Preserve", was paid for with State information funds and has been distributed to all the local communities and county museums. The brochure points out and describes which types of building have cultural historical value and explains how to make large energy savings by very simple means without changing the exterior of the building. As examples of suitable measures, the following are stressed:

- Try to keep a low indoor temperature and to use less hot water and electricity. Reducing the temperature by one degree means a 4 to 5% saving.
- Seal windows and doors with weather strips.
- Keep your burner and heating system fit. Continuous flue sweeping and boiler service is most important. Installation of automatic control equipment is another good measure.
- Seal and thermally insulate easily accessible roof structures and draughty floors. Sealing the edge of the floor structure is often an effective way of improving the floor without having to exchange it.
- Restore old tile furnaces and keep stoves, in case of future energy crises.
- Try unconventional methods. Lower the temperatures in rooms not in use. Pull the blinds or window shades at night. Place heavy carpets on cold floors and do not put furniture in front of the radiators.

Sometimes even more thorough measures have to be taken. Therefore, some good examples of how these could be achieved, without changing the character of the building, are presented in the brochure.

EVALUATION OF THE ENERGY-SAVING CAMPAIGN

As mentioned earlier, the effects of the energy-saving efforts were evaluated after three years, in 1981. Several evaluation projects were started. The economic evaluation is shown in Diagram 4. During the first three years, the savings reached an average of approximately 0.5% per year. That should be compared to the 3% goal of the energy-saving programme (or a total of 30% within ten years). A drastic increase in the rate of savings had to be accomplished in order to achieve this aim. The last available figures show that, actually, in 1982 an energy saving is achieved of 1.5% per year.

In the investigations it was found that the greater part - about 75% - of the loans and subsidies had been used for technical construction measures, mostly thermal insulation of façades and changed windows.

When evaluating the programme, very comprehensive economic calculations were made in order to find out the profitability of different energy-saving measures.

They clearly showed that, in order to effectuate a rapid energy-saving programme in the existing building stock, measures had to be taken primarily to improve the heating systems. The boiler energy losses in a normal single-family house, for example, are approximately 25% of the energy consumption, and the ventilation energy losses are approximately 20%. Adjustment and trimming of boilers and thermostats, heat recycling and a lowering of the indoor temperature can give big energy savings at a low cost, considering the effort expended.

The economic calculations also showed that larger technical construction measures, such as thermal insulation of façades and changing the windows, are only profitable when carried out in connection with a major house renovation. Many wall construction types give quite good heat insulation and, on the whole, extra insulation is not profitable. This is the case for many old timber houses. However, thermal insulation of the roof structure is profitable in most houses. And wooden houses very often need sealing.

From the evaluation, it was also concluded that it was mainly the owners of single-family houses who had carried out the energy-saving measures. Very few multi-family houses and larger buildings had been involved. Among other things, that was due to the regulations in the Rent Negotiation Act, which grant the property owner full coverage of fuel cost. Consequently, there was no economic profit for the landlord in carrying out energy-saving measures.

The CBNA participated in an investigation of how the energy-saving measures had affected the buildings from a cultural, historical and aesthetic point of view.

This investigation was mainly based on a study of 200 statistically selected single-family houses and multi-family houses built before 1940 which, during 1977-78, received state loans and subsidies for thermal insulation of façades and window changes. The statistical selection had been done by the National Building Research Institute, which also performed an extensive technical investigation of the same houses.

The CBNA investigation showed that thermal insulation of façades and window changes had doubtlessly led, in most cases, to great changes in appearance. The architecture of the houses was simplified, enlarged and impoverished, which led, in most cases, to diminished cultural historical value.

The investigation also showed that the changes which were earlier thought to be the main problems following exterior thermal insulation, e.g. deep window bays, smaller eaves, etc., are of minor importance. Instead, the basic problem is that thermal insulation of the façade itself creates extensive changes in façade materials and even other parts of the building, and therefore changes the whole architectural design of a house.

The changes effected are basically of two different kinds: the primary change is due to insulation itself, and the secondary one is due to the measures taken. The primary change is due to the use of a façade material other than the original, deepened window bays, new designs of windows, or a changed window size. In fact, in more than half of the investigated houses, a façade material other than the original has been used - mostly new building materials, such as corrugated sheet metal to replace the original plastered walls. The secondary changes, on the other hand, are alterations or changes in decorations, window frames, porches, entrance doors, or a change of roof material. It is stated that usually all the original decorations disappeared, as well as loft windows, etc., and that the façades were mostly impoverished. A change in colour is another very common secondary change. With new colours and materials, the houses tended to get a darker appearance. All the changes together often mean that, in the end, a completely new house is created which does not harmonize with the surrounding buildings.

There are many reasons why the energy-saving programme did not turn out favourably during the first three years. Among other things, the large scale technical construction measures, e.g. thermal insulation of the façades and window changes, often yielded very small energy savings. The reason why those measures had been carried out on such a large scale was the fact that many buildings badly needed an exterior restoration or renovation, and consequently, the house owners took advantage of the favourable loans and subsidies for thermal insulation.

The investigation carried out by the CBNA and the National Building Research Institute shows that simple and inexpensive measures, which ought to have been chosen in the first place or combined with thermal insulation, were seldom carried out. The necessity for façade maintenance was thus the primary reason for thermal insulation, while energy-saving was clearly secondary. House owners were ignorant about the construction of their houses and what actions were appropriate; this also resulted in the inappropriate routine use of measures and methods on quite different conditions. In general, the energy-conserving qualities of the older houses have been underestimated when the loan applications are made. It must be mentioned that the loan conditions merely for renewal and maintenance are very unfavourable in Sweden.

Another contributing factor to the unsatisfactory result of the energy-saving programme is that measures were taken without any detailed government regulations at all. The municipal surveying work, as part of the original energy-saving plan, did not start as rapidly as would have been desirable. This was due, in part, to a shortage of trained technicians. The municipal energy-saving planning has also been carried out in the communities at various levels of ambition.

In order to get an idea of how the cultural historical values had been handled within the municipal planning, the CBNA, in cooperation with the Swedish National Board of Physical Planning and Building, made a study using questionnaires in 1981. The purpose of the study was to visualize the forms of cooperation used between the county museums and the communities, in planning municipal energy-saving. The questionnaires showed that there is a lack of communication between the county museums and many communities. It was evident that many communities did not have a strong interest in collecting the basic material about culturally and historically valuable buildings needed for the planning, or they had not found the questions to be of great importance. Neither did many communities take advantage of the already existing material from previously made inventories.

THE PRESENT SITUATION

Among other things, the evaluations have resulted in a change of the loan and subsidy system. The subsidies have been abolished totally, because the accomplished energy-saving itself should be justifying the economic measures. Favourable loans, however, are still available for dwelling houses. Today, when the authorities are granting loans, the emphasis is on technical installation measures. Information campaigns are now directed mostly towards owners of multi-family houses, in order to stimulate measures within the big block houses. In Sweden, approximately 60% of all dwellings are multi-family houses.

Extensive research is carried out in the energy field. Among other things, large efforts are made to develop systems for alternative heating sources, such as solar energy, wind, peat and wood shavings. Sweden has large natural resources of peat and wood. There is no domestic oil of any importance and all oil is imported. For economic reasons, the reliance on oil now has to be reduced. During a transition period, the present electricity surplus can be used for heating purposes. This surplus of electricity is due to the development of nuclear power which is taking place. However, according to the referendum mentioned earlier, nuclear power is to be abandoned after 25 years. To reach that goal, the development of alternative energy sources has to be successful.

Finally, it can be concluded that the big changes in façades have now decreased, which is satisfying from a cultural historical point of view. However, there is a concern for the future. During the next decade, great efforts will be concentrated on the renewal and modernization of the dwelling stock. Many of the houses from the 1920's and 1930's have wall constructions which are insufficient for energy conservation, and the retrofitting of insulation to the façades has to be carried out. Some of these houses are interesting examples of early functionalism and most of them have plastered walls. It is very important, from the cultural historical aspect, that these houses be kept intact and not covered with corrugated sheet metal or other materials. Methods for additional insulation on such surfaces have been developed and have proven to be very good, but they cannot compete economically with the more inexpensive corrugated sheet metal.

In the case of the wooden houses,

the question of how to carry out effective sealings without changing the façade material creates a problem. In that area, supplementary research is needed in order to find suitable methods.

Last, but not least, the use of new energy sources, e.g. solar energy, etc., will affect the exterior of buildings in the future, and will thus conflict with the interest of preserving the cultural historical values.

As we see it, the work within the field of architectural heritage and energy-saving will, therefore, be a heavy duty for the responsible bodies for a long time ahead. The stress will have to be laid upon the bodies responsible for the architectural heritage to:

- be well informed,
- produce basic information about the older building stock,
- spread relevant information to the bodies responsible for other parts of the energy-saving programme,
- take part in training and education programmes and work out teaching aids,
- advise and inform the public about the value of the architectural heritage and how to maintain that value.

SUMMARY

Since the energy crisis in 1973, energy-saving has been one of the main political topics in Sweden.

In 1977, a political decision was made to cut down energy consumption by 48 TWh. within a ten-year period. A plan for how this goal should be obtained was presented. The results of the work, along the lines laid out, were to be evaluated after three years and then possibly be altered accordingly.

The report describes the plan and the effects it has led to during the period of 1977 to 1982, with a special focus on the consequences for the architectural heritage. The plan contains no coercive means. The political aim is to encourage house owners to improve their houses by favourable State subsidies and loans. The Minister, though, points out that approximately 30% of the existing building stock should be excluded from a measure that has an impact on its exterior. The question of information and giving advice has, therefore, become a major one for the bodies responsible for physical planning and building, as well as for the bodies responsible for architectural heritage.

Realization on the local level calls for planning programmes and giving direct advice. The communities, therefore, have the possibility of claiming financial subsidies for that purpose from the State.

The Central Board of National Antiquities has taken an active part in the work on a central leval and has also initiated work within its regional organization.

The report takes up the different tasks that have thus been handled, e.g.:

- preparatory work as a basis for political decisions and programme work,
- exchange of information and knowledge with other bodies in society tied to the energy-saving work,
- the working-out of guidelines and information, both for officials concerned and for the public,
- the building-up of a training and education network.

Furthermore, the report presents the evaluation of the first three years' work with the energy-saving plan.

It is stated there that extensive measures, such as thermal insulation and other construction work, are of lesser importance and that heavy emphasis has to be put on measures concerning heating and ventilation systems.

The impact of energy-saving measures on the architectural heritage has been studied in a special evaluation project, the results of which are presented in the report. This project clearly showed that measures, such as the thermal insulation of façades, change of windows and so on, had led, in most cases, to great changes in appearance of the houses.

The evaluation, as a whole, also clearly showed that most of the money spent during the three-year period had been used for measures that were, for technical and economic reasons, hardly defensible - the spur having instead mostly been to use favourable loans for improving the exterior.

Finally, the report describes the present-day situation, where it is possible to envisage a slightly altered goal. This might favour the architectural heritage. All the same, the authors conclude that the work has just begun and that the future will hold heavy duties within the energy-saving field for the bodies responsible for the architectural heritage.

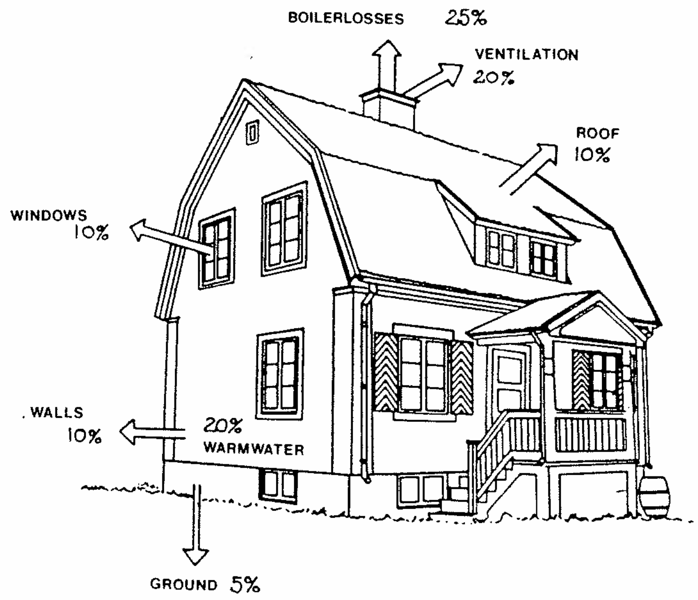

Fig. 1. Where heat is lost from buildings.

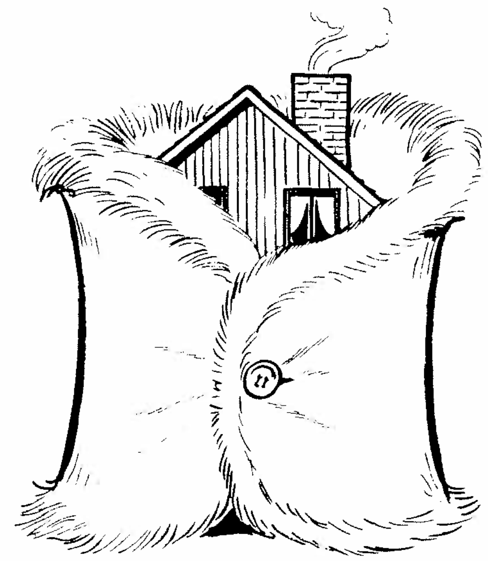

Fig. 2. Energy saving campaign information poster.

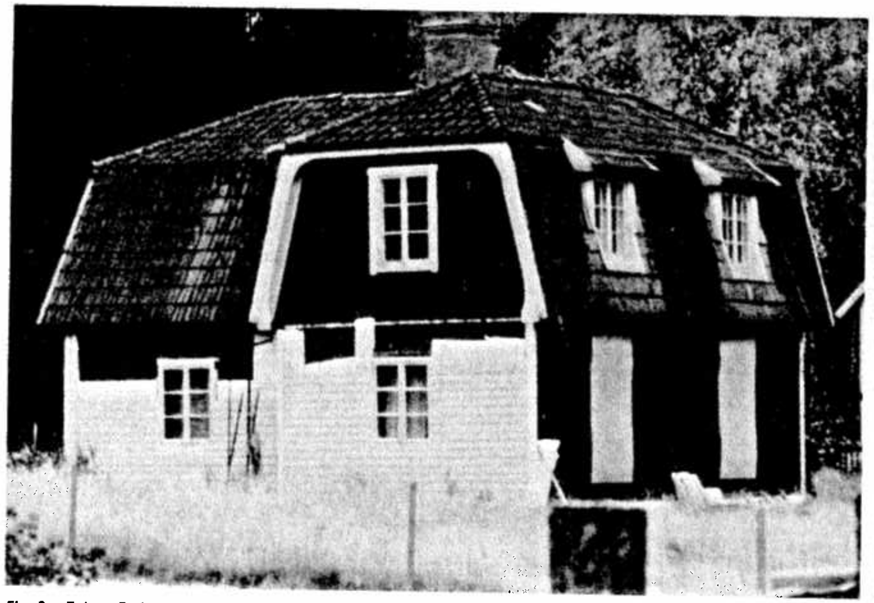

Fig. 3. Falum Red was the traditional exterior paint for wooden buildings in Sweden. The addition of new light coloured thermal insulation panels and new windows destroys the historical and aesthetic value of the building.

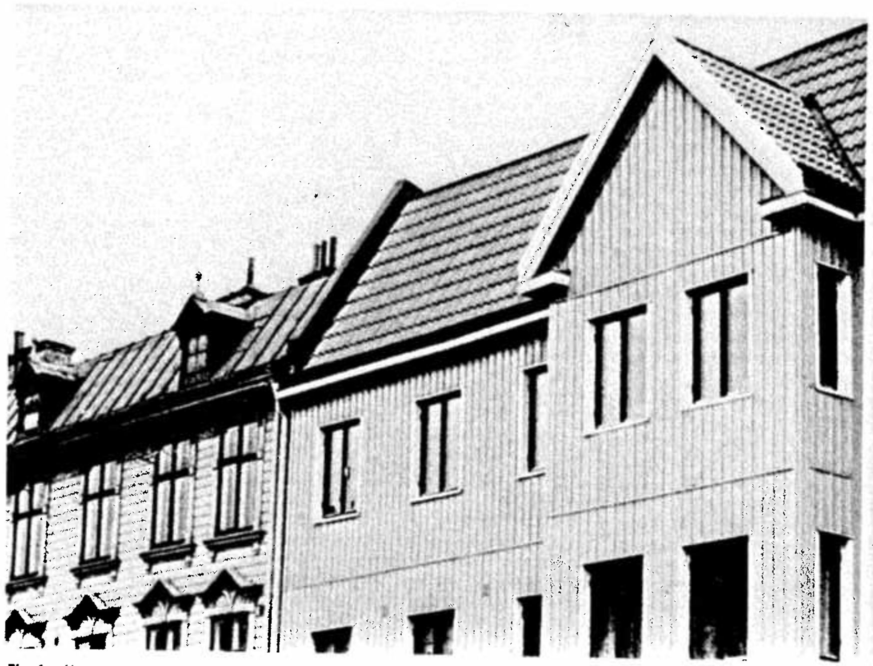

Fig. 4. New exterior insulation and new windows severely damage the building from a historical and aesthetic point of view. The two buildings in this picture originally had the same decorative elements.

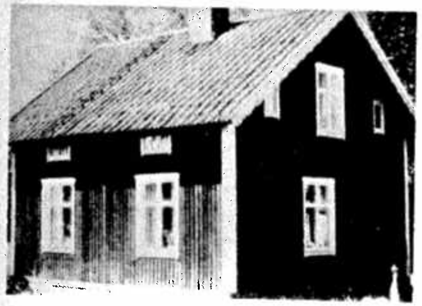

Fig. 5. Before thermal insulation siding application.

Fig. 6. After thermal insulation siding application.

Fig. 7. Original windows were often built flush with the facade.

Fig. 8. After the addition of thermal insulation, new windows are recessed.

Fig. 9. Replacement windows often change the character of a building. The lower windows are newly triple glazed.

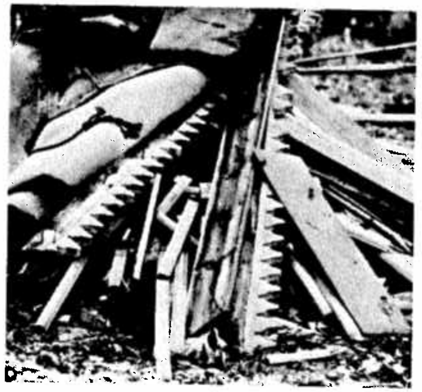

Fig. 10. While restoring the exterior of a building, old decorative details are often discarded.

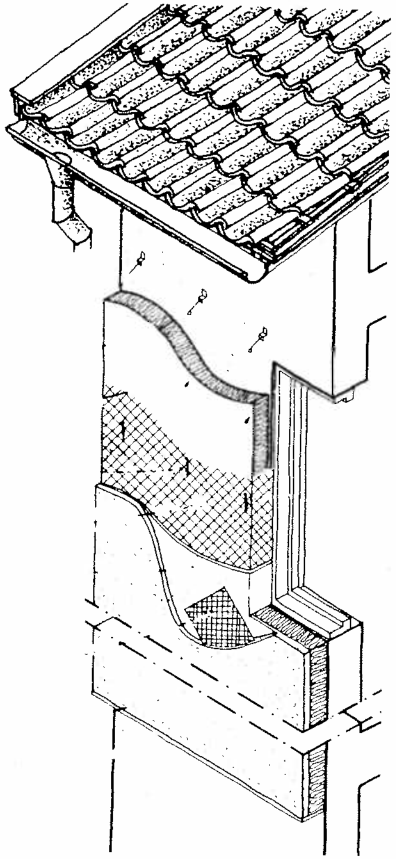

Fig. 11. Thermal insulation with plaster according to the Swedish Serporock method. Mineral Rock is attached to the wall with clasps and then plastered. The plastered mineral wool and the wall can then expand and contract independently.

Photo credits Fig. 3, 7, 8, 9, 10: O. Antell and C. Paves.

Photo credit Fig. 4: Möller.

Photo credits Fig. 5 and 6: The Museum of Architecture, Stockholm.

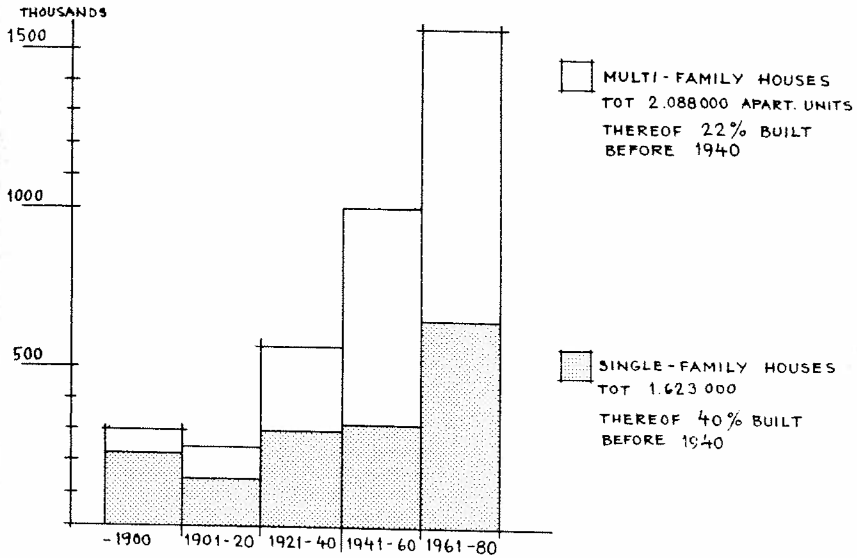

Diagram 1. Dwelling house stock — 1980.

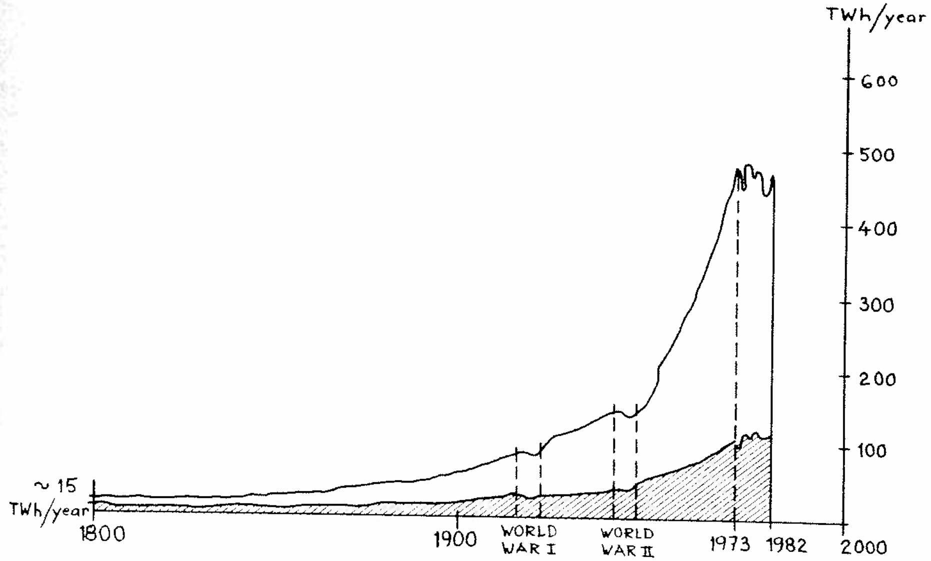

Diagram 2. Energy use in Sweden 1800-present.

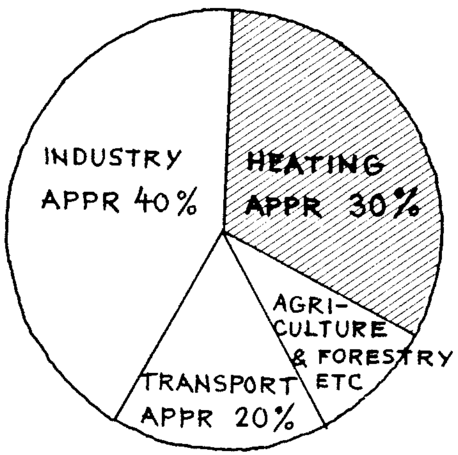

Diagram 3. Energy usage 1982.

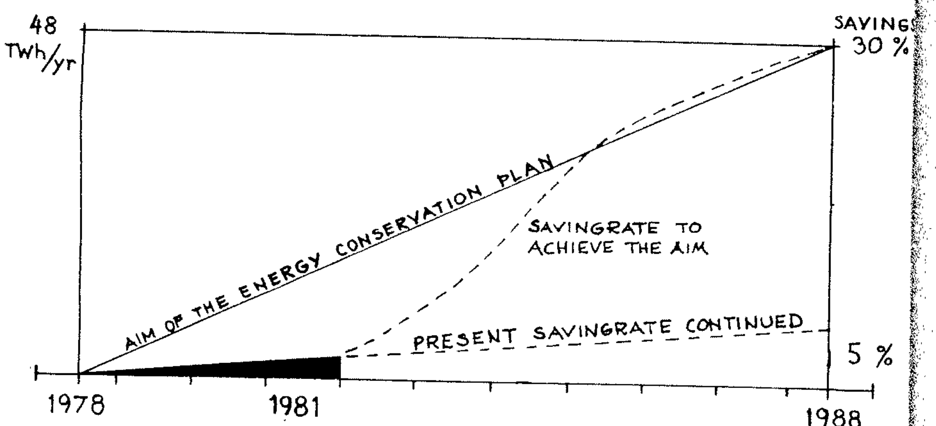

Diagram 4. Energy conservation plan: desired goal and actual result to date.

ABSTRACT

LES ECONOMIES D'ENERGIE: UNE MENACE POUR LE PATRIMOINE ARCHITECTURAL
L'EXPERIENCE SUEDOISE DES CINQ DERNIERES ANNEES

Kerstin Alexandersson et Christina Sandström

Depuis le début de la crise en 1973, les économies d'énergie ont été l'un des principaux thèmes politiques en Suède.

En 1977, une décision politique prônait la baisse considérable de la consommation d'énergie, sur dix ans. Un plan fut présenté à cet effet. Les résultats devaient être évalués après trois ans et des réajustements être faits en conséquence.

Le rapport décrit le plan et les effets qu'il a eus de 1977 à 1982 sur l'immobilier en général et spécifiquement sur le patrimoine architectural.

Le plan ne comportait pas de mesures coercitives mais simplement incitatives comme un encouragement sous forme de subsides ou de prêts aux propriétaires pour l'isolation des maisons. On avait prévu qu'approximativement 30% du parc de bâtiments anciens ne devraient pas être considérés par cette mesure qui aurait eu un impact négatif sur leur extérieur.

La question de diffusion d'informations et de conseils est apparue primordiale tant aux responsables de la planification et de la réalisation qu'à ceux préoccupés par la conservation du patrimoine architectural.

La réalisation au niveau local a exigé un effort de planification et de conseil des communautés qui ont eu à cette fin, la possibilité de réclamer des subsides de l'Etat.

Le rapport énumère les tâches qui ont été accomplies dont le recueil des données de base préliminaires aux décisions politiques et à la planification des projets:

- l'échange d'informations et de connaissances avec les corps intermédiaires et les bénéficiaires;
- la préparation et la diffusion de lignes directrices tant pour les autorités que pour le public;
- la création d'un réseau de formation et d'information.

Plus loin, le rapport présente l'évaluation faite après trois ans de ce plan de gain énergétique. La principale conclusion est que les mesures extensives comme les travaux d'isolation et de construction se sont révélés moins efficaces que les mesures légères, l'emphase doit être placée sur les mesures touchant notamment aux systèmes de chauffage et de ventilation.

L'impact de ce programme sur les bâtiments anciens a aussi été évalué. Il a été clairement démontré que les travaux tels l'isolation des murs de façade, les modifications aux fenêtres, ont profondément altéré l'apparence extérieure des bâtiments.

L'évaluation d'ensemble montre que les résultats justifient difficilement les dépenses engagées.

Enfin le rapport décrit la situation présente où on a réorienté l'objectif qui devrait favoriser la préservation de l'intégrité des maisons anciennes.

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THE SAVING OF WOOD IN THE BUILDING INDUSTRY AND ENERGY CONSERVATION IN FINLAND IN THE 18TH CENTURY

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Panu Kaila

"All this seems to become a little expensive, as it in fact becomes, but the expenses will be returned abundantly by a noticeable saving of firewood, most in the towns, where this is beginning to become expensive enough. A peasant, who thinks he has an infinite forest, does not care much of firewood, but he should also calculate to make his houses warm in this way, preferably because he can use his forest to something more useful than to begin to warm the whole wide air." **Simple thoughts of how wooden houses could be made very warm, with regard to floor, roof and walls.** (Eric Inberg, 1762).

THE CRISIS OF WOOD

The age of enlightenment in the 18th century meant development of new sciences in northern countries. By the side of theology and philosophy, natural sciences and so-called economical sciences arose. The period has been called the Era of Utility, the aim of the new sciences being particularly to promote the prosperity of the nation.

In this context, great attention was paid to the forests as a source of both energy and raw material.

"The forest is almost full of benefit, and poor is the country that has no forest." (Juvelius, 1747).

So much the worse when the forests were generally found to be in a state of decay and misuse. In many academic essays, an alarm was sounded to save the forests; and laws and directions were prescribed to control their use. A sort of energy crisis shadowed the consumers of wood, the newborn industry and the building trade.

THE REASONS FOR THE CRISIS

There were several reasons for this situation. Agriculture, especially in wooded regions, was based on slashing and burning the woodland. The burnt field was used at the most for four years, and then a new patch of woodland was cleared and burned. The Swedish government (Finland was part of Sweden until 1809) made several efforts to limit this wood-consuming type of agriculture.

Secondly, the forests were burned to gain wood-tar*, which since the 17th century had been one of the most important export articles. The means for transport were so undeveloped that the only way to make money out of far-away forests was to burn them into tar. According to an excellent study by Eric Juvelius in 1747, the annual tar production of Ostrobothnia (in western Finland) was estimated to be ten million litres. Two litres of tar could be gained from one trunk (only the root-end was used; it was barked several years in advance to produce resin). Thus the annual consumption of forest was 6000 hectares, only in this part of the country! Alarmed by this information, the government prescribed regulations for the production of tar.

The development of industry was just starting at the time. Ironworks and glassworks were based on the plentiful supply of firewood. The inhabitants of towns sometimes opposed the industry. In Uusikaupunki, for example, in 1682, the new glassworks was ordered to be moved outside the town because it had caused the price of firewood in the town to rise.

In Finland, the new stove with a chimney was just replacing the old smoke oven. In smoke cabins, all the heat of a fire was effectively used, while the new stove rarely had a chimney shutter and most of the heat escaped out through the chimney.

THE BUILDING OF HOUSES

The 18th century building industry was another great consumer of the forest, and it suffered rapidly from the shortage of mature large-sized material. In several studies, the normal way of building was found to be careless, not durable and wasteful. Yet, the great amount of houses of bad quality decayed and disappeared long ago, while only the best ones still remain. This is why we often have the wrong idea that all the old buildings were of high quality.

* also known as Stockholm tar (Editor's note)

In Arnäs, Sweden, there is a building which King Gustavus Wasa visited in the early 16th century, "where the timber is still today as hard and good as the best which is felled today, and so it seems to be able to stand without decay for another few centuries. In contrast to this, we have noticed that buildings constructed 60 or 70 years ago are already so decayed, that more money is needed for their reparation, than for building new ones." (Polhem, 1739).

Descriptions of even worse situations can be found in the records of inspections of parsonages: a building of 12, 20 or 30 years of age is already unfit for living, and rapid action is needed to rescue it from total downfall.

The measures which were taken in this situation were rather similar to those of today, for instance, an active search for new resources of energy (like coal) in Sweden. The following aims were set for the building industry:

- developing more effective and less wood-consuming heating equipment,
- economizing on energy through better construction of new buildings and energy conservation in old buildings,
- economizing on building material through better and more durable construction.

STONE BUILDINGS

Another means of saving wood was the propaganda for stone buildings. Orders were given that the buildings owned by the state and by the state church had to be constructed of fire-proof materials. (Disastrous fires were also a severe problem with wooden buildings.) A law was passed in 1752 that all military residences had to be built of fire-proof material - this was cancelled twenty years later as it was impossible to realize. Another statute against wooden churches was given in 1776 with as little success.

The same recommendation applied to parsonages - in Finland, only three were made out of brick and one out of earth. Above the main entrance of one of them, Maaria parsonage (1787), there is an inscription typical of the time: "A model for saving forest, the wealth of the country."

At the same time in Kaarlela, pastor and economist Andreas Chydenius was rewarded a lifelong exemption from taxes after he had built an economical building of stone for his parsonage. This shows how much more expensive it was to build of brick than of wood, and why the brick was used so little.

SCIENTIFIC STUDIES

In 1739, the Academy of Science was founded in Sweden to publish studies on economical and practical subjects. These papers were often concerned with energy problems and the building trade.

The fundamental article was published in the Treatises of the Academy of Science in 1739 by "Councilor of Commerce and Directeur Mecanices", Kristofer Polhem: 'Reflections about building.' The basic requirements for a good building, according to Polhem, are durability, warmth and clean healthy air. The latter two features are central objects of interest also in discussions today. The aim of saving heating energy has resulted in large scale energy conservation. The worsened quality of indoor air caused by it is one of the main problems.

The same themes were treated in academical essays at the University of Turku in Finland: 'Simple thoughts of how wooden houses could be made very warm, with regard to floor, roof and walls, 1762' (with a special chapter for energy conservation in old buildings) by Eric Inberg, and 'Notes of the building of durable wooden houses, 1775' by Johan Tennberg. These are the principal works that I shall now study in detail.

FOUNDATIONS AND FLOORS

"However warm and weather-tight a house is in the beginning, if it is standing on a treacherous foundation, then inevitably there will appear all kinds of openings and cracks so that the best warmth will find its way out." (Inberg, 1762).

The foundations ought to be laid at the depth of 90 cm. to avoid frost (the actual depth of frost in Finland is 150 to 250 cm.) Usually, the depth was only 15 to 20 cm. and the corner stones were easily removed by the frost. In soft places, strong wooden poles should be driven into the ground.

"It is also important to dig the foundations deep to avoid mice that will carry away the moss filling. Also the ditch along the foundation wall must be filled with densely packed small stones and quicklime.

"The height of a foundation wall must be at least 30 cms. above the ground level, still better if it is 60 to 90 cms. Then rainwater falling from the roof onto the ground can not sprinkle on the sill beam and make it rot. Also, it would be healthier to live a little above the ground, and even the **'prospect'** would be better.

"The earthen filling against the sill beams inside the house ought to consist of small stones, gravel, quicklime and sand. Smashed glass is also mixed in it to avoid mice. The floor planks should be loose along the walls, to make it possible to inspect and improve the filling below.

"It often happens that when a house is built on wet ground, the floor will have fungi and vermin, as well as plenty of dampness. This will not only produce unhealthy air, but often even wallpapers fall off and rot.

"This can be avoided in two ways:

1. some barrels of lime will be spread out on the ground, more along the foundation walls and less in the middle,
2. if there is plenty of good timber available, good pine timber, one can build a double floor with filling of quicklime and gravel, but in that case, the foundation wall should be built with no mortar at all to enable good ventilation underneath the floor and avoid house rot. The space below the floor must be at least 30 cms." (Inberg, 1762).

In the middle of the 19th century, a double floor with high foundation walls and no earthwork gradually replaced the old construction. The ventilated space below the floor became colder when the earthwork was not used any more. At this time, the price of rags went down, because wood pulp was used as raw material for paper, and carpets made of old clothes became popular. During the winter, the whole floor area was covered with such 'rag-carpets' to make it warmer.

Airtightness was considered to be the most important feature in the construction of a warm floor.

"For the warmth, as well as for the strength of floor, it is most advisable to do as in foreign countries: to carve a groove along the sides of all floor planks with an axe, and place there lengthwise a tongue made of small rods wrapped with rope of straw. Then it is hewn so tightly together that no warmth can escape nor any coldness enter." (Polhem, 1739).

I have found a floor construction with rope of straw between the planks only in threshing houses to stop grain from falling out through the floor. In houses, a wooden tongue is usual.

WALLS

When considering the warmth of a building, no attention was paid to the thickness of an insulating material, but only to the airtightness. The timbers of the walls were supposed to have reasonable thickness only to make a deep enough groove for the moss filling and thus prevent the draught. Polhem recommends 10 cm. as minimum width of the groove. As the log should be twice the width of the groove, this means that the log ought to be 20 cm. thick.

Mature pine timber is the best material for wall construction; when pine is not available, spruce will also do. Tennberg recommends at least the three lowest timbers and window sills should be made of pine. He also says that all timber ought to be felled late in the autumn, before the ground freezes. J. Nillman, carpenter, in his article, 'To preserve wooden houses from rot', published in **Household Journal** in 1778, recommends the months of January and February as the correct time for felling trees. He also says that the northern side of the logs should be marked, so that the side that is more dense and has less branches could be placed outwards on the façade.

In several of the essays, it was considered important that the house must be built at first without moss filling, so that the workmen could not hide their bad work, but all joints were visible for inspection.

On the outside, a tight weatherboarding with a layer of birch bark underneath was used, at least on the corners of a house. In this way, a really effective wind-proofing was achieved, and even today, this is found to be of great importance for the warmth of a house. The tradition went on in the 19th century, and when the production of bitumen paper was begun in Finland in the 1870's, it replaced the birch bark. Ventilated weatherboarding, which has little effect as extra insulation, became popular only in the 1950's, when the modern plastic paints started peeling off as moisture travelled through the wall from the inside.

"If one wishes to have his house still more warm, the openings and joints of the walls ought to be sealed with rag-paper or with paper made of sawdust. Old used letters will do in two layers. Also, linen cloth can be used, as well as many other materials.....

"The joints are first filled with wooden sticks or lime plaster mixed with cowhair. The plaster will attach on the wood better, if one nails wooden shoe-pins along both sides of the joint.

"He who can afford it may cover the whole wall with paper, but stripes on every joint will do almost as well, although it does not look so nice.

"The paste glue is made not only of glue water and rye flour, but some wormwood, tobacco or other bad-tasting plant or snuff should be mixed in it to keep away moths and rats.

"If one has poor health and feels ill from the slightest cold, one can build panelling on all the walls and then cover it with rag-paper which will stick very tightly on the smooth boards. In this way, one can close out almost all air, and if one wishes, one can let a painter decorate the walls with anything one considers as beautiful." (Inberg, 1762).

CEILINGS

"The ceiling should be at a height of 240 cm. from the floor, and even 270 cm. will do no harm. Someone could well think that the best warmth will then stay up under the ceiling, and the floor will yet be cold - but, although there can be most of the warmth, it is not the best. Much of it is breathed air, vapours, etc., especially when there are many people in the room. Smoke from candles, especially when they are made of lesser quality tallow and the wicks are too thick, make a low room stuffy.

"Flat ceilings are better than sloping three-folded ones, because the filling stays better on them.

"From experience, it is known that if the ceiling is not tight, the warmth will escape most quickly, and rats and mice will enjoy living there because of the warmth. Therefore, it is better, if one can afford it, to cover the filling of moss not with sand or earth, but with a layer of gravel and quicklime (15 to 20 cm.), well packed together. Instead of quicklime, one can use sawdust from a water sawmill, if there is one in the neighbourhood. This filling does not only make the rooms warm, but the fresh smell of wood makes it impossible for the mice to live in it.

"If the ceiling is covered with paper like the walls, one does not need such a thick filling of sand or earth, which often makes the beams bend." (Inberg, 1762).

WINDOWS

The size of a normal window grew during the 18th century from about 50 x 110 cm., to about 150 x 120 cm. The size of a glass pane grew from 15 x 10 cm., to 55 x 50 cm. A glazed window was a sign of a high standard of living. Well-lit rooms meant luxury that was sought after, at a time when most people were still living in dark smoke cabins. It was not taken into account that big windows meant loss of energy. Today the size of window is limited through regulations to save energy (to 10 to 12% of the floor area).

"He who can afford to provide double glazing, at least on the northern face, will lose less warmth, but they make the room somewhat darker. Glazing fixed with putty will seal the warmth better than that with lead glazing bars." (Inberg, 1762).

The Finnish glass industry had a period of rapid progress in the 1780's. From that time on, double-glazing became popular, and almost every new house had double-glazing by the 1850's. The inner glass was always a loose one, used only during the wintertime.

German-born Carl Ludwig Engel, the most famous Neo-Classical architect in Finland, wrote an essay which was published in Berlin in 1821: 'Guide for building a Russian heating stove, and notes about means used in Russia for insulating houses against cold." (Finland was a part of Russia from 1809 to 1917.)

"If we had double glazing [in Germany] in general use like here in the North, so it would not be necessary for so many families to restrict their heating only to one or two rooms in wintertime in order to save on expensive firewood or other fuel." (Engel, 1821).

Since 1978, Finnish building regulations have required triple glazing, and quadruple glazing is already generally used.

"The gap between window and door frames and the log wall must be well packed with moss, and it must be done carefully so that no bigger or minor slits are left. To be more sure one can quite well glue rag-paper on the joint. This will be hidden by the covering boards.

"It is self-evident that windows are packed and sealed all around with paper and paste glue during the winter." (Inberg, 1762).

The habit of sealing windows with paper for the winter is still to some extent alive in Finland, and a special white sealing paper is available in the shops for the purpose. In a test made by the Technical Research Centre of Finland in 1981 with old windows, it was found out that sealing with paper will result in practically perfect wind-tightness. No modern industrial sealing ribbon of plastic is as effective. In windows, wind-tightness is the most important factor in saving energy. When this can be reached with simple and inexpensive sealing paper, there is no reason to change old windows into modern triple or quadruple windows.

HEATING STOVES

In order to save firewood, it was essential to invent an efficient fireplace. In the beginning of the 18th century, the heating stoves were not much better than a continental fireplace. "When there is a fire in the fireplace, one can see the point of flame coming out of the chimney on the roof, and it is unnecessary to heat the wide air." (Nordenberg, 1739).

The model drawing of a heating stove for military residences shows inside the stove two or three shelves or grates with stones to store some heat. One of the first inventors, Anders Johan Nordenberg, published in 1739, 'Advice on tiled heating stoves and their construction.' There he presents basically the same construction, only with more shelves inside.

Finally, in 1767, the Swedish government ordered architect Carl Johan Cronstedt and General Fabian Wrede to construct an energy-saving heating stove. In the same year, these men presented the results. Inside the stove, there was a clever system of flues, where the smoke was forced to travel up and down and heat was stored in the brick walls of the flues.

The type was published in book form in 1775: 'Collection of designs for different heating stoves intended to save firewood.' The stove became very popular both in Sweden and in Finland. In fact, it has remained basically unchanged until our day.

In the 1820's, C.L. Engel designed stoves for military barracks with a faster heating effect by forming separated flues to heat room-air through the body of the stove.

The stove with several flues has an excellent warming capacity and it cools very slowly. This is what made the Northern countries famous for their warm rooms. When a Finnish officer, Gustaf Mauritz Armfelt, was minister in Naples in the 1790's, he ordered, after his first winter there, the drawings of a tiled heating stove from Sweden to let an Italian mason put it up for him.

ENERGY CONSERVATION

"If one has an old house with good and stable foundations, with no rot in the sill beam, walls in good condition and corners with weatherboarding, but the house is yet cold and untight, it would be too expensive to pull it down and build a new one." (Inberg, 1762).

Here the approach to old building is only practical and economical. No attention is paid to architectural, psychological or historical values (although there were buildings preserved as historical monuments, e.g. the house in Arnäs). When the building industry was slowly developing according to local craft traditions and local materials, these values were not threatened.

"To find the places where the heat is leaking out, one should inspect with a burning candle or shingle every single opening and slit in floor, ceiling and walls. This is done when there is a fire in the stove, and preferably when it is windy outside." Turning of the candle flame indicates draught.

Suggested repairs according to Inberg:

1. The floor should be opened along the walls. If the moss filling is sagging, it should be filled again with lime gravel, sand or some other suitable material.
2. If a draught is discovered around doors and windows, the board should be loosened and the gap packed with moss.
3. The joints between logs in walls should be packed with moss both inside and outside.
4. The openings in the ceiling boardings should be closed with rag-paper or sawdust-paper. This must be done during summer when the boards are dry.
5. To be absolutely sure of the walls, they too should be covered with paper, as well as the joints of door- and window frames.

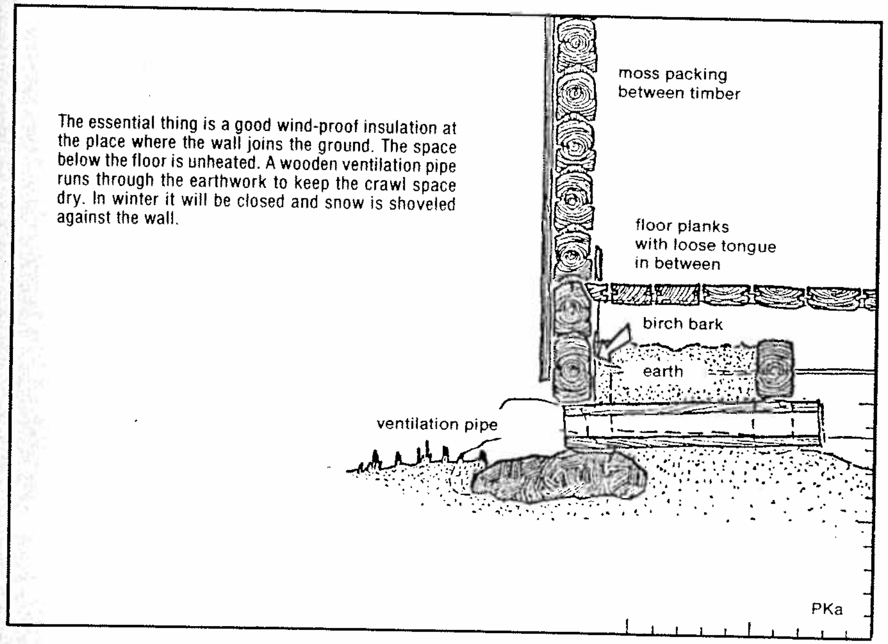


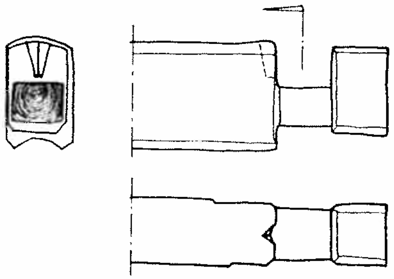
Fig. 1. The floor construction of an 18th century house at Jakkarila manor, Porvoo.

Fig. 2. The floor filling in the Academy of Turku at the turn of the 19th century. Below are the lower planks of the double floor, then a layer of birch bark for windproofing, then moss, then a layer of gravel, a layer of sand and a layer of quicklime to keep out mice.

Fig. 3. A wind-proof wall from outside. The logs are well packed with oakum, with birch bark in double layers, and a tight weatherboarding overall. Degero manor, 1818.

Fig. 4. A wind-proof wall from the inside. Thick grey rag-paper is pasted on the wall. Below only the joints of logs are sealed with pages torn from old books and journals.
Kaskinen.

Fig. 5. The joints of logs are filled with wooden sticks. An arrow points at a wooden pin which nails the stick onto the wall. Nails made of iron were too expensive.
Kronoby parsonage, 1794.



Timber with moss-hole. Lappeenranta.

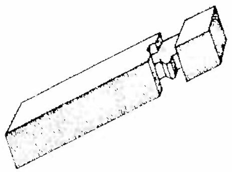


Fig. 6 and 7. A moss hole was criticized by Polhem: "mice will carry away moss and the corner becomes windy." Polhem designed a joint, below, which will become tighter as the logs dry.

Fig. 8. It was very usual to plaster the walls inside especially in sleeping rooms to make them warmer. The plaster was generally made of earth mixed with straw like in this picture. Chaff, shives and manure were also used, and saw dust. The plaster was painted with distemper.
Bodom manor.

Fig. 9. The tradition goes on. The walls are covered with newspapers from 1890. The window is typical of the mid 18th century.
Piintilä manor.

Fig. 10. The heating stove designed by A.J. Nordenberg in 1739. Development of the old type.

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ABSTRACT

L'ECONOMIE DE BOIS DANS LA CONSTRUCTION ET LE CHAUFFAGE EN FINLANDE AU XVIIIe SIECLE

Panu Kaila

La crise du bois, identique à celle de l'énergie, a déjà secoué au XVIIIe siècle les consommateurs, l'industrie naissante et le marché immobilier en Finlande.

Au XVIIIe siècle, le gouvernement suédois a tenté de limiter les effets réfastes du déboisement et du brûlage dus à l'expansion de l'agriculture et à la production du charbon de bois.

Au XVIIIe siècle, l'industrie de la construction était déjà une autre grande consommatrice de forêts et on a appliqué ultérieusement plusieurs moyens pour diminuer la consommation de bois.

A partir de 1739, l'Académie des sciences de la Suède a publié plusieurs études sur les méthodes de construction et les moyens d'économiser l'énergie. Un essai d'Eric Inberg (1762) et des notes de Johan Tennberg (1755), traitant de la construction en bois, sont ensuite présentés en détail et forment la base de la présentation de l'auteur. Il traite, en référence à ces auteurs, des fondations et des planchers, des murs, des plafonds, des fenêtres, des poêles à bois, et de la conservation de l'énergie.

PANU KAILA was born in Helsinki, Finland in 1939, and studied at the Institute of Technology in Helsinki from 1959 to 1967, at which time he received his Diploma in architecture. Since 1971, he has worked as an architect for the National Board of Antiquities and Historical Monuments in Helsinki. He has also lectured widely on wooden architecture and its restoration at such institutions as Tampere University (1976-), Helsinki Institute of Technology (1980-), ICCROM in Rome (1980-). His professional memberships include the ICOMOS Wood Committee, as well as the ICOMOS Committee of Vernacular Architecture. Among his publications are articles and books concerned with traditional building methods, vernacular architecture and the maintenance of wooden structures.

THERMAL UPGRADING OF OLDER WOODEN STRUCTURES

Allen Penney 22399

This is a large subject, and so I am going to concentrate on three aspects which have become important in the past few years in Eastern Canada. I believe them to be universal issues and important enough to discuss at this meeting. In giving them titles, I have simply called them: Philosophy, Economy and Technology.

Much thermal upgrading has been carried out on existing buildings without adequate planning or proper advice and with poor or bad designs. In some cases, the building has been damaged or had its life shortened. In some cases, the cost of fuel has been saved, but the overall cost of building maintenance has been increased.

There is an abundance of published information on how to insulate existing buildings - from manufacturers, installers, private consultants, professionals and all levels of government. Some is good, some is simply incorrect.

In this paper, there are intentionally more questions than answers, although the answers are easy enough to find. I see my job as one of raising basic issues, rather than supplying architecturally detailed solutions.

Having been asked by a University for advice on thermal upgrading a number of old houses used by different departments, I pointed out that door closers on exterior doors would effect a considerable reduction in fuel costs, as students always seem to leave doors open. Insulation was not a primary measure in this case, but a secondary one.

This discussion will not include:
- heating equipment efficiency,
- multiple glazing,
- zoning and zone controls,
- time controls,
- closing off a part of a building in winter,
- draught seals,
- changing lifestyle, e.g. getting rid of the dog to save opening the door,
- heat exchangers or heat pumps.

These things are unlikely to cause radical damage to the basic older wooden buildings.

Far more dangerous, if carelessly installed, is thermal insulation. Thermal upgrading is a rational subject and need not be a worry, but due to a number of building failures, it is of considerable concern in Eastern Canada. In using the headings of Philosophy, Economy and Technology, I wish to demonstrate that this complex subject can be approached.

The main issues here are the nature of the problem, the use of the building, the degree to which the thermal performance can be changed and still be acceptable, and strategies for upgrading.

When old buildings were new, the attitudes to thermal comfort were different from ours, and the means of achieving it were also different. Tolerance of temperature variations and thickness of clothing reduced the need for the building to be heavily insulated, or more probably were direct responses to buildings which were built with much less thermal insulation.

Many older buildings have larger or higher rooms, which reflect a period when personal thermal comfort was less important than style or scale. Thermal comfort for today's standards is thus harder to achieve in substantially larger building volumes, with increased surface areas. Both size and thermal resistance are commonly used to control thermal losses in new buildings, and therefore older buildings with large surfaces, proportionately larger openings and often with a quality of detail and trim which is important to the character of the building, pose a very difficult problem for thermal upgrading, if the integrity of the design is to be maintained.

The use of the building may have a fundamental bearing on the approach taken. A monument may not need to be thermally changed in its fabric. It may either be heated, with a 'money-no-object' attitude, or else may be left unheated and unused, but more importantly undamaged, to retain its historic integrity. This is easier in a mild climate than in a more rigorous one, but even in Eastern Canada, many buildings have lasted many years in spite of being closed and not maintained. It may be preferable to keep the monument unaltered and carefully monitor it, but not expect to use it with any sense of thermal comfort.

If a building falls into the museum category, it may be required to be open for inspection in the summer, but can be left with well-reduced heating for the winter. If thermal upgrading is required, it must be invisible, and the integrity of the structure must not be destroyed.

If the building is to be used as a house, then convenience and comfort must be balanced against the old style; light, heat, power, sanitation, security and colour TV are all required with the minimum of alteration to the older building. In Eastern Canada, there are now many buildings with rather violent external changes, let alone the dramatic internal changes caused by the removal of internal walls, installation of thermally efficient windows and heating systems. Many older buildings retain only the historic shell; the rest is modern construction.

How far one can go and still maintain the integrity of the older building varies widely, but surely the interior has something to say, as well as the exterior.

If the external cladding is to be replaced, it can cover up extensive modification of the wall without damaging trim or interiors, with thermal insulation installed from the exterior. In Halifax, Nova Scotia, the Hydrostone houses, built to replace homes destroyed in the 1917 explosion, received their name from the wall material used in their construction. During the past five years, a large number of these houses have been clad in vinyl siding, which covers over the material from which the name is derived. The dilemma of the owner can be appreciated, but the piecemeal approach can hardly be applauded, as adjacent row houses are clad in different materials, patterns, colours and textures. Although the siding background provides some thermal improvement, it is not valuable insulation.

A derelict or near-derelict house may suggest a radical rebuilding inside, as all interior finishes need to be replaced. In these circumstances, the thermal insulation can be installed from the interior, together with a proper vapour barrier and modern services.

If authentic reconstruction is required, as at Fortress Louisbourg in Cape Breton Island, the insertion of a modern material, such as foam plastic insulation, is obviously ridiculous. Integrity demands that modern materials not be used, even if hidden within a wall. Here lies another problem of the 'authentic' reconstruction. By nature, it's a fake, but at what point is it useless pretending? If a building failure is the inevitable result of a reconstruction carried out with poor materials of an historically authentic type, we find ourselves back in a cycle which would ultimately have led to the building being destroyed initially, or else to a permanent heavy maintenance cost.

Do we have a strategy and is it wisely considered? Do we keep the outer form, but totally remodel the interior for 'energy crisis' comfort standards inside? Where do we draw the line between restoration and rebuilding?

Can we achieve thermal efficiency without destroying the very thing we are trying to preserve? A solid stone wall with exposed surfaces on both sides cannot be thermally efficient. In a museum building, it has to be left alone. It is technically possible to replace it with a reinforced concrete wall and a layer of insulation with reinstated veneers of stone on both sides, but is this reasonable? Can we upgrade without it showing, and can we upgrade safely, ensuring an adequate vapour barrier?

Do we start with a philosophy? Are we careful to weigh the options, integrity versus cost, short term or long term results, or social responsibility? Do we bow to political pressure or speak only after the damage has been done?

In Eastern Canada, there is now evidence to show we are making some very bad mistakes.

How much insulation can be justified? How do heat loss, design temperatures and the amount of thermal insulation influence cost, both initial and long term?

In deciding how much insulation is justifiable, there are a number of factors. The most important of these is the cost of oil. In 1969, the cost of oil was $1.10/bbl., and ten years later it was $28.00/bbl. Since 1979, it has risen to $34.00/bbl., and has now dropped a bit. Cartels, wars,

high technology solutions - like North Sea recovery - have all contributed to a guessing game, as far as oil prices are concerned. As with the price of gold, which is now one-third of what it was a year ago, we have no reliable base for deciding on investment. How much insulation is reasonable, depends upon the price of oil.

Even if we base our guess on present-day oil prices, the interest on the cost of the insulation may also fluctuate, to change our results. It is, therefore, right to make the best informed judgments possible, but also to assume that they will only be informed guesses, and that nobody alive can predict a correct amount of insulation. If we assume the lifetime of a building to be no more than 25 years if built new, then when considering insulation in an older building, we have a further problem of judgment.

But who can determine true cost? To one person - say, a developer - a derelict building (once a house, then a garage, now a disused garage) may be of no value; whereas to the historian, if it's in Pictou, Nova Scotia and is the Deacon Patterson house, it has immense value as the oldest extant building in the town, even though it's not much to look at.

The economics can only be guessed at, but in design, it is possible to be quite accurate in determining fabric heat loss. Much valuable data have been collected on insulation systems, and therefore, it is possible to predict relative proportions of heat loss. In an uninsulated single storey Canadian house, half of the heat loss is through the ceiling. What is not generally understood is that the insulation value of the solid concrete foundation wall is little better than a single sheet of glass. As thermal resistance through the fabric increases, so the proportion of heat loss, due to air exchange, increases. This generates a number of problems for the building user. If ventilation is reduced, there may be an odour problem. If moisture is retained, there may be excessive condensation problems. Ultimately, thermal requirements may affect lifestyle and certainly dress. Air locks and zoned temperatures may become important again, as the latter were a hundred years ago.

But given the constraints of a required building volume, what can we do? Certainly, we need to recognize how extravagance occurs. Compact forms are less energy-expensive than rambling ones, smaller openings than larger ones, and so on. Orientation, colour, texture, shading, topography and siting can all dramatically influence heat loss. There are no simple answers, except that no insulation is likely to be very costly in comparison to other valuations of site or building.

So how do we achieve more thermal resistance in an older building? As has previously been suggested, the insulation may be added from the outside or the inside, and may be more important in one area than another. Further variety can be introduced when we consider the range of insulation materials and the best ways to install them. Although much information is available on the materials, there is not a lot on the potential problems of thermal upgrading on existing buildings.

The most commonly used Canadian insulation materials for older buildings are blown-in mineral wool or cellulose fibre, or else cavity-foamed plastics. Insulation materials range from rigid and brittle to flexible and, ultimately, to loose particles. In all cases, the insulation can be guaranteed to have certain properties, but in every case, the person who installs it may change, or even completely eliminate, its potential for energy-saving. Costs vary for the basic insulation material and also for the installation.

Installation from outside can be justified if the exterior cladding has to be replaced, and from the inside if the interior finishes are damaged. If both are in good condition, it may be wise to insulate from the exterior, while taking into account the necessary damage. Otherwise, internal trim around doors and windows may require removal, with some attendant damage.

Various devices can check whether there is insulation in the wall. Typically, infra-red thermography is used to determine the amount of heat emitted from the wall surface. It is a non-destructive test, but needs careful interpretation, as heat loss can be by air or water migration, as well as a lack of insulation.

Where the insulation is required may determine its type and installation method. A hollow wall may be filled or a solid wall added to. Roof insulation is probably the most effective and the easiest to install, except where the roof structure is exposed internally. Floors are similar, though here the vapour barrier is more difficult to achieve. Basement walls are probably the most difficult, with external rigid and waterproof insulation being the recent best, but possibly already superceded by a slightly porous insulation which permits water to drain through its surface.

The number of solutions is very large, and here professional advice is probably most valuable.

Performance of the materials must be considered separately from that of the operative who installs them.

All foam plastics shrink upon manufacture, which is the nature of the material. Porous and permeable materials will absorb moisture. Soft materials will compact under vibration or pressure. These qualities must be considered when selecting an insulation.

Operative performance is equally important. Unfortunately, many operatives are trained on the job. Not all are honest. In some cases where the extent of insulation has been exposed by later removal of the internal wall surface, voids of up to 50% of the wall cavity have been found. The high proportion of bankruptcies among insulation contractors leaves building owners with few safeguards.

There are no easy alternatives to meticulous research into the proper insulation material and application, and then paying good craftsmen to install it.

Some secondary issues may become significant. Not every wall in the same house necessarily has the same construction. Solid and stud walls exist in the same building and not always due to alterations. A careful survey is required, especially in older buildings.

Another secondary issue is moisture. Thermal upgrading permits an increase in temperature, which permits an increase in the moisture capacity of the air. Excess moisture will condense on the coolest spots, e.g. windows, where it may cause rot in sills, and under roof sheathing, where it may cause rot of the boarding and even of the rafters. Fungal growth and wet staining problems are assisted in these cases.

Yet another secondary issue is the potential increase in the surface temperatures of sun-facing walls and roofs. If a dark paint is used and there is moisture present in the sheathing or cladding, sufficient heat is generated to cause paint to blister.

Adequate ventilation is required to ensure an escape route for the moisture. Roofs of new buildings, such as a house and a swimming pool, were each rebuilt after eight years, having failed basically because of moisture problems and a lack of ventilation.

In one illustration, the insulation was shown installed backwards, with the vapour barrier on the cold side; there was an uninsulated heating duct on the cold side of the wall, but as the floor was not insulated, the insulated wall was rendered ineffective. All rather silly! This was in a museum building in Nova Scotia.

In conclusion, it is important that philosophy, economy and technology be in balance. Illustrations were intended to shock, at least enough to encourage care. Unfortunately, the energy crisis of the late 1970's has caused a succession of panic solutions by both politicians and those who own, or have responsibility for, older buildings. We need to learn to respect our individual climates and make our buildings work properly.

Pessimism is possible, because in Canada 40 years ago, a material called 'Insulbrick', a fibreboard backing with an imitation brick facing of asphalted felt, had widespread use and caused widespread problems. It put the vapour barrier on the outside, and generated rot behind in the wooden buildings to which it was applied.

History does not have to be repeated. May we learn to upgrade the thermal qualities in our older wooden buildings by looking at the past and the present mistakes, but this time do the job correctly? If we don't, who will?

Fig. 1. A derelict interior is suitable for insulating from within. A house at Colby Village, N.S.

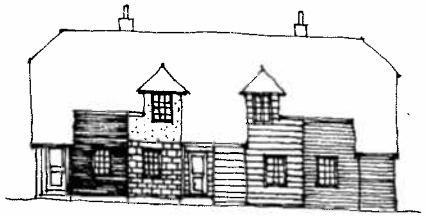

Fig. 2. 'Hydro-stone' houses in Halifax, N.S. with individual owners making cladding decisions in isolation. The original finish is the second from the left, stucco over concrete block.

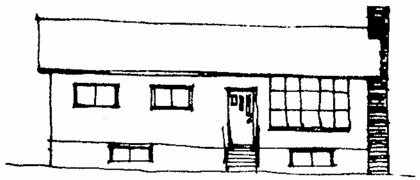

Fig. 3. An un-insulated Canadian bungalow loses about 50% of its heat through the ceiling and 14% through the basement wall. Insulated to 1976 standards it would use about 30% of the fuel and lose 11% of its heat through the ceiling and 31% through the basement wall.

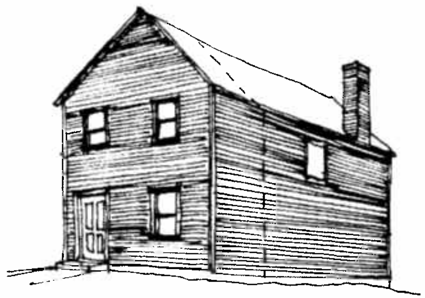

Fig. 4. A house in Halifax, N.S. which has recently been rebuilt externally, in order to remove urea formaldehyde insulation. The house was reinsulated, sheathed and clad, and extended at the same time.

ABSTRACT

L'ISOLATION THERMIQUE DES BATIMENTS ANCIENS DE BOIS

Allen Penney

L'auteur traite de l'approche, de l'économie et des applications techniques. En constatant que souvent en voulant économiser sur les coûts du combustible, on a endommagé des bâtiments et augmenté les dépeuses d'entretien. L'auteur intentionnellement dans sa présentation s'attache au pourquoi, au lieu du comment.

Pourquoi faut-il appliquer nos normes actuelles de confort aux bâtiments anciens? L'utilisation ponctuelle qu'on fait de certains monuments exige-t-elle qu'on modifie leurs qualités thermiques et ne pourrait-on pas les maintenir non chauffés ni utilisés, comme ils l'ont été longtemps, sans dommage, pour maintenir leur intégrité historique?

Qu'il s'agisse d'une utilisation en musée ou en résidence, les normes vont évidemment changer mais pourquoi compromettre l'intégrité historique de l'intérieur et de l'extérieur pour se conformer à ces normes?

L'auteur parle des avantages relatifs d'isoler un bâtiment par l'extérieur ou l'intérieur si les revêtements ou les parements doivent être remplacés. Où traçons-nous la ligne entre la restauration et la reconstruction? Constatant que c'est souvent un dilemme, l'auteur demande encore s'il est possible d'isoler d'une façon efficace sans détruire ce que nous essayons de préserver. Pesons-nous véritablement les options: l'intégrité versus le coût, les résultats à court ou à long terme, la responsabilité sociale? Qui peut déterminer le coût véritable? En quoi la justification d'isoler doit dépendre du coût du combustible? Les économies ne peuvent être qu'évaluées, mais dans la conception, s'il est possible de déterminer avec précision les pertes en chaleur, on peut moins apprécier les effets secondaires de l'isolation.

L'auteur aborde ensuite les questions techniques tenant au choix des matériaux et aux priorités de travaux. Même si l'éventail des solutions est large, chacune présente des avantages et des inconvénients. Ainsi, même si l'isolation intérieure du toit est la plus effective et plus simple, elle ne peut être réalisée si on veut sauvegarder la visibilité de la structure. Il est important, conclut l'auteur, que les choix se fassent en considérant les facteurs philosophiques, économiques et techniques et qu'on ne se laisse pas emporter par une vague de panique tenant à la crise de l'énergie qui a tendance à nous faire appliquer des solutions standardisées.

ALLEN PENNEY is an architect trained in England at the Architectural Association and at Cambridge University. He practiced architecture and taught building construction in London and the United States before moving to Canada. He now teaches architecture at Nova Scotia Technical University in Halifax. Since 1975, Mr. Penney has been a Research Associate with the Nova Scotia Museum and is currently writing ten books on houses in the Museums Collection. His main interests are in the areas of energy conservation and Nova Scotia domestic architecture, and his recent projects include a super-insulated home and a small church. Mr. Penney is also a member of the Royal Architectural Institute of Canada.

LA RESTAURATION DE LA MAISON SYLVIO CARRIERE MUNICIPALITE DE MIRABEL (QUEBEC, CANADA): Résumé de la communication

Laszlo Demeter

INTRODUCTION:

La **Maison Carrière** se situe à Belle-Rivière, à quelques pas du manoir des sulpiciens du début du XIXe siècle d'une part, et d'autre part, de la première église protestante canadienne française, bâtie en 1945. Elle se trouve entre la rue et la rivière où les deux sont bordés d'arbres, assurant à l'ensemble un agréable environnement boisé.

La maison est petite, mais offre un nid sympathique, calme et reposant aux gens (jeunes et âgés) qui sont fatigués du bruit et de l'encombrement des villes et qui sont aussi attirés par la nostalgie de retrouver la tranquilité dans le cadre où leurs ancêtres ont vécu.

Elle fut construite il y a 150 ans en pièce sur pièce, et présente une architecture traditionnelle du XIXe siècle. Elle revêt donc une valeur culturelle, historique et technique.

Elle fait partie d'un environnement historique (cf. le manoir et l'église) dans un site exceptionnel auquel elle contribue à rehausser la valeur par son témoignage culturel. C'est une maison-bloc, unique à Mirabel (la municipalité de Mirabel est composée de 16 villages et parties de villages). La maison-bloc est caractérisée par le fait qu'elle est construite sous le même toit juxtaposé avec des bâtiments agricoles: remise, grange, écurie, etc. Sur la façade principale avec porte au centre, deux fenêtres sont symétriquement disposées. Une galerie longe cette façade sous le toit avancé et galbé. L'ensemble garde un caractère classique d'une esthétique raffinée et des proportions harmonieuses; elle constitue ainsi un exemple caractéristique de l'architecture vernaculaire de la région montréalaise (illustrations 1 et 2).

La maison est restée sans entretien depuis plusieurs années et dernièrement complètement abandonnée, donnant lieu au vandalisme. Elle se trouvait dans un état de délabrement (illustrations 1, 3, 5, 7, 10, 13). Le chauffage, les équipements sanitaires et l'électricité étaient inadéquats et manquants, l'isolation inexistante. Le toit a coulé à plusieurs endroits et les portes et fenêtres brisées, bref, elle était exposée à la pourriture voire même à la démolition.

A) LA CONSTRUCTION ET L'ETAT ACTUEL DE LA MAISON

(voir les plans et les photos)

La fondation est en pierre de carrière. A l'exception de quelques lézardes, elle est en bon état. La rallonge est bâtie sur le sol sans fondation.

Les murs de la maison sont en pièce sur pièce à coulisse, équarris à la hache de 5 po. (12,5 cm) d'épaisseur et de 7 po. à 8 po. (18 à 45 cm) de large. Les poteaux posés aux angles et à chaque côté des ouvertures sont mortaisés dans lesquelles les tenons des éléments horizontaux sont insérés. Les joints entre les pièces sont calfeutrés d'étoupe et couverts de crépi et chaulés. Les murs de la cuisine à la rallonge sont en colombage et planche. A l'exception de quelque planches de finition, les murs sont complètement pourris; ils devront être reconstruits. Le reste de la rallonge est en planche et en bon état.

Le toit est une charpente de bois de type chevron portant fermes avec entraits retroussés. La couverture est en bardeaux de cèdre sur planche. Au début du présent siècle, le bardeau a été recouvert de tôle. Plusieurs composantes sont pourris, le toit coule à plusieurs endroits.

Les planchers: Au rez-de-chaussée, les poutres sont des troncs d'arbres dressés sur une face pour recevoir les madriers. Les poutres au niveau du grenier sont équarries à la hache et distancées à environ 4 pi. 6 po. [c/c], (à 1,40 m environ). Les madriers de 2 po. sont embouvetés. Ils sont en très mauvais état et presque complètement usés par endroit.

Les cloisons sont en planche de 1¼ po. Elles devront être démolies.

Les ouvertures: les **portes** extérieures sont vitrées et celles de l'intérieur sont à panneaux; les **fenêtres**, à la française, sont à deux vanteaux et à six carreaux. Les portes et les fenêtres sont endommagées.

La quincaillerie originale était forgée. Plusieurs targets ont disparu.

Les cadres, les chambranles sont usés et manquants par endroit.

La finition:

A la l'extérieur, une première planche verticale a été directement clouée sur les pièces. En deuxième lieu, un déclin fut posé au tournant du siècle selon la coutume de l'époque et troisièmmement, un papier brique a recouvert le tout vers les années 1940 à 1950 pour donner à la maison une "allure moderne". Les murs de la rallonge sont en planches verticales posées directement sur la charpente.

A l'intérieur, l'enduit composés de chaux et de sable est appliqué sur lattis de bois cloué directement ou par l'intermédiare des fourrures sur les pièces.

Peinture et **papiers peints** furent utilisés.

L'escalier en planche est usé.

La galerie est en béton coulé sur le sol; les poteaux manquent, le soffite est en très mauvaise condition.

La cheminée a été démolie, sa base existe à la cave et la structure du pignon ouest témoigne également de son existence.

L'isolation est inexistante.

La mécanique est aussi inexistante à l'exception de l'entrée d'eau potable venant du voisinage. La fosse septique est également manquante.

Le chauffage: le poêle à bois est disparu.

Le système électrique est inadéquat et inutilisable.

Plan, affectation: la cave mesure à peine 4 pi. (1,20 m) de hauteur. Au rez-de-chausée, il y a une petite chambre et une plus grande pièce, au grenier (à l'étage), deux chambres divisées par une cloison en planche. La rallonge abrite la cuisine-salle à manger. Il y a aussi un garage et un abri ouvert. Les portes sont en planche.

B) LA RESTAURATION

(voir les plans et les photos)

La maison est restaurée en conservant le maximum de ses composantes. Par contre, à la rallonge, la partie abritant la cuisine-salle à manger est démolie et reconstruite sur une fondation en béton. Le reste de la rallonge, l'abri et le garage sont consolidés, réparés et, sous les appuis, la fondation est complétée en béton.

La fondation en pierre est réparée, les joints sont tirés et une partie est remaçonnée à l'aide de mortier de type S (1 partie, par volume de ciment portland, ½ partie de chaux hydratée et 4½ parties de sable sec).

Les murs extérieurs sont mis à nu, nettoyés et consolidés. Les joints sont calfeutrés avec de la laine de verre et imperméabilisés avec un mastic qui garde l'élasticité. A l'intérieur, après curetage, les fourrures de 2 po. par 4 po. sont installée, 4 po. de laine de verre et le coupe-vapeur sont posés. Entre la laine et les pièces, l'on garde un espace d'un pouce (2 cm) environ pour assurer la respiration des murs. A la rallonge, les murs de la cuisine et la salle à manger sont reconstruits en colombage sur une fondation en béton et isolés avec 4 po. de laine posée avec le coupe-vapeur. Le reste de la rallonge est entièrement conservée avec quelques réparations mineures.

Le toit: La charpente est réparée, consolidée et isolée à l'intérieur entre les chevrons avec 3 po. de mousse bleue isolante et couverte avec une feuille de gypse de 5/8 po. (environ 14 mm). La charpente de la partie reconstruite de la rallonge de 2 po. par 6 po. (5 cm par 15 cm environ) est isolée avec 6 po. de laine de verre pourvue d'un coupe-vapeur. Le toit de l'abri et du garage sont réparés et les planches détruites par la pourriture sont remplacées.

Les planchers sont complètement rénovés et refaits. Les troncs d'arbres au niveau du rez-de-chaussée sont nivelés et, à l'étage (grenier), les deux-troisièmes des poutres sont changés à cause de leur mauvais état. Aux deux niveaux, les planchers sont reconstruits avec des madriers de 2 po. (5 cm) en pin blanc embouveté. Le plancher de la cuisine-salle à manger est refait en solives de 2 po. par 8 po. (5 cm par 20 cm) à 16 po. (40 cm environ) [c/c] et en contreplaqué de ¾ po. et, à l'étage, en poutres et madriers.

Les cloisons sont en colombage de 2 po. par 4 po. (5 cm par 10 cm) et ½ po. de feuilles de gypse.

Les ouvertures: Trois **portes** extérieures sont restaurées et une quatrième est refaite. Plusieurs **fenêtres** sont réparées et réinstallées et plusieurs autres sont nouvellement fabriquées. Pour compléter les éléments manquants, **la quincaillerie** est forgée par un forgeron québécois. Le tout est exécuté d'après des modèles déjà existants.

Les finis: La finition **extérieure** est de la peinture latex appliquée sur toutes les surfaces verticales à l'extérieur de la maison et de la rallonge. Cette peinture a la particularité de laisser respirer le bois. Le toit est recouvert avec de la tôle. La peinture **intérieure** est appliquée sur les panneaux de gypse de ½ po. et ¾ po. d'épaisseur. Les madriers des planchers sont recouverts avec du varatane qui offre une bonne protection et une facilité d'entretien. Le plancher des salles de bains et de la cuisine, ainsi que les murs jusqu'a une certaine hauteur, sont recouverts de tuiles céramiques.

L'escalier en pin rouge est refait selon la tradition (illustration 12).

La galerie est en béton et les poteaux en pin blanc de 6 po. par 6 po., sont peints en blanc.

La mécanique comprend l'installation complète du système de chauffage et la plomberie. Le chauffage est à air chaud au rez-de-chaussée et à l'électricité à l'étage. Une salle de bain complète et une petite toilette sont équipées avec des appareils de plomberie. Un évier dans la cuisine ainsi qu'une machine à laver et une sécheuse sont également installés. Tous les appareils sont alimentés avec de l'eau chaude et de l'eau froide. Une nouvelle fosse septique remplie le rôle d'égout.

L'électricité: Une entrée de 200 ampères assure tous les besoins énergétiques de la maison.

Aménagement: Deux solutions furent présentées dont la plus modeste est retenue par le propriétaire. Elle comprend un salon, la salle à manger-cuisine, la salle de bain, une armoire pour machine à laver et sécheuse et un vestiaire au rez-de-chausée; trois chambres à coucher avec penderies et tiroirs et une petite toilette (WC et lavabo) à l'étage, au niveau du grenier, sous le toit. L'abri et le garage sont conservés tel qu'originalement. Le terrain est paysagé, enrichi de quelques arbustes et plantes pour mieux cadrer dans ce lieu exceptionnellement riche en tradition de presque deux siècles.

C) REFERENCE THEORIQUES ET TECHNIQUES

Les démarches, tant pour la préparation que pour l'exécution de la restauration (recherche, relevé, curetage, stabilisation, choix et application des matériaux et des méthodes) sont suivies et guidées en observant la théorie de la restauration critique. Cette théorie, selon les écrits des italiens Brandi et Bonelli, contrairement à la restauration scientifique, ne considère pas les oeuvres comme des documents, mais comme des oeuvres d'art. Restaurer l'objet tel qu'il nous est parvenu. Procéder avec loyauté et sens moral, intervenir le moins possible et tâcher de tout conserver. La restauration ne doit pas effacer l'histoire. En d'autres mots, l'on respecte le moment de la création de l'oeuvre ainsi que sa vie à travers l'histoire. L'on conserve les éléments qui marquent la trace du temps.

Hors de cette théorie, il a été observé un autre principe découlant de l'intervention minimum: la réversibilité des interventions. Choisir des matériaux et des méthodes d'applicatíon réversibles de manière à ne pas porter atteinte aux composantes de l'oeuvre.

Il est important de noter qu'une bonne partie de la problématique de la restauration de cette petite maison s'inscrit dans les deux premiers thèmes de travail du présent colloque, notamment la crise de l'énergie (problème d'isolation et le chauffage) et ensuite, les atteintes aux structures et les moyens d'intervention (abandon, causes socio-économiques, hygiène, vieillissement, manque d'entretien, etc.).

Isolation: La qualité et la quantité utilisées à la maison Carrière répondent aux exigences de l'économie énergétique. Ils sont de nature (laine et panneaux rigides) à pouvoir être enlevés facilement, sans laisser de traces; ils n'adhèrent pas aux éléments structuraux, comme par exemple l'uréthane giclé. Donc, toute intervention et changement demeurent possibles sans endommager les éléments structuraux et sans porter atteinte à leur intégrité physique ou historique. Mais, l'utilisation du polyuréthane et tout autre isolant giclé qui adhère au bois et à la pierre devra être prohibée. Cette application, malheureusement si fréquente, même chez les architectes soi-disant spécialistes dans la restauration au Québec, n'est pas réversible sans endommager le bois ou la pierre. Le nettoyage ne pourra être exécuté qu'avec l'utilisation du jet de sable, dont l'application à de rares exceptions près, doit également être prohibée.

Si la charpente du toit et le voligeage sont propres et offrent une ambiance sympatique à l'intérieur ou, pour toute autre raison, l'isolation du toit peut être exécutée par l'extérieur en utilisant deux rangs de 1½ po. (4 cm environ) de styrofoam bleu (panneau rigide de 60 cm par 2 m 20 cm environ) avec ± 2 cm d'espace de ventilation au-dessus (illustration 1).

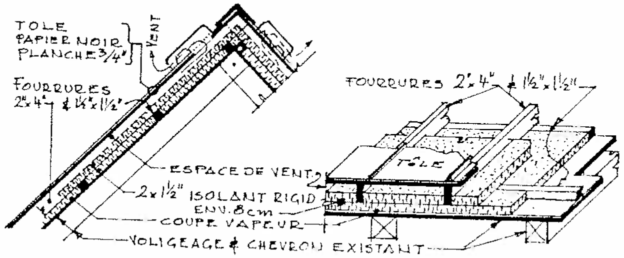

Fig. 1.

Le chauffage: Tel que mentioné, est assuré par un système à air chaud au rez-de-chaussée et à l'électricité à l'étage. La consommation est minime, les murs représentent 24R (5 po. de bois pièce sur pièce, les joints étampés avec de la laine, espace de 2 po., isolant 4 po. de laine de verre, coupe-vapeur et 5/8 po. de feuille de gypse) (illustration 2).

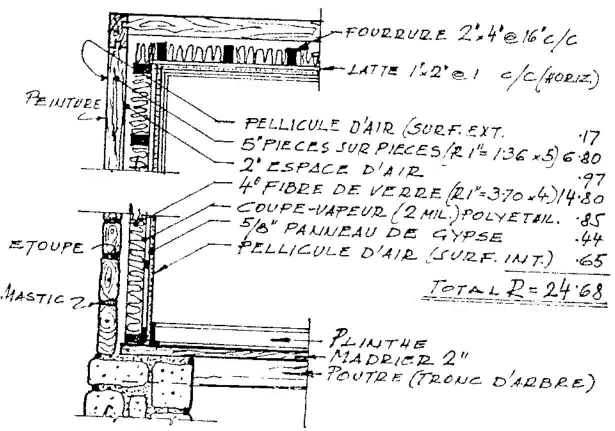

Fig. 2.

Les traces des changements du passé sont conservés, ainsi que la volumétrie malgré la reconstruction d'une partie de la rallonge pour la conservation inchangée de l'ensemble.

En ce qui concerne le thème, "l'atteinte aux structures et moyens d'intervention", il est représenté sur l'ensemble du projet vu l'absence d'entretien depuis longtemps ainsi que l'abandon total de la maison durant les deux dernières années. La toiture usée laisse pénétrer l'eau faisant pourrir le voligeage, le plancher du grenier (à l'étage) et du rez-du-chausée ainsi que quelques poutres. L'eau a causé du tassement à la fondation en pierre ainsi qu'à quelques appuis de la rallonge. La neige, le vent, le gel, les intempéries et le vandalisme ont terminé le ravage de ce bel ensemble. La réfection de la toiture, le redressement de la charpente, le changement des éléments pourris et l'assèchement total de l'édifice ainsi que le complètement des composantes ont redonné l'âme et la fonction originale de ce petit bâtiment. La peinture blanche à l'extérieur substitue à la chaux de jadis pour rendre ainsi l'aspect traditionnel de la maison.

Fig. 3. Avant

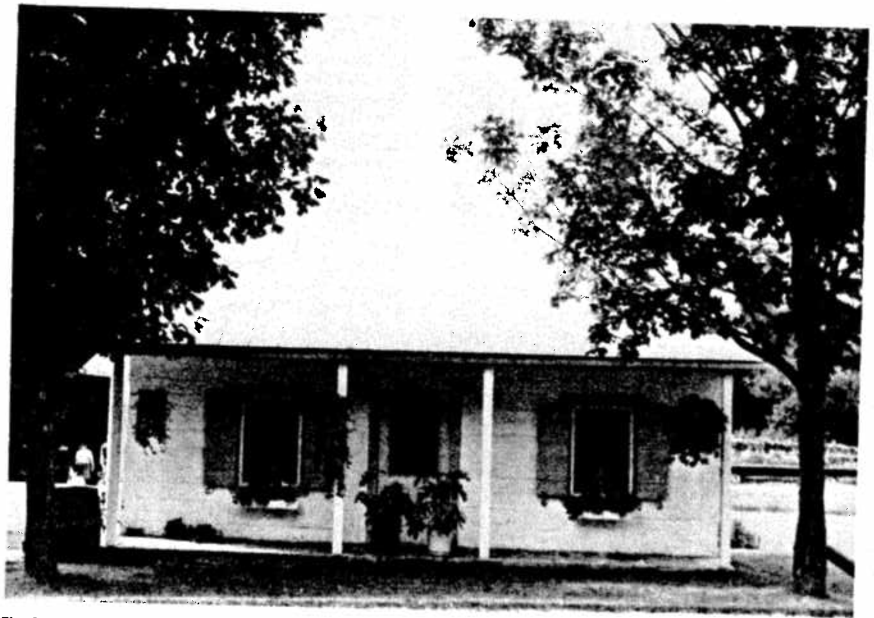

Fig. 4. Après.

Fig. 5. Avant.

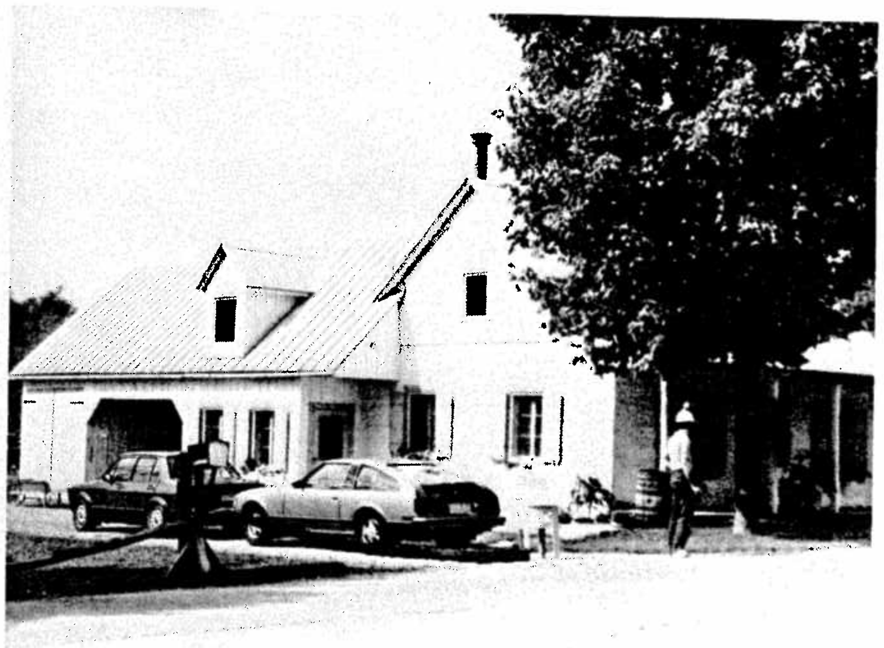

Fig. 6. Après.

Fig. 7. Avant.

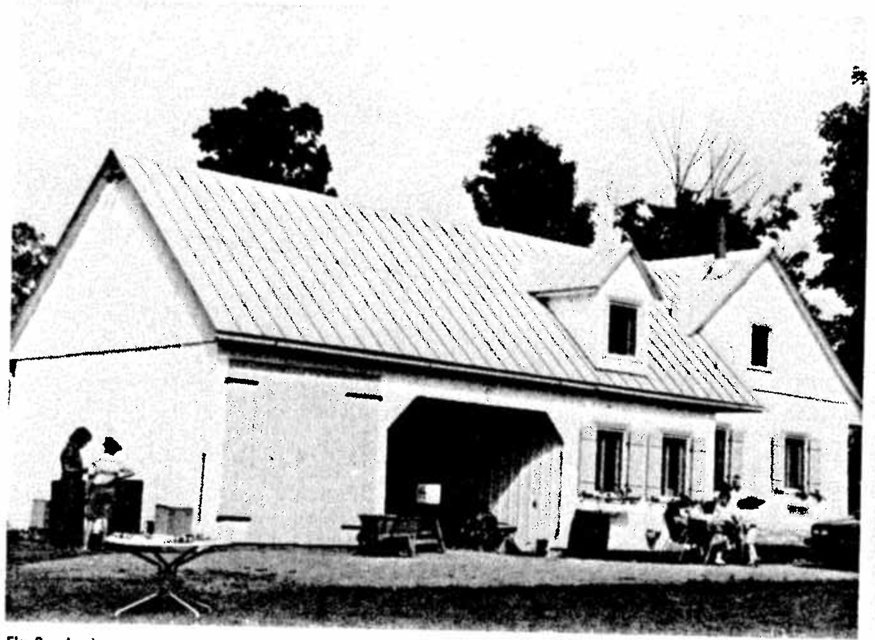
Fig. 8. Après.


Fig. 9. Pendant.


Fig. 10. Après.


Fig. 11. Avant.

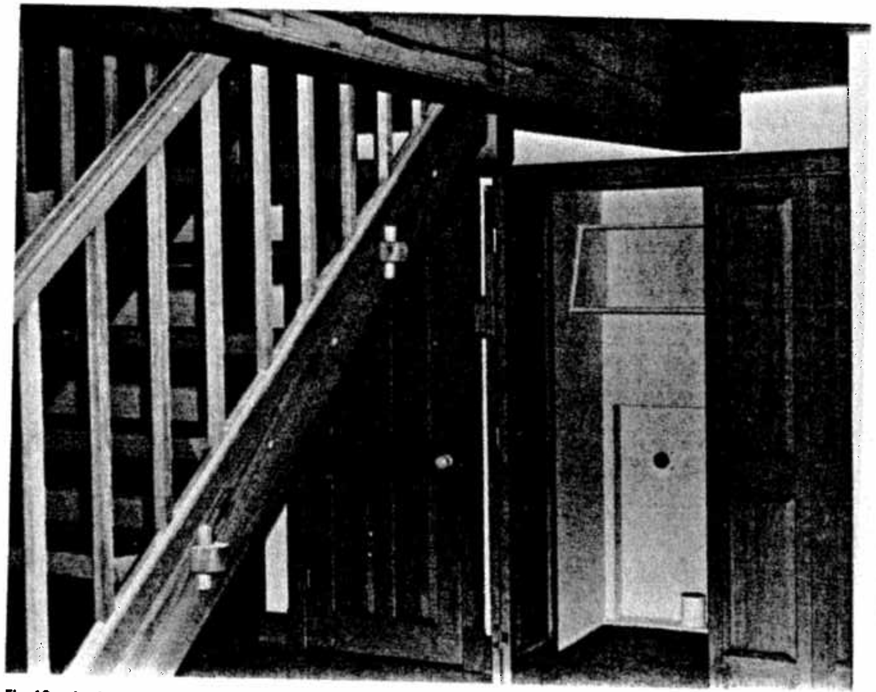
Fig. 12. Après.

ABSTRACT

THE RESTORATION OF THE SYLVIO CARRIERE HOUSE IN THE MUNICIPALITY OF MIRABEL
Laszlo Demeter

The Sylvio Carrière House, located in a wooded area in Belle Rivière, Québec, was built approximately 150 years ago. Constructed of wooden logs, this house is typical of a traditional 19th century vernacular building type known as the "Maison-bloc", where one finds agricultural buildings such as a coach house and barn built adjacent to the main building under the same roof.

The principal façade of the Sylvio Carrière House is symmetrical and harmoniously proportioned in a classical manner. From a technical as well as cultural viewpoint, the house is of architectural interest. As well, the building is located near a Sulpician Manor and the first Protestant church in French Canada, built at the beginning of the 19th century and in 1845 respectively.

Over the years the house was poorly maintained and gradually its condition deteriorated. Poor electrical and heating systems, broken windows and doors accelerated the general spread of decay. With the exception of several finished boards, the walls were completely rotten and in need of reconstruction. The original cedar shingle roof from the beginning of the 20th century had been covered in sheet metal and it was restored in wood after the insulation was installed. Since there was no insulation in the original structure, thermal upgrading was a major part of the restoration process. The house's exterior had asphalt sheeting added during the 1940's and '50's as a 'modernization', and this was removed during the restoration. The exterior siding was painted with a latex paint to permit the wood to breathe.

The philosophical approach to this project was a significant factor in its overall restoration. Additions were not removed and the least harmful means of intervention were chosen wherever possible, according to the Venice Charter. The reversability of the work was another major consideration and thus, the house was able to retain its historic and architectural integrity. Today, it contains modern services and is an attractive home.

LASZLO DEMETER est né en Hongrie, et il est licencié en géographie et histoire. Il a étudié et a pratiqué l'architecture à Paris et à Montréal comme professeur d'histoire de l'art à l'Ecole des Beaux Arts de Montréal en ensuite à l'Ecole d'architecture de l'Université de Montréal. M. Demeter a publié sur la charpente de la maison en pierre de la région montréalaise et sur la construction générale en bois. Maintenant, il pratique et enseigne la restauration et la sauvegarde de l'architecture historique en tant que professeur émérite. Il est un membre du Comité du bois de l'ICOMOS, de l'Association pour la Préservation et ses Techniques, et du Conseil des Monuments et Sites du Québec.

RESTAURATION DES TOITS DU PARLEMENT DE QUEBEC 22401

Charles Dorval, architecte

La restauration de la charpente des toits n'est qu'une partie d'un vaste projet visant la restauration et la rénovation des édifices historiques qui logent l'Assemblée nationale du Québec. Ce projet est en cours depuis 1975 et est réalisé par le ministère des Travaux Publics et de l'Approvisionnement du Québec.

Le mandat confié aux architectes comporte plusieurs contraintes qui marqueront les interventions:

a) L'obligation de maintenir l'édifice occupé et opérationnel. Pendant les travaux, l'Assemblée nationale devra opérer normalement sans interruption ni ennui important. De plus, l'absence d'espaces vacants à proximité limitera la relocalisation dans des espaces disponibles à l'intérieur de l'édifice.

b) Les limites budgétaires: les différentes opérations seront limitées par les disponibilités budgétaires du gouvernement, établies annuellement.

LES GRANDES ETAPES D'INTERVENTION:

Tenant compte de la logique du bâtiment et de son état général, des contraintes mentionnées précédemment, les interventions ont été planifiées comme suit:

- les travaux à l'enveloppe extérieure - mise hors d'eau et consolidation de l'édifice;
- l'infrastructure mécanique-électrique préalable à la distribution des systèmes;
- les travaux visant à rendre l'édifice conforme aux normes et codes, la sécurité des occupants et de l'édifice;
- l'aménagement général, la restauration et la rénovation des espaces intérieurs.

L'INTERVENTION AU NIVEAU DES TOITS

L'intervention au niveau des toits en générale et particulièrement à l'emplacement du Salon Bleu (la Chambre) était devenue nécessaire en raison des faits suivants:

- la formation de glace à la bordure inférieure des toits mettant en danger les piétons qui circulent autour de l'édifice et causant des bris à l'édifice;
- l'infiltration d'eau généralisée nécessitant une intervention majeure;
- la pourriture observée sur certains éléments de pontage de bois et les inquiétudes sur la pourriture possible de certains éléments structuraux cachés;
- les faiblesses structurales de certaines composantes des toits et les besoins de corriger les déflexions;
- l'état du plafond du Salon Bleu jugé fragile, particulièrement délicat en raison de la présence d'une peinture de Charles Huot marouflée directement sur ce plafond.

Cette toiture à l'origine était composée d'une charpente de bois recouverte de tôle posée à baguettes et peinte de couleur gris plomb. En 1961, une réfection complète de la toiture fut l'occasion de remplacement de la tôle par des feuilles de cuivre étamé (l'étain empêche l'oxydation et rejoint la couleur d'origine). Au même moment, les terrassons sont modifiés et convertis en toits à bassin, en asphalte et gravier avec drains dans le but semble-t-il de corriger le problème de formation de glace en bordure des toits et de ruissellement d'eau sur les façades. C'est un bel exemple, nous le démontrerons plus loin, où parfois le remède est pire que le mal d'origine.

On peut également observer des affaissements significatifs aux toits et plafonds à l'endroit des longues portées de plafonds des Salons Bleu et Rouge. Or, ces affaissements remontent à l'origine du bâtiment. D'après les archives du ministère, dès 1895-96 les fermes de bois à longue portée durent être renforcées en raison de l'affaissement des combles et des plafonds de plâtre endommagés et présentant des déflexions inquiétantes.

Les fermes de bois furent donc dès ce moment renforcées au moyen de tirants métalliques et de plaques de métal. Les déflexions n'auraient pas été corrigées mais on a cherché à éviter de nouveaux affaissements. Cependent, la corde inférieure de la ferme fut négligée et demeura une faiblesse structurale. En somme la structure d'origine n'avait même pas su satisfaire aux exigences de longue portée sans fléchissements et même les correctifs avaient certaines faiblesses.

La plus grande surprise de cette partie des travaux fut toutefois la découverte de pourriture généralisée. La plupart des extrémités des fermes enfouies dans la maçonnerie s'avérèrent pourries, certaines n'avaient plus que 250 mm d'appui. Les sablières et brisis des mansardes, également enfouis dans la maçonnerie étaient par endroit, complètement rongés par la pourriture. Nous avions prévu quelques cas de pourriture mais la réalité surpassa toutes nos prévisions. Toute cette maçonnerie avait pour but de servir de lest pour la pierre de corniche sur laquelle reposait la sablière, mais il semble que les besoins de conservation des éléments de bois furent oubliés.

En plus de remplacer les éléments pourris, consolider la charpente et étancher les toits, il fallait trouver les causes à tous ces problèmes pour y remédier et être assurés d'y apporter des solutions appropriées.

Nous avons identifié les causes suivantes de la pourriture:

- l'absence de ventilation naturelle dans les murs et toits, particulièrement aux endroits susceptibles de subir des infiltrations;
- le système de toit à bassin pour retenir la neige et l'eau sur un toit non isolé était une solution menant inévitablement à l'infiltration dans un climat à multiples cycles de gel/dégel comme le nôtre;
- le manque de solins efficaces pour rejeter l'eau à la base des mansardes;
- les pertes de chaleur et la condensation dans les espaces entre les murs et les toits.

LES SOLUTIONS ET CORRECTIFS APPORTES

Forme des toits

Nous avons opté de redonner aux toits leur forme originale, éliminant le bassin à la partie supérieure. Ainsi la toiture n'accumulera ni neige ni eau.

Au bas des mansardes, à la rencontre avec la corniche de pierre, des solins avec pente ont été ajoutés pour favoriser l'écoulement de l'eau, éviter les accumulations de neige et arrêter les infiltrations. Des dalles et gouttières existaient à l'origine mais n'ont pas été remises en place, parce que ce système est trop fragile et vulnérable pour notre climat devenant ainsi souvent inefficace. Pour compenser un drainage spécial est mis en place à la base de l'édifice.

Charpente des toits

En raison des contraintes imposées à la réalisation, la solution de remplacer la charpente existante par une nouvelle charpente métallique plus rigide et plus stable fut rejetée dès le départ.

Les faiblesses structurales des fermes affectaient surtout la corde inférieure et les appuis aux extrémités. Pour renforcer la corde inférieure, l'ingénieur choisit d'utiliser des plaques de cisaillement permettant de transférer les efforts d'une pièce de bois à une autre d'une façon plus efficace qu'avec des assemblages à boulons. Cette technique n'était pas utilisée dans les fermes existantes mais est une pratique courante dans l'industrie du bois lamellé. L'utilisation maximum de plaque de cisaillement était une solution fragile dans les circonstances, compte tenu de l'état des lieux et de la charpente. Cependent elle fut jugée raisonnablement sécuritaire.

De plus un tirant métallique a été ajouté à la partie inférieure de la ferme, sans y appliquer de tension pour ne pas affecter le très fragile plafond de plâtre que ces fermes supportent. Il aura pour fonction de prévenir des affaissements futurs et non pas de redresser la structure ou de tenir lieu de composante de la ferme.

Pour compléter le travail, toutes les fermes ont été contraventées et les pièces de charpente défectueuses mais moins critiques, corrigées par l'ajout de nouvelles pièces boulonnées aux pièces d'origine.

Traitement du bois

Toutes les pièces de bois nouvelles ou existantes ont reçu un traitement au moyen de préservatif hydrofuge par l'application par trempage ou l'application à la brosse. Le préservatif utilisé est à base de naphthalate de cuivre à concentration de 2%. De plus, les pièces de bois devant demeurer en contact avec la maçonnerie sont enrobées d'un feutre d'asphalte saturé.

Isolation

Pour régler le problème de perte de chaleur (premier responsable de la formation de glace en bordure des toits), il fallait de toute évidence isoler. Les problèmes rencontrés furent:

- l'obligation d'isoler par l'extérieur (bâtiment occupé);
- l'encombrement des membrures rendant la continuité difficile;
- les endroits inaccessibles.

Partout ou il fut possible on utilisa la laine minérale. Dans les endroits inaccessibles ou trop encombrés, on utilisa la mousse de polyuréthane giclée.

Nous sommes conscients de l'instabilité de ce matériau mais la seule alternative était l'évacuation des locaux, choix qui fut refusé dès le départ.

Ventilation

L'isolation n'étant pas suffisante pour régler le problème, un espace d'air continu et ventilé est assuré sous le pontage des toits et mansardes, avec prises d'air extérieur adéquates. Nous avons jugé cette mesure indispensable pour empêcher la pourriture et palier aux effets des infiltrations et de la condensation qui pourraient se produire.

Coupe-vapeur

Devant l'impossibilité d'assurer un coupe-vapeur continu et efficace du côté chaud des murs et toits, nous ferons en sorte de maintenir l'humidité au niveau le plus bas possible. Toutefois, nous appliquerons sur toutes les surfaces des murs et toits, deux couches de vernis aluminium sous le fini régulier de peinture.

Garde-neige

Même après isolation, certains risques d'avalanche de neige demeurent pour les gens qui circulent près de l'édifice. Pour pallier ces risques, un système de crampons est fixé à la toiture; ce système empêche les glissements soudains sans favoriser l'accumulation.

CONTEXTE DE REALISATION

Ce contexte, à lui seul, pourrait faire l'objet d'un exposé; nous nous contenterons d'en résumer les principaux éléments qui ont rendu ce travail très délicat, sinon périlleux.

La charpente des toits supporte également le plafond du Salon Bleu sur lequel est peinte une fresque d'une très grande valeur. Or ce plafond est d'une stabilité douteuse, le plâtre se détache graduellement de son support de latte de bois. Du côté technique ceci signifie que:

- des charges additionnelles ne peuvent être appliquées à la structure sans mettre le plafond en danger;
- des précautions extraordinaires doivent être prises pour permettre la circulation et le travail au-dessus du plafond;
- on ne peut affaiblir temporairement une membrure sans précautions et supports très sécuritaires.

Des restrictions nous sont imposées sur l'encombrement des échafaudages alors que nous devons assurer un abri très sécuritaire permettant d'enlever les membranes et d'ouvrir les toit. Le maintien de l'édifice occupé et opérationnel pendant les travaux sera finalement le pire handicap à la réalisation des travaux.

Tous les travaux devront être faits à partir de l'extérieur, exigeant entre autre l'ouverture complète des toits et la mise en place de plateforme de travail et d'accès, et de toute une structure d'abri permettant de conserver l'édifice occupé.

POURSUITE DES TRAVAUX

Les travaux de restauration du Parlement ont maintenant franchi les deux premières phases de consolidation de l'enveloppe et de mise en place de l'infrastructure mécanique. Les travaux se poursuivent maintenant du côté de la conformité aux normes et codes, et de la restauration des espaces intérieures. Un aspect technique particulièrement intéressant concernera la restauration du plafond du Salon Bleu qui se détache de son support de latte de bois.

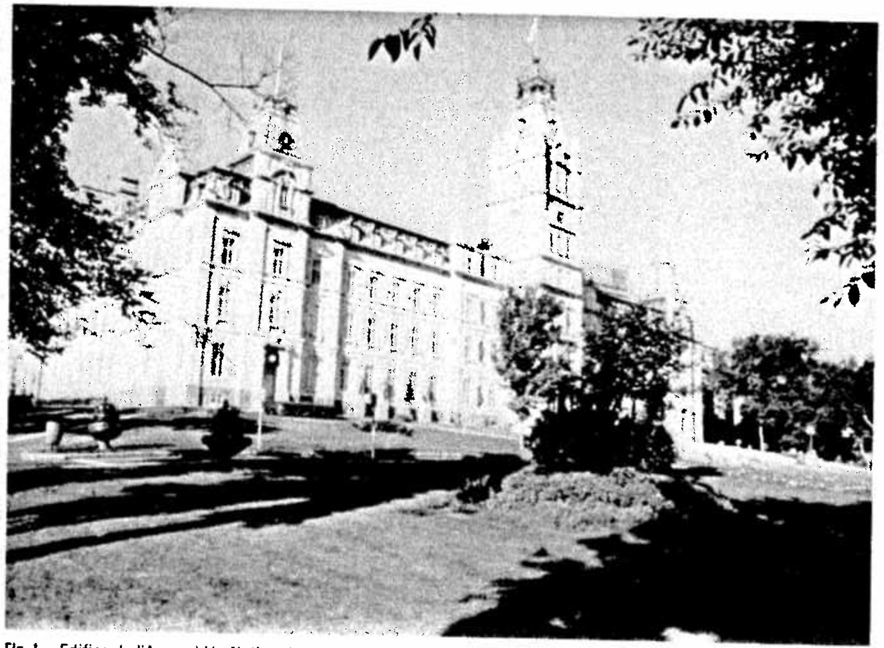

Fig. 1. Edifice de l'Assemblée Nationale.

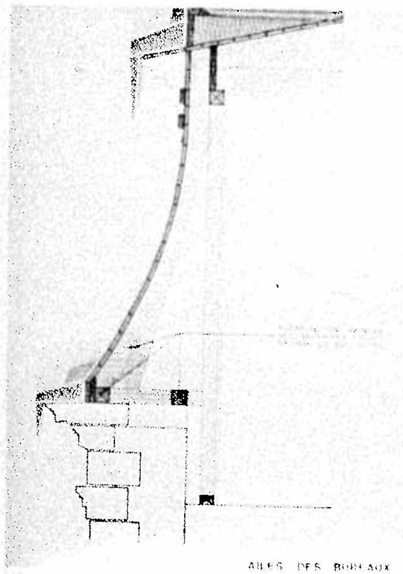

Fig. 2. Coupe des mansardes avec glace, "Etat existant".

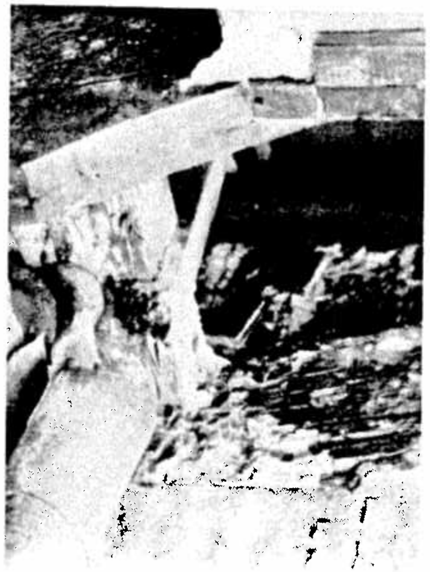

Fig. 3. Pourriture des brisis.

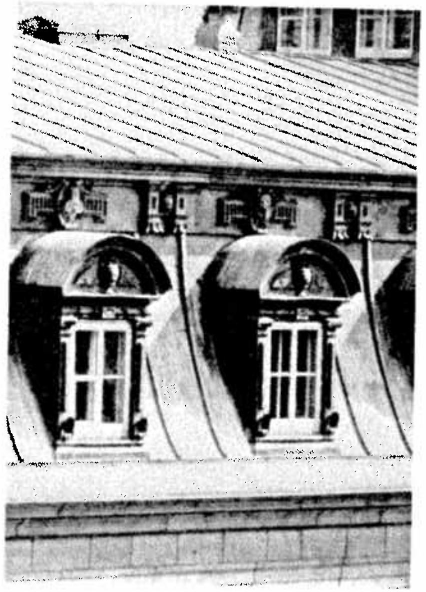

Fig. 4. Detail des mansardes avec garde-neige.

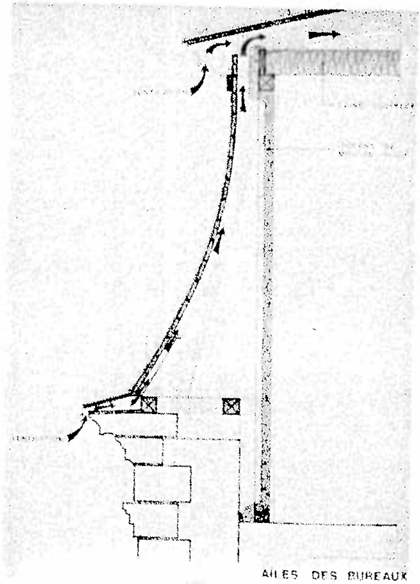

Fig. 5. Coupe des mansardes, ailes des brueaux "Après travaux".

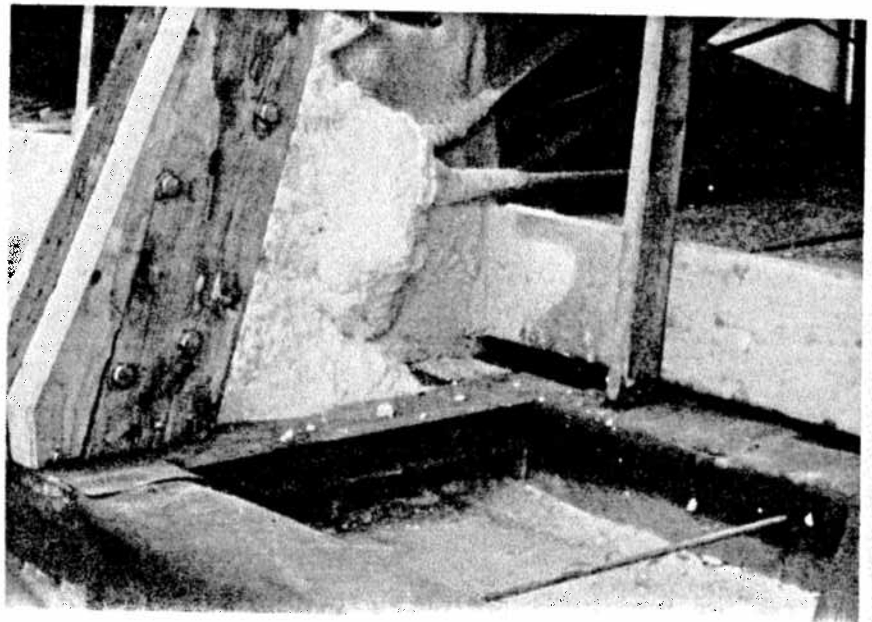

Fig. 6. Nouveaux brisis et nouvelles sablières.

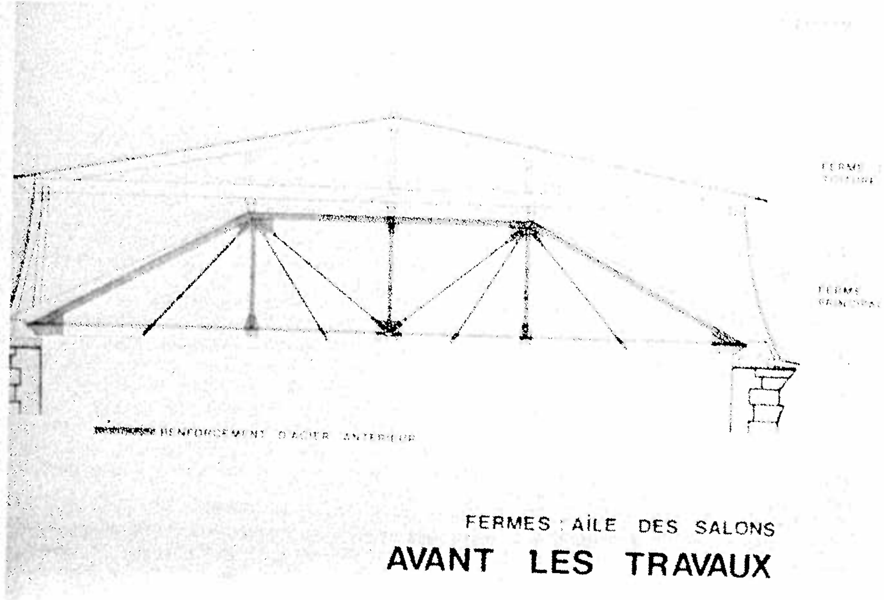

Fig. 7. Coupe des fermes, ailes des salons, avant les travaux.

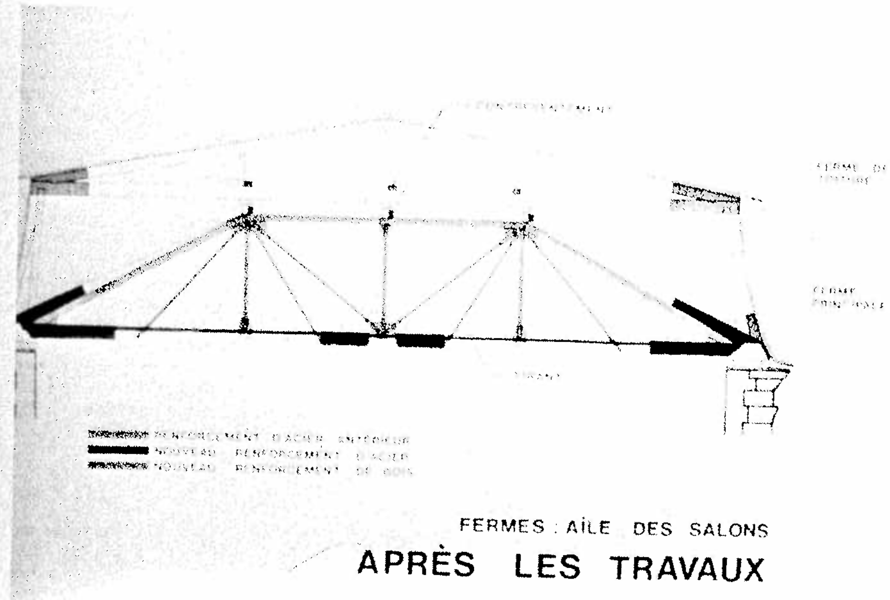

Fig. 8. Coupe des fermes, ailes des salons, après les travaux.

ABSTRACT

RESTORATION OF THE ROOF AT THE PARLIAMENT BUILDINGS, QUEBEC CITY

Charles Dorval

The restoration of the wooden roof of the Québec National Assembly's main structure is part of a major restoration programme begun by the provincial Department of Public Works in 1975. The local architectural firm of Dorval and Fortin was retained as the consulting architect for the project. Two key factors have influenced progress to date - the need to keep the building operational during the restoration work and budgetary restrictions which require the requisition of funds on an annual basis. As a result, the restoration process is on-going in a phased programme.

First, work was undertaken on the exterior of the building in order to consolidate the structure. Particular attention was paid to roof damage caused by leaks, ice, localized decay and structural weaknesses, as well as the sagging and fragile painted ceiling of the Salon Bleu. Originally, the roof was comprised of a wooden frame covered with iron sheet metal attached with rods and painted a lead-coloured grey. In 1961, it was completely refurbished and the sheet metal was replaced with tin-plated copper sheets. After identifying the causes of the rot - the lack of natural ventilation, the lack of a proper drainage system and extensive heat loss in the walls - the architects sought solutions to rectify the situation.

In restoring the roof, a decision was made to emulate the original as much as possible. The original shape was recreated, since the introduction of a new metal frame was not in keeping with the original design. Instead, shear-plates were introduced which permitted the transfer of stress from one piece of wood to another, rather than connecting them with bolts. This is a technique used in the wood lamination industry. The new pieces of wood were treated with a 2% copper naphthalate concentrate solution, applied either with a brush or by dipping the wood in the preservative.

Problems related to insulation, ventilation, vapour barriers and snow build-up were also treated as part of the restoration process which is still underway. Following the first two phases of work, which included the consolidation of the structure and the installation of mechanical systems, renovation has become the major emphasis of the project. Current work involved altering the building to comply with building codes, and also the restoration of the interior of the building, including the ceiling of the Salon Bleu which is becoming detached from its wooden frame.

CHARLES DORVAL est diplômé de l'Ecole d'architecture de l'Université de Montréal en 1959. Il est impliqué dans la restauration et ses techniques depuis 1970. M. Dorval a travaillé à la restauration de l'îlôt à Place Royale à Québec et depuis 1975, il est l'architecte responsable de la restauration et rénovation des vieux édifices de la Colline Parlementaire de Québec. Il est membre de l'Ordre des Architectes du Québec, de l'Institut Royal d'Architecture du Canada, d'ICOMOS CANADA et de l'Association pour la Préservation et ses Techniques.

HAIDA TOTEM POLE CONSERVATION PROGRAM
NINSTINTS VILLAGE, ANTHONY ISLAND, BRITISH COLUMBIA 22402

Mary-Lou E. Florian, Richard Beauchamp and Barbara Kennedy

The present mandate of the conservation program for the totem poles on Anthony Island is that they should be stabilized in situ in their natural outdoor environment. Any conservation program under such conditions can only lengthen the life of the totem poles by minimizing the physical, chemical and biological deterioration due to wind, rain, the sun and organisms of all sorts, e.g. fungi, bacteria, higher plants, insects and even woodpeckers.

This in itself is a major undertaking, but one unexpected problem which has kept occurring during all aspects of the development of the conservation program is that no matter who, scientist or layman, everyone readily offers well-meaning advice and recommendations for treatment. Because we have not immediately responded to this advice, we are made to feel inadequate or guilty of neglect. Our response to this advice is cautious only because such advice must come from a thorough knowledge of the materials, a demonstrated need for treatment and the success of the treatment.

As we are proceeding in our conservation program, we realize more and more that each totem pole is unique and no general treatment can be recommended. We have investigated the environmental history of each totem pole to determine why each pole is the way it is and what has caused the specific deterioration of each pole. We are undertaking many types of analysis to help us understand the material and to determine its conservation needs. We are also undertaking limited research on non-artifact material to test some conservation treatments.

The ongoing preventative conservation program has already reduced deterioration and stabilized the poles dramatically in the natural environment. This paper presents chronologically the details and development of the conservation program for the totem poles on Anthony Island. It is a slow job and a difficult one and one made more difficult by the isolation of Anthony Island.

Anthony Island is a small island (2.4 km by 0.8 km) at the southernmost tip of the southwest corner of the Queen Charlotte Islands in the Pacific Ocean (Fig. 1) off the coast of British Columbia, Canada. The Haida Indians who lived there called the island and their village skung-gwai after the red cod which is so abundant there. The fur traders called the village after Ninstints, the last chief of the village.

Anthony Island's natural heritage is unique. It is a low rocky island covered by spruce forest and almost completely surrounded by rocky islets and reefs.

The forest contains mainly Sitka spruce with a few scattered hemlock, and western red cedar. There is a very sparse understorey. The forest floor is a tangle of dead trees completely covered by moss.

The shores consist of bare rocky points, cliffs broken by deep gorges and a few small pebble beaches, on one of which is Ninstints Village.

The surrounding islets and foreshore abound in marine life. They are outstanding because of the nesting grounds for large colonies of sea birds, gulls, guillemots, auklets, puffins and murrelets. Because of these ecologically sensitive nesting grounds, the islets were designated as an Ecological Reserve in 1979 by the British Columbia Provincial Government.

Meteorological data from the Cape St. James lighthouse station, some 24 km south of Anthony Island, indicate a humid maritime climate with a temperature range of 3° to 14° C. The average rainfall is 140 cm, which is uniquely low for this coastal region. However, the prevailing southeast winds are high and steady with sustained velocities of 80 to 130 km per hour, which may reach 150 km in winter months. The winds whip the ocean into a fury of thunderous waves and drive the rain with gale force.

Ninstints Village is on the east side of the island in a small shallow bay about 200 m long, protected from the fury of the ocean and winds by a small islet, almost the length of the bay, that runs directly in front of the village. A narrow channel about 30 m wide is the only access to the bay, which completely empties at low tide (Fig. 2).

The story of the once flourishing culture is incomplete and tragic. The only history of the village is recorded in the logs and journals of explorers and fur traders, which has been researched and reconstructed by contemporary authors (Acheson, 1980; Duff and Kew, 1957). It is a story of sea otter fur trading and unusual affluence; a story of aculturization and a story of decimation from fighting and smallpox. Duff and Kew (1957) report that there were 307 people at Ninstints Village between 1835 and 1841, and only 30 in 1884. The village was abandoned shortly after 1884; the exact date is not known.

Today, there are no known living descendants of the people of the village. Because of this and because the Haida had no written language, there is little known about the people who lived there. Thus their lineage, the relationship between the clans, the meaning of the totemic figures, etc. must be interpreted by ethnologists (Swanton, 1905). The straggling line of weathered totem poles around the rim of the bay poses many unanswered questions. Who carved them? Why so many mortuary poles? When were they erected? For whom were they erected? The house remains also pose similar questions. Who lived in them, how many, for how long, and so on?

The cultural heritage in Ninstints Village is unique.

In 1884, Newton Chittendon visited Ninstints Village while exploring the Queen Charlotte Islands for the British Columbia Provincial Government. He recorded 20 houses and 45 totem poles (Duff and Kew, 1957). Since then, 15 totem poles have been removed and placed in museums or outdoor displays (Barbeau, 1950; Duff and Kew, 1957; Anon., 1981).

Today, there are only the fallen remains of the longhouses, 21 standing poles and six recognizable poles which have fallen. Ninstints Village has the largest and best-preserved collection in the world of totem poles in situ. The house remains are an outstanding resource for documenting classic Haida house structures and the carved poles are an important record of the unique Haida totem pole carving.

Of the 27 poles, 20 are carved mortuary poles, three plain uncarved mortuary poles, two carved memorial poles, and two carved house frontal poles. The frontal poles have fallen and are almost unrecognizable.

Halpin (1981) defines the different types of poles:

"House front post - poles standing against the front of the house usually containing the opening through which the house was entered.

"Memorial or commemorative poles - poles erected in honour of a person who had died, usually by the successor to his name.

"Mortuary poles - poles containing the remains of the dead, usually in grave boxes incorporated into the pole."

These totem pole types are illustrated in Figure 3.

The carving of the poles shows great virtuosity and technical skill. The style among the poles is consistent and represents a mature style which shows an outstanding respect for the cylindrical form of the tree. The style is unique, but similar to other Queen Charlotte Islands Haida totem poles.

It is not known why there were so many mortuary poles.

Haida funerary practices are known only from ethnographic reconstruction. In Blackman's review (1973a and b), she states:

"The body of an important individual might be put in a niche carved into a gravepost which might contain the remains of other members of the deceased's matriclan.

"Such posts would thus be 'communal markers'."

If the deceased were an important person of either sex, a gravepost or memorial totem pole might be raised in his/her honour.

Blackman (1973a) also reports that Collison, the first Anglican missionary to Masset, QCI, in 1878 wrote that the dead were placed in hollowed poles carved and erected near the houses. Haida traditional methods of disposal of the dead were abandoned in Masset in favour of interment, due to the introduction of Christianity around that time.

The size of the poles varies with their use. The two memorial poles are 15.5 and 11.5 m high, while the mortuary poles range from 5.2 to 7.7 m (average: approximately 6 m) and at the base, all are between 2.2 and 3.2 m in circumference (average: 2.8 m).

Details of type, dimensions and placement of the totem poles are listed in Table 1.

Many of the mortuary poles are noticeably larger at the top than at the base (Fig. 4). Analysis of branch (knots) orientation verified that, in this case, the top of the pole is the wider base of the tree from which the pole was made.

The age of the totem poles is not known.

Duff (1964b) discussed the antiquity of totem poles. From his appraisal of the evidence from archival research and informants, he suggests that frontal poles, mortuary poles and memorial poles were a well-established feature of the precontact culture of the Northwest Coast Indians.

On the other hand, Barbeau (1942) states (for totem poles other than carved internal house posts): "It is only after 1830, more precisely after 1850, that totem poles became a feature of the village of the Haidas."

The written record for the poles at Ninstints dates to 1884. Thus, they were at least 98 years old in 1982.

A dendrochronology research project, which will tell the time when the trees were felled, is underway.

In September, 1981, Anthony Island was designated by UNESCO as a World Heritage Site because of this outstanding cultural and natural heritage on the island.

Simonsen (1981) describes this World Heritage Site as "the only one of its kind to exemplify dramatically the achievements of a once flourishing culture in the form of totemic art within a natural setting."

Anthony Island was never registered as an Indian Reserve, but the main island and surrounding islets and foreshore have been protected by provincial legislation since 1957.

The main island was designated as a Class A Provincial Park in 1957. As stated before, the islets and foreshore were designated an Ecological Reserve in 1979. In the spring of 1980, the island was designated as a Provincial Archaeological and Heritage Site. Thus, the World Heritage designation will complement the existing provincial government heritage program.

When Anthony Island became a Provincial Archaeological and Heritage Site, a planning task force was struck which outlined the objectives, goals and future management of the site.

The basic points of the goals were (Anon., 1981):

"To conserve, in situ, cultural remains and features relating to the occupation of Skung-gwai by historic and prehistoric Haida Indian peoples.

"To conserve the natural environment of the Park in a manner which is in harmony with the other goals as stated here.

"To allow public visitation to the park in a controlled manner so as to ensure the conservation of cultural features and the natural environment.

"To provide programs which will interpret the island's cultural and natural history."

Thus, there are many aspects of the future development of this unique World Heritage Site, but this paper is solely on the conservation program for the totem poles and house remains.

A preventative conservation program for the cultural remains (the totem poles and longhouse remains) was initiated by the Conservation Division of the British Columbia Provincial Museum in 1978.

Today, the ongoing conservation program is under the overall direction of Richard Beauchamp, Head of the Conservation Division at the British Columbia Provincial Museum. It is a cooperative program, involving Haida Indians of the Skidegate Band Council, the Heritage Conservation Branch and the British Columbia Provincial Museum of the Ministry of the Provincial Secretary and Parks and Outdoor Recreation Division of the Ministry of Lands, Parks and Housing.

The conservation program is based on sound philosophy and ethics.

Martin Weaver, in the article "Conservation Philosophy: The Experts Respond" (Anon., 1982), outlines the basic philosophy of conservation for historic monuments and sites as upheld by the International Council of Monuments and Sites (ICOMOS) which is applicable to this program:

"It is essential to the conservation of monuments that they be permanently maintained. The aim of conservation is to retain or recover the cultural significance of a monument or site and must also include provisions for its security and its future, as well as its maintenance.

"The conservation of monuments is facilitated by using them for socially useful purposes. Such uses, though desirable, should not change the layout or decoration of the monument or site. Conservation is based on respect for existing fabric and should involve the least possible physical intervention. Above all, it should not distort evidence provided by the fabric.

"No new construction, demolition or modifications should be permitted to damage an original setting. The conservation of a monument or site implies preserving a setting in terms of scale, form, colour, texture and materials.

"A monument or site should remain in its historical location. The moving of all or part of a building or work is unacceptable unless this is the sole means of ensuring its survival.

"The removal of contents which form part of the cultural significance of a monument or site is unacceptable unless it is the sole means of ensuring their security and preservation. Such contents must be returned should changed circumstances make this practicable. Contents may include sculpture, paintings, decoration, furniture and artifacts.

"Conservation of a monument or site should take into consideration all aspects of its cultural significance without unwarranted emphasis on any one at the expense of others.

"Conservation should make use of all disciplines which can contribute to the study and protection of a monument or site. Techniques and materials used should be traditional, but may be compatible modern ones for which a firm scientific basis exists and which are supported by a body of experience."

This philosophy forms the basis of the Conservation Program for Anthony Island.

The conservation program also respects the code of ethics for the artifact material, as outlined by the American Institute of Conservation (AIC, 1979). Pertinent points relating to the obligations to historic and artistic works (totem poles and house remains) are as follows:

"Respect for Integrity of Object. All professional actions of the conservator are governed by unswerving respect for the aesthetic, historic and physical integrity of the object.

"Competence and Facilities. It is the conservator's responsibility to undertake the investigations or treatment of an historic or artistic work only within the limits of his professional competence and facilities.

"Suitability of Treatment. The conservator should not perform or recommend any treatment which is not appropriate to the preservation or best interests of the historic or artistic work.....

"Principle of Reversibility. The conservator is guided by and endeavors to apply the 'principle of reversibility' in his treatments. He should avoid the use of materials which may become so intractable that their future removal could endanger the physical safety of the object."

The priorities of the conservation program must be based on the needs of the individual totem poles.

In developing a conservation program for Australian aboriginal carved trees, Florian states (1982):

"...it must be realized that each artifact is unique. Unique in both its environmental and cultural history. Thus the conservation program must be flexible enough to allow for the uniqueness of the individual artifact."

This also is applicable to the totem poles and house remains on Anthony Island.

There have been many outdoor totem pole restorations in British Columbia (Barbeau, 1950; Duff, 1964a; Ward, 1976; Darling and Cole, 1980). In most of these, the poles were cut down, repainted, placed in cement bases or supported on or above cement pads and bolted to a supporting upright. In the Skeen Project (Darling and Cole, 1980), 30 totem poles were restored; now most of them have been completely destroyed. Ward (1967) pointed out that the bases rotted more quickly in the concrete than if directly placed in the ground. Bolt fastenings produced lines of weakness which eventually caused splitting. The main problems in this project were that priorities of the restoration program were for tourist promotion and commercial gain, while the totem poles themselves were treated as being of lesser importance. Also, the methods of restoration had not been thoroughly tested. Finally, the program lacked a continuing responsibility for maintenance. There have been other methods of restoration suggested (Ward, 1978), but before these could be considered by us, an analysis of each totem pole has to be undertaken and the method of restoration thoroughly tested.

To date, the conservation program has taken three phases. An initial phase of preventative conservation, followed by a second phase of preventative conservation which was recommended as a result of a detailed description of the vegetation at Ninstints Village and the role of vegetation in the deterioration of the totem poles and house remains (Hebda, 1980; Florian, 1981; and Florian and Hebda, 1981). The third phase is an analysis of each totem pole to determine what, if anything, should be done in terms of conservation treatment to stabilize them _in situ_. The need for detailed analysis is emphasized by Florian (Anon., 1982):

"...a complete analysis to determine the physical, chemical and biological aspects of the heritage site or material of the heritage object must be undertaken prior to conservation ..... The interpretation of this analysis is necessary to determine 'what', if anything, should be done...."

The details of the conservation program are presented chronologically.

The initial preventative conservation, initiated in 1978, was undertaken and supervised by Richard Beauchamp and Barbara Kennedy, Conservators at the British Columbia Provincial Museum. This ongoing activity involved removing the vegetation which was causing physical damage by growing on the totem poles or immediately around them. Condition reports of the individual poles were also started (Beauchamp _et al_., 1978).

At the initiation of the conservation program, the 26 totem poles were seen in a shroud of spruce foliage (Fig. 5) which extended right to the beach and, in some cases, was growing in the poles. Carved exposed end grain also supported bryophytes and small vascular plants.

The second phase of preventative conservation was recommended after analysis of the vegetation and its role in deterioration of the totem poles and house remains. In 1980, to better assess the hazards of this engulfing spruce forest, Florian and Hebda (1981) "felt that if the totem poles and house remains were to be conserved _in situ_, it was essential to assess the relationship between the present environment and the cultural remains."

The present environment was described by vegetation data and soil samples collected in 1980. The on-site vegetation formed seven vegetation types, as described by Hebda (1981):

"1. **Gravel Beach.** The shelving, gravel beach (pebbles and coarse sand), which forms the frontal apron of the site, is sparsely colonized by hardy, salt-tolerant species. The most conspicuous of these is sour grass (_Rumex salicifolius_) which sprawls over the gravel. Poorly developed rosettes of other plants, such as _Conioselinum pacificum_ also occur. This vegetation is scarcely established because the habitat where it can grow is restricted by the steep angle of the beach. Best examples of it are at the north end of the beach.

"2. **Beach Grasses.** A band of tall, coarse grasses, predominantly Dune wild rye grass (_Elymus mollis_) and Pacific small reed grass (_Calamagrostic nutkaensis_) occupies the zone behind the beach. Tussocks of these grasses grow among driftwood tossed up by the storm waves. Beach grasses are best established at the north end of the site, but form only an intermittent band in front of the central groups of poles.

"3. **Shoreline Sitka Spruce.** An intermittent wall of intermediate to tall Sitka spruces occupies the front of the site behind the band of beach grasses. Spruce branches and small spruce trees form a dense screen across the seaward face of the northern part of the site. The ground is littered with Sitka spruce needles and cones, scattered patches of grasses and the moss _Rhytidiadelphus loreus_. This vegetation type has been distinguished from 'Sitka spruce forest' because of its distinct appearance and prominent position in front of the site.

"4. **Young Sitka Spruce, Grasses, Moss.** Some openings within the mature Sitka spruce overstorey are occupied by a dense, 1 m tall association of Sitka spruces, straggly plants of velvet grass (_Holcus lanatus_) and Pacific small reed grass (_C. nutkaensis_), all surrounded by a loose matrix of the moss, _Rhytidiadelphys loreus_. During maintenance activities in the summer, many small spruces were cleared out, exposing loose moss cushions with bare ground at their core. Foot traffic through such cleared spots disturbs and erodes moss and soil humus because protective cover has been removed.

"The spruce/grass/moss vegetation occurs behind the shoreline Sitka spruce band at the northern end of the site and in large patches at the back of the site on the house terrace at the foot of rock faces. This vegetation likely was more widespread before recent clearing, especially in open habitats where Sitka spruce was beginning to invade.

"5. **Grass Meadow.** Velvet grass, Pacific small reed grass and possibly other grasses occupy large open patches at the front of the site and on the terraces of the south end of the site (burnt poles). Growth form is low, maintained probably by clearing and human traffic. Velvet grass (H. lanatus) is an excellent colonizer of acidic humus substrates (grows well on exposed peat). This grass also withstands traffic well, adopting a low growth form. Where trails at Ninstints pass through Grass Meadow, erosion of the soil does not occur because velvet grass resists foot damage and protects the surface.

"6. **Rush Tussocks.** Seepage sites and mucky habitats are dominated by common rush (Juncus effusus). Tussocks reach 1.5 m and because of this height are relatively unstable. Small spruces (1 m) may grow among some of the tussocks. Common rush growth protects the wet ground surface, which otherwise, if subjected to foot traffic, would become a muck hole.

"7. **Sitka Spruce Forest.** Tall Sitka spruces form a more or less closed canopy over most of the central part of the site (especially on the back terrace with the house remains). The forest floor is covered in humus (needles and cones) or patches of mosses and liverworts (feather moss Stokesiella oregana, Plagiothecium undulatum, Dicranum spp., Rhytidiadelphus loreus and others). Where light filters in, straggly grass plants, probably C. nutkaensis, grow. At the back of the central part of the site, beside the small creek, there is a large expanse of the grass Festuca. A couple of 3 m tall elderberry (Sambucus racemosa) plants grow at the edges of the Sitka spruce forest.

"The microenvironment under the trees is very humid, with little wind or sun penetrating. Moss growth is excellent, especially on dead wood such as house timbers."

The totem poles are located mainly in the 'Young Sitka Spruce, Grasses, Moss' vegetation type (Fig. 5). All the house remains are in the 'Sitka Spruce Forest' vegetation type (Fig. 6.).

The bryophytes in the different vegetation classes and on the totem poles are described by Hebda (1981). He reported,

"Five bryophyte microhabitats on poles at Ninstints:

1. Rotted heartwood core;
2. Cracks or fissures on surface connecting to heartwood core;
3. Ledges (horizontal or angle) formed by carved design;
4. Vertical face of pole;
5. Base of poles where bacteria, fungi and plant roots are destroying wood."

In all above microhabitats, except the vertical face of poles, mosses and liverworts are established on a crumbly substrate which is produced by degradation of wood and an accumulation of forest litter.

"The most frequently found mosses in these habitats are cushion mosses Dicranum scoparium, Dicranum fuscescens, Isothecium stoloniferum, and Plagiothecium undulatum.

"Rhizomnium glabrescens and Isothecium stoloniferum are particularly interesting, because these mosses can grow on the as yet undecomposed but softened wood surfaces of poles. These two species seem somewhat tolerant of exposure and drying-out and hence survive even on poles in open habitats.

"Cushion moss, Dicranum scoparium, is the most successful of all bryophytes on exposed faces of poles, and forms small cushions in fissures or cracks which retain some moisture and possibly connect to rotten heartwood inside.

"Vertical faces of poles (microhabitat No. 4), excluding fissures, are not successfully colonized by mosses or liverworts, unless they are heavily shaded and protected from sun and wind. However, the lichen Cladonia macilenta does become established on seaward faces, forming a grey crust which may sprout low (1 cm) branched stalks. The lichen colony is unlikely to be responsible directly for wood decomposition, even though it is partly a fungus. But the colony increases moisture retention and hence improves the conditions for wood rot."

A suggested role of vegetation in pole deterioration is also described by Hebda (1981):

"**Vascular Plant Damage:** Vascular plants are the primary agents of pole and timber damage and play both indirect and direct roles in deterioration of wooden materials. Roots of Sitka spruce, salal (Gaultheria shallon), crowberry (Empetrum nigrum), Ribes sp. and red huckleberry (Vaccinium parvifolium) penetrate...the poles. Large Sitka spruce roots have destroyed a number of poles. Trees have been removed, but roots remain embedded. Roots of shrubs proliferate into poles, especially in the heartwood or on ledges. Not only do shrubs cause physical damage, but they help retain humus and moisture on poles, accelerating microorganism decomposition of wood.

"This indirect role of vascular plants has been most important in decomposition at the base of poles. Here, shrubs, grasses, etc. have produced optimal conditions (moisture or shade) for bacterial and fungal attack on wood. Fallen poles and house timbers have been heavily damaged in this way. Once a pole or timber falls to the ground, it rots very quickly.

"**Bryophyte Damage:** Bryophytes are not themselves directly responsible for wood deterioration, as most of these plants obtain nutrients from rainwater or detritus produced by microbial activity. Bryophytes are, however, indirectly responsible for pole deterioration and often disfigure poles.

"Bryophyte colonies produce two effects detrimental to pole survival:

1. Colonies retain moisture, thus maintaining an optimal environment for wood rot. Microorganisms are protected by the colony and, especially on ledges, can continue attack along the grain into the pole.
2. Cushions and mats provide beds for germination of vascular plant seeds, such as salal (Gaultheria shallon), crowberry (Empetrum nigrum), Sitka spruce and red huckleberry (Vaccinium parvifolium).

"Most of the Coast Forest mosses (those growing at Ninstints) require shaded moist microenvironments, such as exist under the canopy of Sitka spruce stands. These environments also provide optimal growth conditions for microorganisms and fungi which thrive on dead organic matter, especially wood."

Soil analysis was also undertaken by Hebda (1981).

"Soil samples were obtained from off- and on-site environments and specifically from the bases of poles, both from the surface and at depth. Purpose of sampling was to determine pH and general nature of soils on the site and in which poles were set.

"Methods: Samples were collected in the field and placed in plastic bags. pH was determined in the British Columbia Provincial Museum Archaeology Division laboratory, using a Fisher Accumet Model 140 pH meter. (Samples were made into a 1:1 and 1:2 soil/distilled water slurry.) Two separate determinations were made for each sample. Results of pH analyses are presented in Table 2."

A discussion of the results is given by Hebda, 1981:

"**Off-Site Soils:** The upper 0.10 to 0.30 m of forest soil horizon consists of undecomposed to decomposed (humified) organic material (cones, needles, wood). The pH of this humus is very acidic, varying between 4.8 and 5.2. In contrast, sands and gravels from the beach in front of the site are free of humic components and have a neutral to moderately basic pH (Table 1).

"**On-Site Soils:** Surface deposits, usually to a depth of 5 cm, consist of acidic organic humus similar to material on the forest floor; pH ranges from 4.8 to 6.0. In this well-aerated moist layer, particularly at the surface, biological activity is pronounced. These conditions are particularly suitable for wood-decomposing microorganisms of the forest floor (Kaarik, 1974). In other words, conditions are optimal for decomposition, for, as far as the decomposers are concerned, the base of a pole is just another log on the forest floor. Attack at base of poles has proceeded 2 cm inward in most cases.

"At depths greater than 5 cm, soil profile grades to black organic-rich shelly gravel. This deposit contains cultural materials, such as window glass, a stone bowl, etc. This shelly gravel has neutral to basic pH, and is free of humic components. pH levels and composition of sediments compare to that of beach gravel (see Table 1, SN 6). Preservation of poles at that depth is unknown, because no excavations were made. Preservation may be substantially better than at ground level, because of isolation from decomposers at the aerated soil surface.

"During village occupation, these coarse-grained alkaline deposits were at the surface and hence provided the natural setting around poles. Acid humus accumulated following abandonment and subsequent encroachment of the forest."

As previously mentioned, it was essential to assess the relationship between the present environment and the cultural remains. The vegetation data and soil analysis, as described above, were considered the important aspects of the present environment which related to the deterioration or hazards of the cultural remains.

At this stage in the conservation program of the cultural remains, because of time limitations, only the totem poles were analysed in detail. The house remains will be analysed next. More detailed condition reports of the individual totem poles were started in 1980.

The reports revealed that each totem pole was unique in its condition. For example, some of the poles showed no losses at ground contact, whereas others showed extensive losses (Fig. 4). Some were physically intact and others had portions split off (Fig. 7). Some showed fine details in carving and others isolated regions of deterioration on the carving (Fig. 4). Some had fallen and others not. These are only a few examples. This unexpected degree of variation promoted a detailed analysis of the vegetation and totem pole changes over the past 79 years, which is illus- trated in the extensive British Columbia Provincial Museum collection of ethnohistoric photographs of Ninstints Village, covering the period of 1901 to 1980.

The vegetation changes over the 79 years were very dramatic.

Unfortunately, there are no photographs of Ninstints Village prior to abandonment. Thus, the original village environment can only be imagined to be similar to that in photographs of occupied villages, such as Figure 8, which shows a typical village plan of the row of houses parallel to the beach just above high tide mark, with the totem poles placed in front of the houses. These poles are placed in gravel shell areas with little surrounding ground vegetation. Ninstints, by conjecture, was the same.

Some of the environmental changes which occurred after abandonment are illustrated by the following: the Newcombe photographs of 1901 (Figs. 3 and 9) show Ninstints abandoned. The forest growth is restricted to behind the bluff which is approximately 6 m behind the houses. The vegetation among the houses and poles which grew after abandonment is made up of a few small spruce trees, isolated clumps of salal, elderberry and salmonberry of several meters in height. In front of the poles, a continuous herbaceous cover (nettles, composites, umbels) is in transition with bunchgrass at the beach level.

The 1913 Newcombe photograph (Fig. 3) shows a complete change of environment around the poles. The herbaceous cover is gone and replaced by beach grass or some coarse leaf grass. Among and behind the houses are salmonberry bushes. The reason for this dramatic change can only be guessed; it could be a result of fire or salt water damage.

The 1936 H.W. Soulsby photograph (Fig. 11) shows that the spruce forest has encroached from the bluff, in some areas almost to the height of the tide line. Young spruce trees ranging in size up to the height of the poles (5 m+) are in turn mixed with salal and other small shrubs which surround the poles.

The 1957 Bernard Atkins photographs (Fig. 12) show another dramatic change in the ground cover around the poles. The salal and salmonberry shrubs are dead and there is a low coverage of a fine low grass. The spruce forest in the back is engulfing the poles with its branches. Little salal and salmonberry can survive in the heavy shade.

The 1977 J. Haggerty photograph (Fig. 5) shows the overpowering height of the spruce trees and extent of forest covering among the tops of the totem poles. The ground cover around the poles is low grass cover with some small shrubs and spruce intermixed.

An environmental history of each pole was reconstructed (Florian, 1981b) to determine the cause of the differences of deterioration of each totem pole, by using the chronological ethnohistoric photographic record. From this information the physical change in poles can be followed in the past 79 years.

The following observations were made (Florian, 1981b):

"1. The present condition of the poles can only be understood by following the sequence of events that occurred with each individual pole.

"2. The fate of each pole is unique.

"3. No additional radial cracks, or extensive opening of radial cracks, have occurred since 1901.

"4. The weathered silver surface, where it has been continuously exposed, has retained much of its original sculptured details. The normal loss of surface cells due to weathering is a few mm per century.

"5. Loss of nailed or attached pieces has occurred by pressure from growing vegetation and corrosion of the nails.

"6. Exposed end grain and deeply carved areas and the burial niche collect sufficient organic material (seeds, needles, leaves) to support growth of moss liverworts and small shrubs such as salal and huckleberry. This litter and the vegetation allow moisture retention and allow wood-decaying fungi to grow.

"The leaf litter (conifer needles, deciduous leaves, dust, seeds), collected on horizontal surfaces, has a slow rate of decomposition. It takes about seven years on the forest floor before it becomes humified. This litter when humified may retain up to 150% moisture content, which supports growth of wood decay fungi. The acidic pH of conifer forest litter is selective but not limiting to fungi growth.

"7. Poles that have fallen, or which have had parts fallen off, have done so because of the weight of spruce trees growing in the pole itself or the growth expansion of spruce roots or trunks growing against the pole. The roots in the heart of the pole cause mechanical breaking of the heart rot interior, enhancing moisture penetration and retention.

"8. The poles have undergone some surface soft rot at ground contact, but not enough to weaken the pole to cause it to break at this point and fall by its own weight.

"9. The inclination or slant of the poles is due mainly to poor original placement or by the weight of spruce trees growing in the poles.

"10. Mechanical damage has occurred by abrasion of boughs and vandalism.

"11. Fallen poles in a horizontal position in ground contact retain moisture which encourages complete coverage of mosses, lichens and liverworts and wood-decaying fungi. All such poles are undergoing active deterioration."

The recommendations for immediate preventative conservation which follow from Hebda's analysis (1981) of the role of vegetation and soil on the deterioration of the poles, and Florian's condition reports (1981b) and environmental history of each totem pole, are listed below, along with the actions which have been taken:

1. Physical stabilization of poles by continuing removal of spruce roots or trunks which extend out of the poles, but are not embedded in the pole; and physical support of leaning or unstable poles.

• What could be started using manpower and a stepladder has been undertaken; in the future, scaffolding will be available to allow better access to the poles' full height.

2. Kill <u>in situ</u> vascular plants and bryophytes growing in the poles. Do not remove the vegetation.

• In 1982, several cryptocides were tested on bryophytes growing on non-artifact material on the site. Also a systemic herbicide is being tested on huckleberry and salal growing on non-artifact material on the site. The results were be observable next summer.

3. Remove humus layer from around the base of the poles at ground level and replace with beach gravel.

• The removal of the humus from around the bases of the totem poles required an archaeological excavation permit, because the site is a designated archaeological site. In June, 1982, archaeologist Steve Acheson of Heritage Conservation Branch excavated 2 m square around each pole base. The humus was removed to the next culturally altered level which was the shell midden. The artifacts which were excavated were post-contact, including mainly china fragments, trade beads, firearm pieces and iron remnants. The excavated areas were filled with clean beach gravel.

4. Replace the humus under fallen poles with beach gravel and place the fallen poles on some support to eliminate ground contact. Protect the fallen poles from rain.

• Where possible, the humus has been removed, but this job was limited because of lack of mechanical equipment to assist in moving the fallen poles. A chain-driven tripod hoist has been requested for 1983. Architectural designs for protective structures are under consideration.

5. Remove spruce overstorey to eliminate moist shaded microenvironment.

• The removal of the spruce boughs and small trees has been ongoing since 1978. There was always an underlying unspoken constraint against removal of the trees close to the totem poles. It originated from the western acquired mystique and aesthetics that the totem poles should be seen amongst the trees.

In summer of 1981, it was by accident that the full potential hazard of the spruce trees was realized. Several spruce trees at the back of the site had fallen because of their own weight and lack of deep root anchorage. The uprooted trees showed an extensive shallow root system, which, when uprooted, lifted all the humus and trees, etc. which were growing on top of it. It was realized that trees of similar age, which were growing among the totem poles, could also become uprooted and pull with them the adjacent totem poles.

Thus, in 1982, every effort was made to fell as many large trees as possible, adjacent to the totem poles and house remains. A professional tree feller, Tom Greene, a Haida from Skidegate, skillfully felled 18 trees without damage to the cultural remains (Fig. 13). The trees were immediately cut, removed and burned on the beach to prevent a fire hazard. Growth ring counts of the trees adjacent to the totem poles were from 50 to 56. One tree behind the house remains showed 85 growth rings. The age of the trees points to the fact that these trees are of no cultural significance, because they started to grow well after abandonment of Ninstints Village. Because of the hazard they presented to the cultural remains, they rightly were removed.

The mature forest (behind the cliff delineating the village), with its magnificent trees and shroud area of moss, is being preserved as part of the natural heritage of the island.

The third phase of the conservation program is the analysis of the individual totem poles.

The condition reports of the individual totem poles were initiated in 1978. Detailed observations and photographic records made in 1981 and 1982 have further revealed the tremendously variable condition of the wood in each pole.

One totem pole may have regions of wood altered by brown rot, white rot, soft rot and weathering, as well as regions of sound wood. Also, it may have regions invaded by bryophytes, rhizoids or roots from small herbaceous plants or large spruce trees.

To understand what it is that has to be conserved required the understanding of all of these materials, i.e. the chemically and physically altered and unaltered wood and the tissues of its invaders. The trees used for the totem poles are all western red cedar (Thuja plicata, Donn). A literature survey of the physical and chemical (mainly fungicidal extractives) characteristics of the western red cedar has been undertaken. Dr. D. Ethridge, retired Forest Pathologist of Victoria, British Columbia, undertook a literature survey of the fungi causing decay of western red cedar. Literature on the characteristic patterns or compartmentalization of decay in western red cedar, and the chemical and physical nature of decayed wood has also been researched. Some of the information is given in the following references: Florian, 1981a; Florian and Beauchamp, 1982; and Gardner, 1963.

The future analysis of the totem poles was outlined in the conservation working papers by Florian (1981b).

To determine the physical stability and residual strength of each totem pole, three aspects must be analysed: the internal region, the buried base and the exposed surface.

Ideally, a three-dimensional diagram of the whole totem pole, showing regions of decayed and sound wood, root inclusions and voids, etc., should be constructed. The purpose of this analysis would be to determine if the totem pole is physically stable or has a potential danger of splitting or falling due to weakened wood which cannot support its own weight. It should also determine if surface pieces are in danger of falling off.

Analysis of the internal physical condition is underway.

A literature survey on non-destructive testing for residual strength was undertaken, as were consultations on this topic with Mr. I. Allen, British Columbia Research, Vancouver; Mr. W.D. Gardner, Forestry Commission, N.S.W., Australia; Dr. Robert Kellogg, Forintek, Vancouver; Mr. P.R. Ward, Canadian Conservation Institute, Ottawa; and Mr. Martin Weaver, Heritage Canada Foundation, Ottawa. Radiography appeared to be the most promising method of non-destructive testing.

The Canadian Conservation Institute (CCI) Conservation Process Research Section offered assistance in radiography. Dr. David Gratton and Mr. Wilfred Bokman of CCI researched and tested the use of X-ray densitometry, supported with physical tests (Pilodyn penetration for density and percent moisture content) on totem poles at Ottawa, in museums and outdoor display.

In June, 1982, the CCI research team came to Anthony Island and radiographed and collected the physical data, at the ground level region, of all the standing totem poles and some of the longhouse board remains.

They initially have found the internal wood at this region of the standing totem poles to be incredibly dense. It will be a while yet before the data collected will be interpreted to give pertinent information about residual strength.

The interface region at ground level, in the wood technology world, is usually considered the most vulnerable area because of surface losses due to soft rot and decay. It must, however, be remembered that telephone poles and fence posts are quite different from the totem poles.

In totem poles, the ground level interface may not be the most vulnerable area, because of unique situations in the totem poles, such as: the presence of the burial niche at the top, internal spruce roots (Fig. 7), naturally occurring butt or heart rot, inversion of the pole (top of tree buried), height-diameter relationships, the small amount of surface sapwood, base diameters greater than 100 cm as compared to about 30 cm with telephone poles and fence posts, and non-load-bearing qualities.

It is interesting to note that, in photographs of the salvage operations in 1957, the cut ends of the poles removed show very little heart rot and an extensive region of sound wood, as is also the situation on many stumps of poles remaining at Ninstints. Despite this and because of the visible surface losses at ground level, it seemed appropriate to analyse this region first. Eventually, the whole totem pole will have to be analysed.

The analysis of the buried base was undertaken to determine the depth of the base, the ethnographic use of materials for erection of the pole and surface pretreatment, and surface deterioration due to soft rot, bacteria or waterlogging.

Excavation of the bases of two totem poles, which had been cut down at ground level in 1957, was undertaken during the summer of 1981 by Mr. D. Abbott and Mr. R. Powell, of the Archaeology Division of British Columbia Provincial Museum. Two 1 m square excavation pits were dug for each pole (Fig. 14). Arbitrary levels of 5 cm were removed sequentially to the depths of 82 cm and 128 cm. Unfortunately, the bottoms of the poles were not reached because of the obstruction of large boulders which were placed around the base during erection of the pole. It was found that the area or archaeological excavation was less than the area excavated for erection of the pole. The soil removed, a black gravel shell matrix, was only fill. There was no evidence of undisturbed stratigraphy of cultural deposits. The artifacts excavated were postcontact, mainly pottery beads and iron, with the exception of one stone adze blade.

Scrapings from the buried surface were taken and analysed for charred material which would suggest ethnographic pretreatment prior to erection. No charred material was observed.

Two increment cores were taken from each pole. These are being assessed by X-ray densitometry, not only to analyse the density of the wood, but also for dendrochronology.

Analysis of the physical state of the surface of the totem poles is underway.

On the carved totem poles, the wood presents a variable surface of end, radial and tangential grain. The differences of the wood tissue organization exposed on these three grains are shown in the scanning electron microscope (SEM) micrographs (Figs. 15, 16 and 17) of normal western red cedar.

The surface of the carved or uncarved totem pole is mainly tangential grain. Radial grain is minimal and is due to carving and radial cracks. The end grain, due to carving, is also minimal, but these regions of horizontal surfaces are the most badly deteriorated. The above are shown in Figure 4.

In all the standing poles, the tangential surface shows the typical silvered look of weathered wood. An extensive literature survey and analysis of this weathered wood has been undertaken (Florian, 1980).

Briefly, the process of weathering involved wet/dry, hot/cold cycles and ultraviolet (UV) photochemical reaction, which cause selective solubilization of the lignin in the cell walls of the surface cells (lignin gives wood cells their brown colour). Rain washes out the solubilized lignin, leaving wood cells with only a white cellulose shell. This weathered surface is a fraction of a millimetre in depth and acts as a UV filter, protecting the sound wood directly below it.

The weathered surface is an austere environment for decay organisms to grow in. UV from light and lack of retained moisture prevent growth of most surface fungi. The fungus Aureobasidium pullulans is one which is associated with the weathered surface. On an exposed surface which dries rapidly, it imparts a silver grey colour. If the surface does not dry rapidly because it is shaded or covered by vegetation, this fungus causes dark grey to black discoloration of the surface. On lower regions of the poles that have been surrounded by vegetation, the dark surface discoloration is caused by this surface fungus. Also, continued water retention and elimination of sunlight in these areas resulted in brown rot and white rot fungi decay of the wood surface. The greatest surface disfiguration and decay has occurred in the basal region which was surrounded by vegetation.

Minute samples from the tangential surface of the totem poles have been examined by light microscopy and scanning electron microscopy (SEM). An interpretation of the results is not yet complete, but the analysis thus far suggests that this surface is much more variable than was expected.

The following are just a few examples of this variability:

- Areas which are visually different in colour, such as the well-defined white spots seen on the eye of the carving in Figures 18 and 4, show no difference between their surfaces and those of adjacent grey areas when viewed under SEM (Fig. 19). Under light microscopy, the cross-section through the white area shows an unsuspected symbiotic relationship of green algae cells and fungal hyphae. Light sensitive green algae cells are lying in the spring wood (early wood) tracheids, protected by a coating of cellulose matrix of collapsed cells. Below the algae cells, fungal hyphae are in the late wood tracheids, causing typical morphological characteristics of soft rot deterioration (Fig. 20). This type of symbiot has not been reported before.
- Silvered grey surfaces show a surface of consolidated wood cells with a few randomly-placed dark pigmented fungal spores of Aureobasidium pullulans (Fig. 19). Darker grey areas are similar, but have more pigmented fungal spores (Fig. 21).
- Insect damage is also present. Wasps use the surface wood cells of the weathered surface, which are basically cellulose shells, to make their paper nests. The wasps rasp off the surface, leaving unweathered wood exposed.
- Beetle damage is apparent, on most surfaces, by flight and entry holes (Fig. 18). In a region of sapwood directly below the weathered surface, the beetles tunnel out the wood, leaving behind fecal pellets of sawdust (Fig. 22). The beetles selectively tunnel out the large thin-walled early wood tracheids, leaving the stronger late wood tracheids which maintain the integrity of the wood.

The southeast exposed carved surface of the totem poles shows a much greater degree of deterioration than the northeast exposed surface (Figs. 23 and 24). The southeast exposure is facing the prevailing winds. Thus, the differential weathering pattern suggests wind-rain erosion due to direction of exposure. It is interesting to note that in the 1901 and 1913 photographs (Figs. 3, 9 and 10), there appears to be no differential weathering pattern. A house frontal pole removed from Ninstints in 1957, and presently displayed at the British Columbia Provincial Museum, shows a similar differential weathering pattern (Fig. 25), as is seen on the totem poles today. From visual comparisons, there seems to be no obviously greater deterioration by 1982 than in 1957. One theory which could explain a period of intense weathering followed by a slowing down of the degree of weathering comes from the environmental history of Ninstints Village. In 1892, a fire burned a wind shelter of spruce trees at the southeast end of the village (Fig. 26). Photographs after 1936 show a regrowth of trees sufficient to act as a wind shield. Present-day tree removal on the village has not disturbed this wind shield. Negotiations are underway to place equipment by the totem poles to measure the present wind force.

The weathered surface is one example in which many treatments have been freely recommended. Usually the treatments recommended have had their success with freshly milled or kiln-dried new wood, or scraped or sanded weathered wood, not with pristine weathered wood. In many cases, the treatments may not be successful. For example, treating weathered cells with resin/wax used as a water repellent may increase surface wetting and water absorption, because of a lack of a firm base to hold the water repellent, or in other words because of the lack of coherent cell wall surface to support the deposit (Voulgaridis and Banks, 1981). Certainly, this is the case with weathered wood (Fig. 3).

The use of biocides on the weathered surface may also be a mistreatment. From SEM and light microscopy, it appears that the surface fungi which are ubiquitous and cosmopolitan may play an important role in adhering the cellulose shells of weathered wood cells to the surface (Florian, 1980; Florian, 1982).

To assist in determining a methodology to assess the need for treatment of the tangential grain surfaces, percentage of moisture content (% MC) and depth of surface deterioration were analysed.

This work was undertaken by Hugh V. Martin, Section Head, Wood Coating, Treatment and Preservaton at MacMillan Bloedel Research Laboratory in Vancouver, B.C. His report on the methods used were as follows:

"Test methods:

"Two conditions were measured on each pole - depth of rot and moisture content.

1. **Depth of Rot** - this was determined both at or up to 100 mm below grade line (depending on the amount of humus previously removed from the pole base by an earlier work party) and at approximately breast height, at least every 90° around the pole circumference. The technique used was to insert a spring steel vernier depth gauge of ·3 x 0.5 mm section, with a 1.5 x 0.5 mm square end tip, into the rot until resistance was felt (Fig. 27). The depth of rot was then measured to the nearest 1/16" with the vernier and converted to the nearest millimetre for record purposes. In those few areas where the rot depth exceeded the limits of the gauge (635 mm), the rot was probed with a sheath knife and the depth of the blade buried measured directly, to the nearest 2 mm, with a steel tape. The results are recorded in Table I.
2. **Moisture Content** - this was determined using a Delmhorst Pocket Moisture Tester, Model J, Serial #921, fitted with ½" stainless steel needle probes. The instrument has in the past been checked as accurate to ± 2%, over the range of 7 to 25% moisture in sound wood. While not extremely accurate, it therefore provides a quick and easy means of establishing when the moisture content is approaching fibre saturation point. The calibration was checked at least every 30 minutes while tests were in progress. Moisture contents were measured at, or at the minimum distance above, the grade line in the solid wood, and at approximately breast height in solid wood, at least every 90° around the circumference of the poles."

The range of percentage of moisture content, taken at the base and chest level, and depth of surface penetration at chest level for each totem pole are recorded in Table 1.

The data base for both depth of penetration and % MC is not large enough to form conclusions, but it does illustrate several points.

First, from the depth of penetration datum, it is apparent that there is a variable thickness of softer wood outside harder heartwood. This softer wood may be in part naturally less dense sapwood or heartwood, which has been deteriorated. It could be a normal characteristic of the wood, but freshly dried western cedar logs have not been tested for comparison.

The sapwood of western red cedar is reported to be approximately 30 mm in thickness. 73% of the recordings for depth of penetration were less than 30 mm. The variations from 1 to 30 mm could be due to unequal removal of sapwood during preparation of the log prior to caring, a normal variation or due to deterioration. This is under investigation. Depth of penetration of over 30 mm suggests pockets of decayed wood.

Secondly, the % MC datum was surprising. Considering the rapid and tremendous fluctuations of relative humidity at a beach environment with alternating sun and shade, the % MC of the sound tangential surface suggests that it is fluctuating, but below the fibre saturation point. At ground contact, in cases where there were pockets of decay, the % MC was above fibre saturation point. This suggests regions of active or potential biodeterioration.

The previous information on the surface of the totem pole relates to the tangential grain. The end grain is minimal, but the most badly deteriorated. The reason for this is basically due to its tissue organization, which can be compared to the end of a box full of drinking straws (Fig. 17). The open ends absorb water easily. Also, the lower horizontal surface collects more rain and drips. Weathering of end grain is more rapid than of tangential or radial grain. The under areas of exposed end grain are, in many cases, undercut due to deterioration. Many pieces of carving - for example, short legs (Fig. 4) - with exposed end grain at the top and bottom, are physically unstable because of the interior deterioration under the shell of weathered wood. This is the most imminent problem in physical stability of the carved surface.

Horizontal surfaces also collect dust and forest litter which may form an absorbant layer on which bryophytes may become established.

In the first phase of preventative conservation, the bryophytes growing on these end grains were removed, exposing a friable substrate of deteriorated wood, almost like humus. Over the past few years, this surface has been consolidated by the regrowth of the bryophytes. Because the micro-environment has changed due to cutting back the trees, the bryophytes' growth has been limited.

Investigation of the method of attachment of bryophytes to the end grain is underway.

Scanning electron micrographs (Figs. 28 & 29) show that the rhizoids are opportunists and pass through cracks and insect holes already present, and are not physically deteriorating the wood, but basically sewing it together. Tests are being undertaken on non-artifact material, using a cryptocide (weed killer for moss) to determine if it is satisfactory to kill these bryophytes in situ without removing them. Lichens also grow on end grain. Their role in wood deterioration is also under investigation. The scanning electron micrographs (Figs. 31 & 32) of a dusty yellow-green unidentified lichen suggest only surface attachment of this species to the wood. There are many other types of analyses which could be done, but have little application to the conservation needs of the totem poles.

One question which must be answered is the age of the totem poles. As mentioned before, a research project of dendrochronology, using X-ray densitometry, is underway. The project is being funded by the Friends of the Provincial Museum and contracted to Forintek, Vancouver, BC. At present, a feasibility study is underway to determine if the chronologies, already in their computerized shifting Unit Dating Program for western red cedar, are sufficient for cross-dating with the wood of the totem poles.

Pigment analysis was considered for assisting with dating. Two pigment samples, one found on a totem pole and one on a burial box, have been analysed by SEM, with an energy dispersive X-ray attachment, and found to be of trade origin. The possibility of repainting cannot be ruled out, thus significance for dating cannot be placed on this information alone.

Photogrammetry is also planned. This record will not only be essential for documentation, but will also assist conservation by allowing the monitoring of the rate of surface deterioration or other changes in the totem poles.

There are many other aspects which will have to be monitored, because of water relationships as a result of the change of environment due to the removal of the encroaching shoreline spruce trees: collapse of waterlogged wood and enlargement of radial cracks during drying are only two examples.

In closing, briefly, the conservation program has two basic aspects. The first aspect is the maintenance and control of the environment to prevent or minimize deterioration or physical damage to the totem poles, and the continual monitoring of the totem poles to observe changes that might occur due to environmental changes. The second aspect is the analysis of the materials of the totem poles. The chemical, physical and tissue organization of the materials must be analysed to determine if there is a need for conservation treatment. Logically, conservation treatments will have to be tested to assure that they will be successful in the natural environment and that they do not cause further deterioration or physical damage. Some of the analysis done may not be significant, but at this stage, it is important to record as much information as possible. It will make an essential record for assistance with other projects. It is an exciting conservation program, because of the many interdisciplinary contributions and involvements. We are indebted to all who have assisted - there are many.

To date we feel that we have stabilized the totem poles, which are suffering from the ravages of the past environment. We are now proceeding cautiously to determine the need for conservation treatment. We are also testing treatments on non-artifact material in the same environment as the totem poles. We can only hope to minimize the physical, chemical and biological deterioration due to wind, rain, the sun and organisms. The task is not an easy one and is one made more difficult by the isolation of Anthony Island.

Fig. 1. "Anthony Island is a small island at the southernmost tip of the southward corner of the Queen Charlotte Islands in the Pacific Ocean off the coast of British Columbia, Canada".

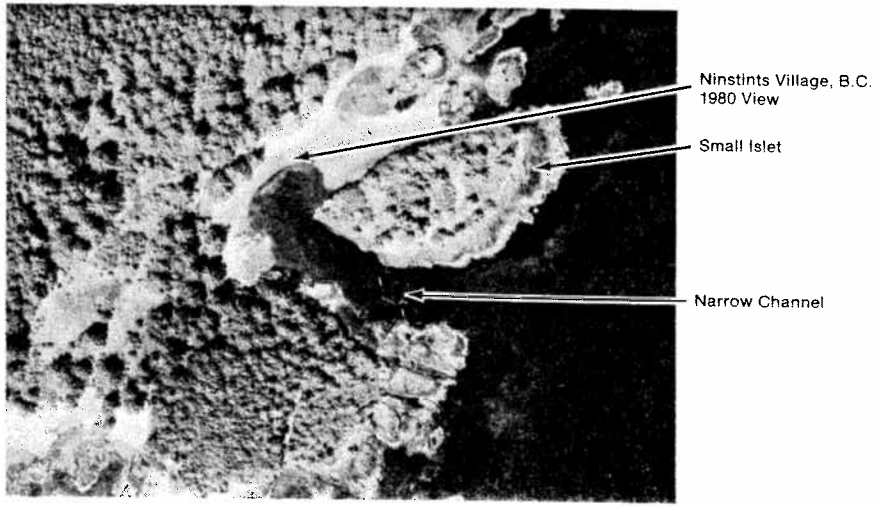

Fig. 2. "Ninstints Village is on a shallow bay protected from the fury of the open ocean by a small islet that runs in front of the village". This aerial view of the southeast tip of Anthony Island showing the position of Ninstints Village was taken in 1980. Credit Surveys and Mapping Branch, B.C. Provincial Government.

Fig. 3. Totem poles at Ninstints Village in 1901. The photo was taken several years after abandonment. Credit British Columbia Provincial Museum.

The totem poles with the cross head board are carved *mortuary poles*. The remains of the dead were placed in a burial niche behind the head board.

The two small figure poles with the potlatch hats are *memorial poles* which were erected in honour of a person who died. A large *house frontal pole* with three human figures on a bird head is shown at the far right.

Fig. 4. Totem poles Ninstints Village 1982. Credit Vicky Husband, Victoria, B.C.

— Many of the mortuary poles are noticeably larger at the top than at the base. In this case the top of the pole is the wider base of the tree from which the pole was made.

— The two poles illustrate the variability of deterioration of each pole. Some have losses at the bases, others not; some show fine detail of carved surface, some isolated areas of the carved surfaces have deteriorated.

— The tangential surface or grain of the standing totem poles show the typical silvered look of weathered wood.

— Portions of the pole such as the legs of the right hand pole are physically unstable because of the extensive deterioration at the top and bottom of end grain.

— The line down the eyes on this pole is due to a tree growth phenomenon and not deterioration.

Fig. 5. In 1977 these mortuary poles are seen in a shroud of spruce foliage. Vascular plants are growing in the burial niche at the top.

— Most of the totem poles at Ninstints in 1980 were in this vegetation type of "young Sitka spruce, grass and moss". Credit Jim Haggarty, British Columbia Provincial Museum.

Fig. 6. In 1980 the house remains were in the "Sitka spruce forest" vegetation type. The view is looking from behind the village towards the beach. Credit R. Hebda. British Columbia Provincial Museum.

Fig. 7. Some of the poles are physically intact, others have portions split off them by the falling of spruce trees growing in the burial niche.

— The pole on the left shows dished out areas resulting from fire damage which occurred in 1892.

— The line through the eye on the left is remnant of a mend which was done to even the surface off. Credit J. Haggarty, British Columbia Provincial Museum.

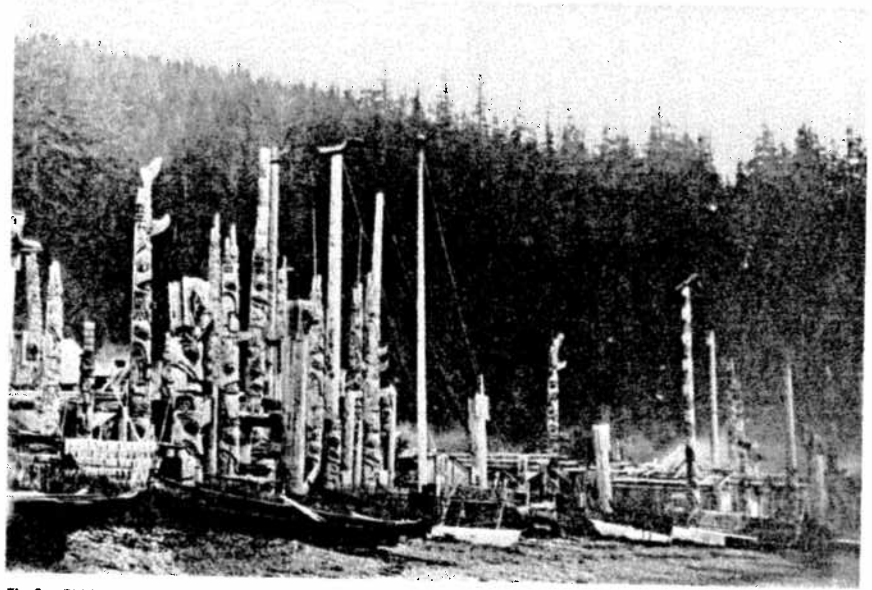

Fig. 8. Skidegate, Queen Charlotte Islands 1884. A typical village plan of the row of houses parallel with the beach just above high tide mark with the totem poles placed in front of the longhouses. The poles were placed in shell and gravel area with little surrounding ground vegetation. Credit R. Maynard, British Columbia Provincial Museum.

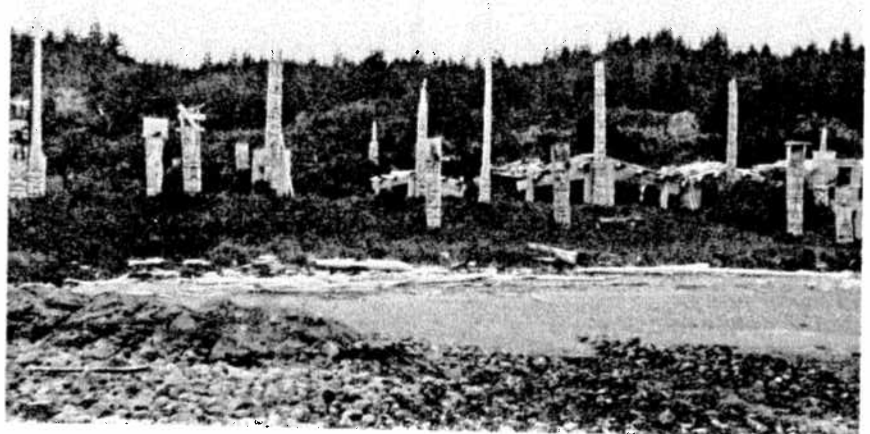

Fig. 9. Ninstints Village in 1901. The forest growth is restricted to the bluff behind the village but the village ground is covered with dense herbaceous vegetation which grew up after abandonment. Credit C.F. Newcombe, British Columbia Provincial Museum.

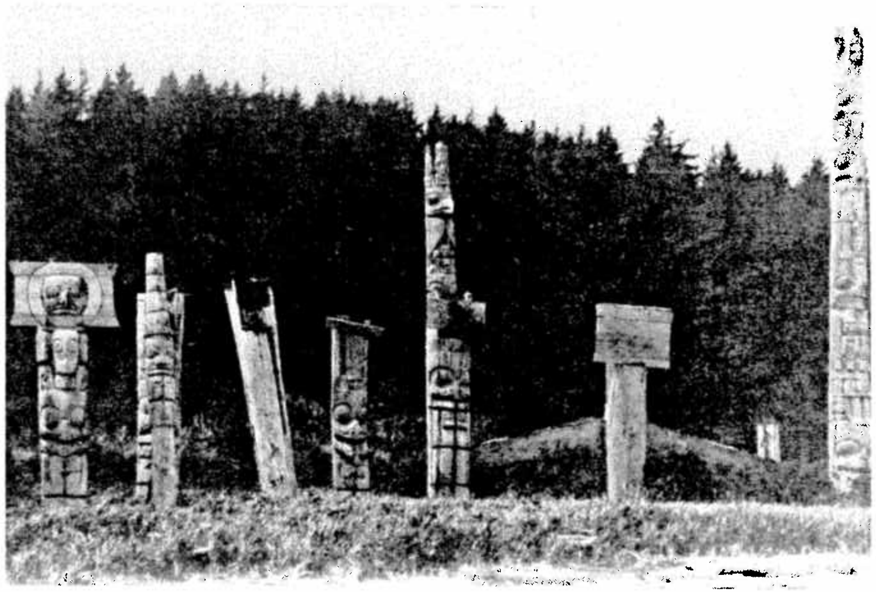

Fig. 10. Ninstints Village in 1913. There is a complete change from the herbaceous vegetation cover of 1901 (Fig. 9) which has been replaced by beach grass. The cause of this could be a ground fire or salt water damage. Credit C.F. Newcombe, British Columbia Provincial Museum.

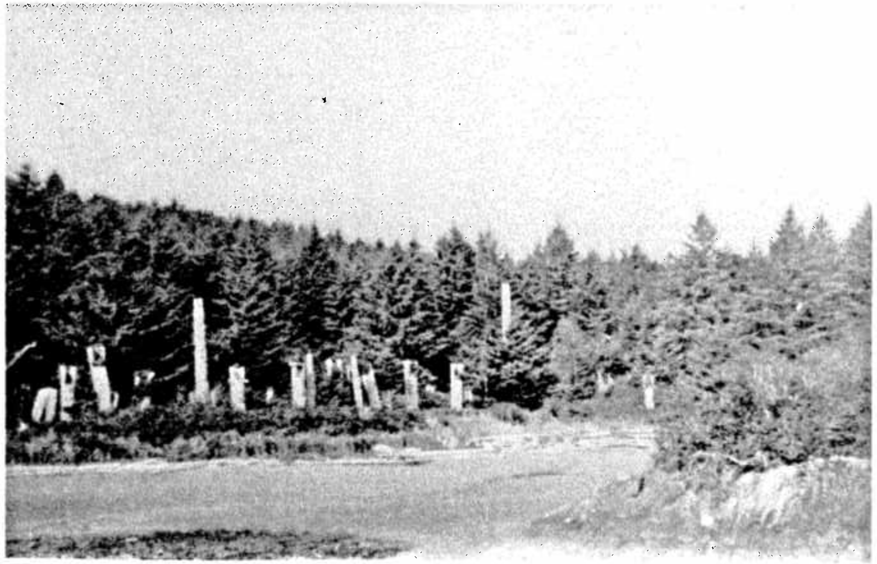

Fig. 11. Ninstints Village in 1936. The Sitka spruce forest has encroached from the bluff at the back (Fig. 9) to just above high tide mark. There are many young spruce trees among the totem poles and a heavy herbaceous ground cover. Credit H.W.S. Soulsby, British Columbia Provincial Museum.

Fig. 12. Ninstints Village in 1957. Another dramatic loss of herbaceous ground cover of 1936 (Fig. 11). This could be due to fire, salt water damage or shade from the overhanging Sitka spruce trees. Credit B. Atkins, British Columbia Provincial Museum.

Fig. 13. Ninstints Village in 1982. Tom Greene, a Haida from Skidegate, skillfully felled eighteen large Sitka spruce trees among the cultural remains without any damage to the remains. The trees in this area were shown to be 50-56 years old. Credit Vicky Husband, Victoria, B.C.

Fig. 14. · The excavation of the buried base of one of the totem poles cut down and removed in 1957 was undertaken by D. Abbott (above) and R. Powell, Archaeology Division of British Columbia Provincial Museum. Credit Ruth Kirk, Tacoma, Washington.

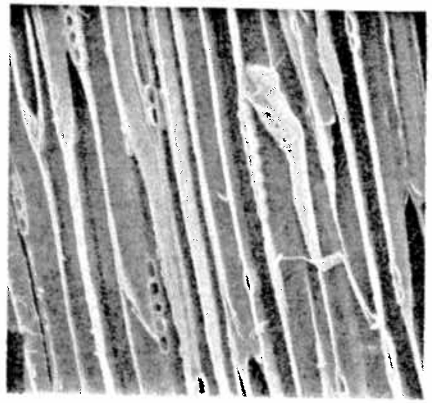

Fig. 15. Scanning electron micrograph of normal western red cedar, *Thuja plicata* Donn. Credit Mary Mager, Department of Metallurgical Engineering, University of British Columbia, Vancouver.

— showing tissue organization of the tangential surface grain. The rows of small cells are wood rays which run radially inwards at right angle to the longitudinally oriented wood tracheids. There are no pits present on the tangential walls of the wood tracheids.

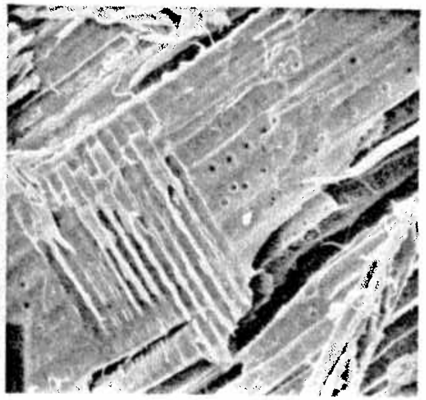

Fig. 16. Scanning electron micrograph of normal western red cedar, *Thuja plicata* Donn. Credit Mary Mager, Department of Metallurgical Engineering, University of British Columbia, Vancouver.

— showing tissue organization of the radial surface grain. The group of narrow cells are the wood rays placed across the wood tracheids. The round structures on the radial walls of the wood tracheids are bordered pits which allow water to move from cell to cell.

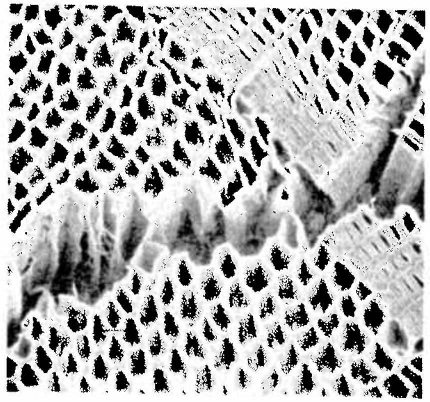

Fig. 17. Scanning electron micrograph of normal western red cedar, *Thuja plicata* Donn. Credit Mary Mager, etc.

— showing tissue organization of the cross section on end grain. The end grain deteriorates more rapidly than the tangential and radial grain because the surface is horizontal and collects more rain or drips and debris and absorbs more water because the cells act like straws and fill up with water.

Fig. 18. The weathered surface shows variation in color. These sharply defined white spots provoked analysis (Figs. 19 and 20). Credit M.L. Florian, British Columbia Provincial Museum.

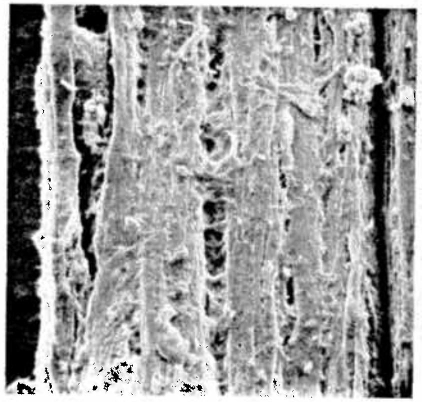

Fig. 19. The surface at the sharp line (running from lower left to upper left) of demarkation in color front grey to white showed no structural difference under SEM. The weathered tangential grain (Fig. 15) shows loss of wood ray cells and consolidation of collapsed wood tracheids. Credit M.L. Florian, British Columbia Provincial Museums*.

*All M.L. Florian, British Columbia Provincial Museum scanning electron micrographs were taken with an Ontec Autoscan Scanning Electron Microscope, Dept. of Metallurgical Engineering, U.B.C., Vancouver, with the assistance of Mrs. Mary Mager.

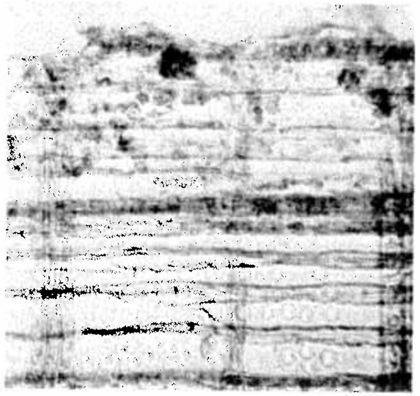

Fig. 20. A light microscopy photomicrograph showing the radial view through a thin section of the weathered surface of a white spot (Fig. 18). The top outer layer of collapsed cellulose cell walls shields the green algae cells (seen as dark nearly spherical bodies) lying in the outer early wood tracheids from intense ultraviolet light. On the region of the smaller late wood tracheids the cross thatch marks are characteristic of soft rot decay. The bottom wood tracheids and wood rays appear normal. The association of the green algae and soft rot fungi suggest a symbiotic relationship. The thickness of the altered wood is approximately 0.3 mm. Credit M.L. Florian, British Columbia Provincial Museum.

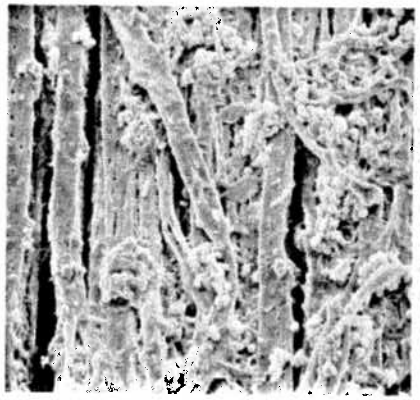

Fig. 21. SEM micrograph of a sample of the tangential weathered surface that is dark grey due to the spores of the fungus *Aureobasidium pullulans*. Credit M.L. Florian, British Columbia Provincial Museum.

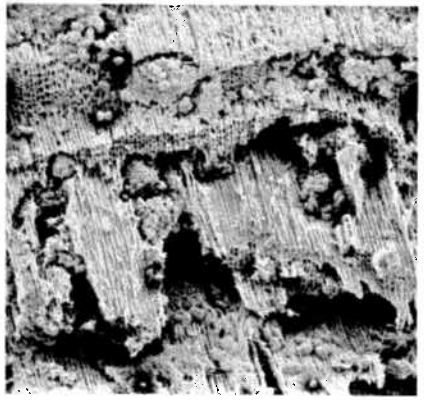

Fig. 22. SEM micrograph of a region of sapwood directly below the weathered surface. The beetles tunnel out selectively thin walled early wood tracheids leaving the stronger late wood tracheids which maintains the integrity of the wood. The tunnels are filled with feacal pellets and frass which are similar to sawdust. Credit M.L. Florian, British Columbia Provincial Museum.

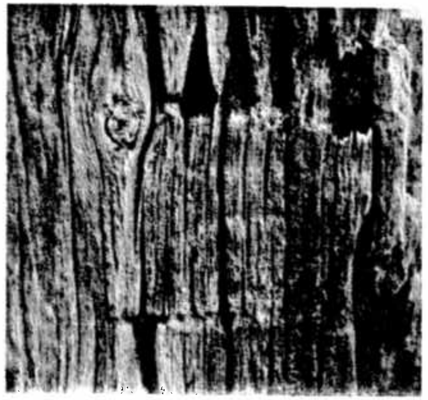

Fig. 23. See caption below.

Fig. 23 and 24. These two photographs show the same region on a totem pole but Figure 23 is taken of the southeast side of the pole and Figure 24 the northeast side. The differential weathering pattern is a result of the direction of exposure. The intense weathering is due to wind and rain direction. Credit M.L. Florian, British Columbia Provincial Museum.

Fig. 25. A similar differential weathering pattern is apparent on a totem pole removed from Ninstints in 1957. Credit M.L. Florian, British Columbia Provincial Museum.

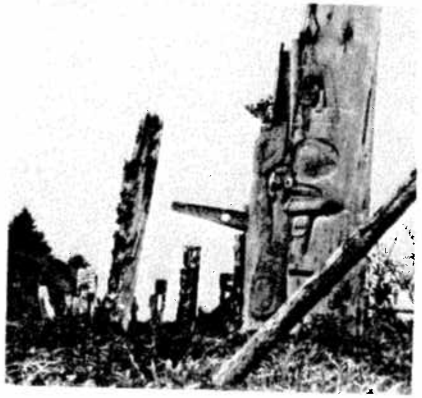

Fig. 26. This photograph taken in 1901 shows the dramatic effects of the fire of 1892 which burnt the southeast end of Ninstints Village removing a possible wind shelter and damaging many totem poles. Credit Newcombe, British Columbia Provincial Museum.

Fig. 27. Hugh V. Martin, MacMillan Bloedel Research Laboratory, Vancouver, B.C. taking depth of penetration measurements on the tangential surface of the totem pole with a spring steele vernier depth gauge. Credit Ruth Kirk, Tacoma, Washington.

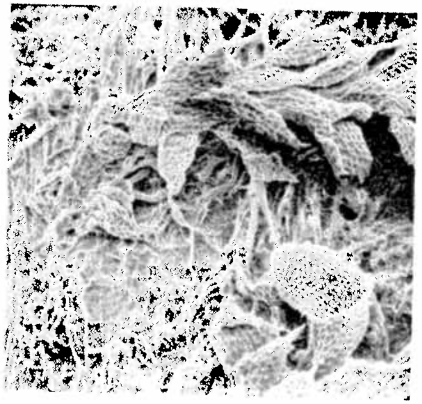

Fig. 28. SEM micrograph of a liverwort growing on the surface of consolidated weathered wood. Credit M.L. Florian. British Columbia Provincial Museum.

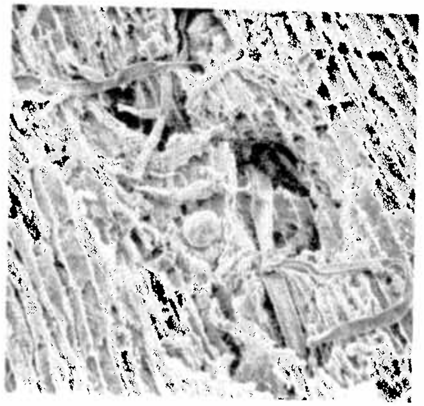

Fig. 29. SEM micrograph of the liverwort (Fig. 28) rhizoids which pass through cracks and insect tunnels but do not physically deteriorate the wood. Credit M.L. Florian. British Columbia Provincial Museum.

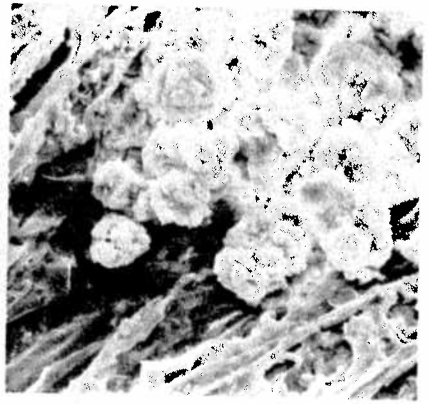

Fig. 30. SEM micrograph of dusty yellow green lichen growing on the top of weathered wood surface. Credit M.L. Florian. British Columbia Provincial Museum.

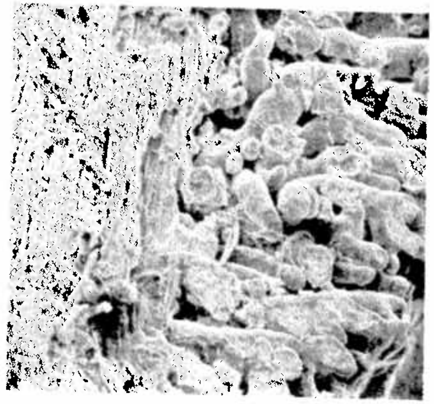

Fig. 31. This SEM micrograph of the undersurface of the above lichen (Fig. 30) shows flat ends of the thallus which suggest only a surface attachment to the wood with no thallus penetration. Credit M.L. Florian. British Columbia Provincial Museum.

Table 1. A tabulation of the type, dimensions and placement of the totem poles at Ninstints Village, Anthony Island. The last two columns give the results of analysis of range of % moisture content and depth of surface penetration. (Details of methods of analysis are given in the text)

1 f - front 2 pr - proper right 3 pl - proper left 4 b - back

X = positive - = negative

	Type of Pole			Dimensions		Placement			Range of % Moisture Content (from 4-10 reading)		Depth (mm) of Surface Penetration at Chest Level
Pole Reference Number	Mortuary	Memorial	Carved	Height (m)	Circumference (m)	Front compass reading	Inclination (approx.)	Fallen	Base	Chest level	
1	X		X	5.7	2.7	NE80	2f, 5pr		30+	17-20	11, 12, 15, 16
2	X		-	6.5	2.7	-	5pr		18-30+	14-22	6, 6, 12, 6, 38, 19
3	X		X	5.7	3.0	E	2.5b, 2.5pr		22-28	11-15	11, 11, 12
4	X		X	3.6	2.2				(fragment of pole not done)		
5	X		-	5.2	2.7		15b		20-25	17-25	8, 38, 38
6	X		X	4.8	2.8		10b		23-25	19-20	(fragment of pole not done)
7	X		X	6.5	2.8	NE45	10pr		24-30+	14-24	13, 19, 5, 8
8	X		X	5.7	2.6	NE60	17b		20-25	13-30	12, 14, 66, 8
9	X		X	4.7	3.0	NE60	2b		18-30	9-16	9, 7, 40, 12
10	X		-	6.8	2.7	NE60	12b		22-27	11-22	12, 12, 28, 68
11	X		X	5.7	2.7	NE60	0		23-28	12-21	18, 9, 3, 15, 32
12	X		X	6.3	2.9	NE60	2b		17-25	14-17	5, 6, 7, 5
13	X		X	7.7	3.2	NE60	2f		25-30	25-30	13, 24, 6, 0
14	X		X	6.9	2.2	NE60		X			
15		X	X	15.5	2.3	NE30	7pl		25-30	16-22	12, 37, 15, 6
16	X		X	-	3.0	NE30		X	-	-	20, 30
17	X		X	-	4.0	-		X			12, 10, 14, 125, 12
18	X		X	5.8	3.4	-		X		17-30+	
19	-	X	X	11.5	2.9	NE30	5rp, 5b		23-25	13-26	10, 125, 8, 6, 10
20	X		X	6.5	3.0	NE30	5b		21-30	14-20	73, 73, 12, 28
21	X		X	6.5	2.6	N	5b		30+	18-27	7, 20, 70
22	X		X	6.5	2.7	NW20	5pr		24-30+	24-25	12, 60, 40, 40
23	X		X	5.3	2.7	N	5f		24-25	15-19	12, 23, 38, 16
24	X		X	4.2	2.6	N	0		24-25	14-30	35, 20, 15, 150
25	X		X	6.7	2.7	N	0		25	15-19	22, 75, 82, 40

Table 2. pH Values, Soil Samples
Ninstints, Anthony Island, Queen Charlotte Islands

Submitted by R. Hebda, Archaeology
October 1, 1980

Samples taken September 26, 1980
pH Determination: 4-6 cc soil with enough water to make a slurry left to sit one hour
Standardized with Buffer pH 4

		Day 1 (1:1 Water to Soil)	Day 2 (2:1 Water to Soil)
SN-1	Near Base of Pole	5.3	5.4
SN-2	At Base of Pole	4.6	4.8
SN-3	Forest Floor	4.9	5.0
SN-4	Base of Pole	4.8	4.9
SN-5	Base of Pole shell present - 20 cm deep	6.7	7.0
SN-6	Beach Gravel shell present	7.8	8.1
SN-7	Base of Pole, Surface	5.7	5.5
SN-8	Base of Pole 20 cm deep	6.9	6.8
SN-9	Back of Pole, Surface	6.0	6.0
SN-10	Back of Pole Central Group 20 cm deep some small pieces of shell	6.7	6.5
SN-11	House Terrace	4.8	4.8
SN-12	Behind wall of House Pit	7.7	7.6
SN-13	House Floor	6.6	6.7
SN-14	Forest Floor	5.2	4.8
SN-15	Surface Behind Burned Pole	5.4	5.7
SN-16	Burned Pole	7.5	7.6

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ABSTRACT

PROGRAMME DE CONSERVATION DE MATS TOTEMIQUES DES HAIDA AU VILLAGE DE NINSTINTS, ILE ANTHONY, COLOMBIE-BRITANNIQUE

Mary Lou E. Florian, R. Beauchamp et Barbara Kennedy

L'UNESCO a classé en Septembre 1981, le village de Ninstints ou "skung-gwai", situé sur l'île Anthony dans les îles Reine-Charlotte, comme site du patrimoine mondial pour l'art totémique et les cultures qui en sont à l'origine. Le village, aujourd'hui abandonné, de Ninstints présente le rassemblement le plus considérable et le mieux conservé de mâts totémiques du monde entier; ils sont le produit de la culture amérindienne des Haida de Colombie-Britannique. Des 45 mâts totémiques que comptait le village en 1884, il en reste aujourd'hui 27. Bien qu'on puisse avancer avec certitude que, par analogie avec d'autres cultures aborigènes de la Colombie-Britannique, les totems avaient une fonction funéraire ou commémorative, la signification précise d'un rassemblement si considérable reste inconnue, en l'absence de tout document écrit et l'extinction probable de la communauté qui habitait le village.

Suite au classement du site par l'UNESCO, le musée provincial de la Colombie-Britannique a mis sur pied un programme visant à assumer la préservation du site et la conservation des totems. Les principes qui doivent guider cette action s'inspirent du respect de l'intégrité du site. Dans le cas des mâts totémiques de Colombie-Britannique, il s'agissait de ne pas répéter les mêmes erreurs qui, dans le passé, avaient entraîné la détérioration irréversible de plusieurs spécimens dans les parcs et musées de cette province.

Plusieurs étapes ont été nécessaires pour parvenir au but fixé par ce programme. La première consista en une évaluation de l'environnement physique, particulièrement de la végétation et des sols afin de déterminer leur influence à court et à long termes sur l'état des mâts. En ce qui concerne l'environnement forestier, on procéda à un réaménagement pour mettre en valeur la disposition des totems. On procéda aussi à une étude du rôle des différentes lichens et mousses qui rongeaient la matière ligneuse; divers procédés furent testés pour contrer leur action.

De minutieuses investigations sur l'état de chaque totem révélèrent que chacun présentait un caractère unique et qu'aucune méthode générale de conservation ne pouvait être appliquée. Le seul élément commun était l'essence même utilisée pour la fabrication des totems, le cèdre rouge du Pacifique, ce qui permet de porter un certain nombre de conclusions générales quant au comportement de cette essence particulière face aux différents facteurs de détérioration, particulièrement l'humidité. Ce dernier

facteur a d'ailleurs fait l'objet de tests en laboratoire, de même que l'acidité des sols sur lesquels reposent les totems. Aucune de ces investigations n'a permis néanmoins de dater avec précision les totems et force est d'en rester aux conjectures en ce domaine.

Si l'objectif ultime de mise en valeur idéale du site n'a pas encore été atteint, le programme a tout au moins permis à ce jour de stabiliser l'état de conservation des totems, en contrôlant leur environnement naturel et en appliquant à l'occasion un traitement éprouvé et sûr.

MARY-LOU FLORIAN was born in Vancouver, British Columbia and studied Botany at the University of British Columbia and at the University of Texas. She worked as a biologist at the National Gallery of Canada and the Canadian Conservation Institute in Ottawa. Since 1978, she has been a conservation analyst in the Conservation Division at the British Columbia Provincial Museum in Victoria, B.C. Her numerous publications include articles on the conservation of wooden artifacts, plant materials in ethnological artifacts and conservation methodology. In December 1980, she became a member of the Science Council of Canada.

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PREVENTION CONTRE LA DETERIORATION DU BOIS DANS LES CONSTRUCTIONS

J.P. Hösli et Y. Fortin 22 403

INTRODUCTION

Le bois, produit d'une source renouvelable, était et est toujours un des plus importants matériaux de construction, et ceci pour différentes raisons: il peut être transformé en éléments utilisables avec un minimum d'énergie; on peut le travailler avec des outils simples; ses valeurs de résistance spécifique, c'est-à-dire, le rapport contrainte/densité, sont très hautes; il est un excellent isolant thermique, électrique et acoustique, et jouit d'une très grande valeur esthétique.

Ces caractéristiques ont fait que, déjà à des époques très anciennes, l'homme utilisait le bois non seulement comme source d'énergie, mais également pour s'abriter ou se fabriquer des outils et des embarcations, ce qui le confrontait alors avec le problème de la durabilité relativement faible du bois. Cette faiblesse du bois s'explique par sa propre nature, car celui-ci peut être considéré comme une concrétisation de l'énergie solaire qui représente en retour une source d'énergie pour l'activité vitale des destructeurs du bois. Dans l'arbre sur pied, on trouve non seulement du bois vivant, mais aussi du bois mort, protégé de différentes façons des destructeurs biologiques par l'arbre lui-même. Ce bois naturellement protégé le reste donc plus ou mois après l'abattage de l'arbre. Un des exemples les plus évidents de préservation naturelle du bois est la formation de "bois de coeur." La durabilité de celui-ci varie cependant grandement avec les essences (tableau 1). Malheureusement, dans les climats tempérés, les bois de construction proviennent pour la plupart d'essences qui forment un coeur susceptible à la destruction biologique. Ils sont donc à considérer comme bois de classe de durabilité naturelle "faible" ou "peu durable" ce qui implique qu'en général, ils ne peuvent pas être utilisés à l'extérieur pour une période excédant cinq ans, sans avoir recours à un traitement de préservation.

Au cours de l'histoire, l'homme a utilisé des mesures de plus en plus sophistiquées pour prolonger la vie utile du bois en service. Celles-ci peuvent être classifiées en trois groupes: emploi de techniques de construction adéquates, choix de bois durables, préservation chimique du bois.

Le premier groupe constitue des moyens de préservation du bois qui étaient déjà observés dans les toutes premières habitations hors terre de l'homme et qui demeurent toujours d'importance primordiale. Ces techniques sont donc le résultat d'une très longue tradition de construction. Par la simplicité du principe, elles permettent de protéger le bois avec peu d'effort et peu de frais. Il existe encore des constructions faites entièrement de bois qui datent de plus de mille ans, citons entre autres le cas du temple de Horyuji au Japon, qui a été construit vers l'an 700 A.D. Ceci est un exemple typique de l'efficacité de la préservation du bois par des techniques de construction adéquates. Quant aux deux autres groupes de moyens de préservation mentionnés ci-dessus, ils ne servent uniquement qu'à protéger le bois pour un temps relativement limité ou à enrayer le risque de dégradation, dans des conditions favorables intermittentes. Le cadre de cet exposé se limitera au premier type de préservation du bois.

LA PRESERVATION DU BOIS PAR DES TECHNIQUES DE CONSTRUCTION ADEQUATES

Malheureusement, les règles traditionnelles valables de construction en bois ont été moins bien observées avec la venue des constructions modernes. L'apparition de nouveaux matériaux, de nouvelles techniques de construction ainsi que de nouvelles tendances architecturales ont fait oublier certaines règles de base inhérentes à une saine utilisation du bois. En ce qui a trait à la situation présente, on peut invoquer au moins trois raisons précises qui sont à l'origine de plusieurs défauts de construction: le manque de connaissances des utilisateurs du bois en ce qui concerne les propriétés fondamentales du bois autres que méchaniques; la propagande trompeuse de certains fournisseurs de bois artificiellement protégé, laissant croire que la protection du bois préservé est absolue et qu'on peut utiliser ce produit à des fins impropres; la tendance de surisolation thermique des constructions qui va à l'encontre des exigences de la préservation du bois par des moyens architecturaux.

Les mauvaises expériences vécues avec des constructions en bois inadéquates font hésiter de nombreux constructeurs à demeurer fidèles au bois; ils craignent le danger de la dégradation microbiologique qui en plus d'affecter la valeur esthétique de ce matériau, diminue sa résistance mécanique (Fortin, 1982), et nécessite ensuite des efforts supplémentaires pour sa maintenance en service. D'un autre côté, certains témoignages de la destruction même de constructions lauréates (Rosenberg et Wilkox, 1982) n'encouragent sûrement pas les utilisateurs éventuels à intégrer le bois dans leurs ouvrages.

Le principe de préserver le bois par des moyens de construction est très simple et peut se résumer aux deux consignes suivantes: utiliser du bois sec; garder le bois sec. L'application de ce principe, par contre, pose souvent des difficultés. A notre époque moderne, un problème additionnel a surgi avec la présence de nouveaux matériaux permettant de nouvelles possibilités de construction: la tentation d'utiliser les mêmes techniques pour les constructions en bois est souvent trop grande.

Pour mieux comprendre le principe d'utiliser du bois sec, il est nécessaire de se rappeler en bref les conditions sous lesquelles les destructeurs du bois peuvent attaquer ce matériau. De ces divers organismes (bactéries, champignons, insectes, xylophages marins, etc.), les champignons jouent un rôle primordial, étant donné qu'ils sont de vrais cosmopolites et certainement les plus grands destructeurs du bois. De plus, ils sont actifs dans une large gamme de température et d'humidité. Ce dernier point est d'intérêt particulier, car l'humidité dans le bois peut être contrôlée en grande partie par des moyens de construction. Dans ce contexte, on doit préciser que le développement des champignons n'est possible qu'à partir d'une certaine quantité d'eau liquide dans le bois. Une teneur en humidité inférieure à 20% (par rapport à la masse sèche) ne permet plus le développement des champignons. Tout bois ayant moins de 20% de teneur en humidité peut donc être considéré comme "sec" en référence aux deux consignes données précédemment. Pour être encore plus précis, le terme "sec" doit correspondre à l'humidité d'équilibre de l'usage choisi. Cette dernière condition vise à améliorer la stabilité dimensionnelle de l'ouvrage, ce qui contribue déjà dans une large mesure à diminuer les risques de réhumidification.

Il est très important de se rappeler que la réhumidification du bois n'est pas uniquement causée par l'attraction capillaire qui implique un contact direct du bois avec l'eau liquide, mais aussi par la condensation capillaire de la vapeur d'eau de l'air ambiant. Bien comprendre ces deux phénomènes est d'importance particulière pour le practicien de la construction. En effet, on peut par ces connaissances éviter la plupart des sources d'humidité dans une construction.

Par l'action du phénomène d'attraction capillaire, tout liquide mouillant qui vient en contact avec un pore y est attiré et retenu. Plus le diamètre du pore est petit, plus cet effet est prononcé. Dans le bois, nous trouvons un système de capillaires communicants de toutes dimentions, ce qui explique que le bois se réhumidifie bien une fois en contact avec de l'eau liquide. Le phénomène n'est pas limité à des capillaires de forme cylindrique. En effet, il se manifeste non seulement dans le structure ligneuse elle-même, mais aussi dans les joints, dans les trous de clous, dans les gerces et les fentes du bois, dans les matériaux isolants, sous les peintures écaillées, etc. L'eau retenue dans ces structures favorise ainsi l'infection et c'est d'ailleurs de cette manière que la destruction par des champignons commence le plus souvent.

Le phénomène de l'attraction capillaire de l'eau explique quels types de structures du bois sont accessibles à la pénétration de l'eau et avec quelle force celle-ci est retenue dans le bois. Par contre, cela n'indique pas la vitesse avec laquelle l'eau pénètre dans le bois. Celle-ci peut être exprimée par un coefficient de

perméabilité, qui lui dépend largement de la direction suivant laquelle l'eau pénètre, le bois étant en effet un matériau hautement anisotrope. Par exemple, la perméabilité à l'état saturé en direction longitudinale peut être plusieurs milliers de fois plus grande que celles suivant les directions transversales (tableau 2). Ainsi dans une construction, une section transversale du bois ne devrait jamais être exposée à une source d'eau car elle pourrait donner accès à la pénétration longitudinale rapide.

En ce qui concerne le phénomène de la condensation capillaire, il dépend aussi fortement du diamètre des pores où il est susceptible de prendre place: plus les pores sont petits, plus les conditions sont favorables à la condensation de la vapeur d'eau de l'air ambiant à l'intérieur de ceux-ci. D'autre part, plus l'humidité relative de l'air est élevée, plus grande sera la quantité d'eau condensée dans les pores du bois. Donc, contrairement à ce qu'on semble souvent prétendre dans la littérature, ce phénomène n'intervient pas seulement à 100% d'humidité relative de l'air (ce qui est le cas pour une surface plane), mais bien en-dessous de ce niveau. La température y joue aussi un rôle important, principalement lorsque celle-ci occasionne un changement de l'humidité relative de l'air comme c'est le cas pour les gradients thermiques à traver les murs d'habitation. Enfin, l'effet de la condensation sera encore accentué par la présence de gerces et de fentes minces qui formeront des réservoirs d'eau liquide propices à une infection.

Les consignes "utiliser du bois sec" et "garder le bois sec" exigent donc que toutes les structures favorables à la formation de réservoirs d'humidité soient éliminées. Ceci est d'autant plus important que les champignons destructeurs, une fois installés dans une zone de bois favorable à leur développement, peuvent produire eux-même l'humidité nécessaire pour leur activité de sorte que leur propagation peut s'étendre dans des zones de bois originalement non favorables à leur croissance. Il existe même des champignons capables de former des rhizomorphes; ces "organes" peuvent atteindre des bois éloignés de plusieurs mètres du bois infecté et de s'y installer de nouveau. Ces rhizomorphes sont même capables de percer des murs de béton! L'élimination de tout assemblage favorisant la réhumidification du bois est donc une mesure préventive très importante (illustration 1).

APERCU SUR L'HISTOIRE DES TECHNIQUES DE CONSTRUCTION EN BOIS

Déjà les toutes premières habitations hors terre de l'homme rendaient compte du principe de préserver le bois par des moyens de construction (Singer, 1956; Derry et Williams, 1966). Les constructions étaient alors munies d'un toit distinctement surplombant qui les protégeait de la pluie et le contact du bois avec le sol était réduit par la carbonisation du bois, procédé qui consistait à former en surface une couche hydrofuge et légèrement fongicide.

Plus tard, la protection des habitations contre l'eau environnante devint encore plus poussée. Par exemple, chez les maisons de la période néolithique la construction en bois était érigée sur des murs de pierre et un toit de pierre surplombait largement l'habitation. Ce principe est encore fréquemment appliqué dans les Alpes européennes où des grandes quantités de pierres sont utilisées quoique le bois facile à travailler soit abondant dans ces régions. Ce même principe était appliqué dans les constructions sacrées des grecs. Les colonnes, originalement en bois, étaient érigées sur des bases de pierre et protégées contre la pluie par un avant-toit.

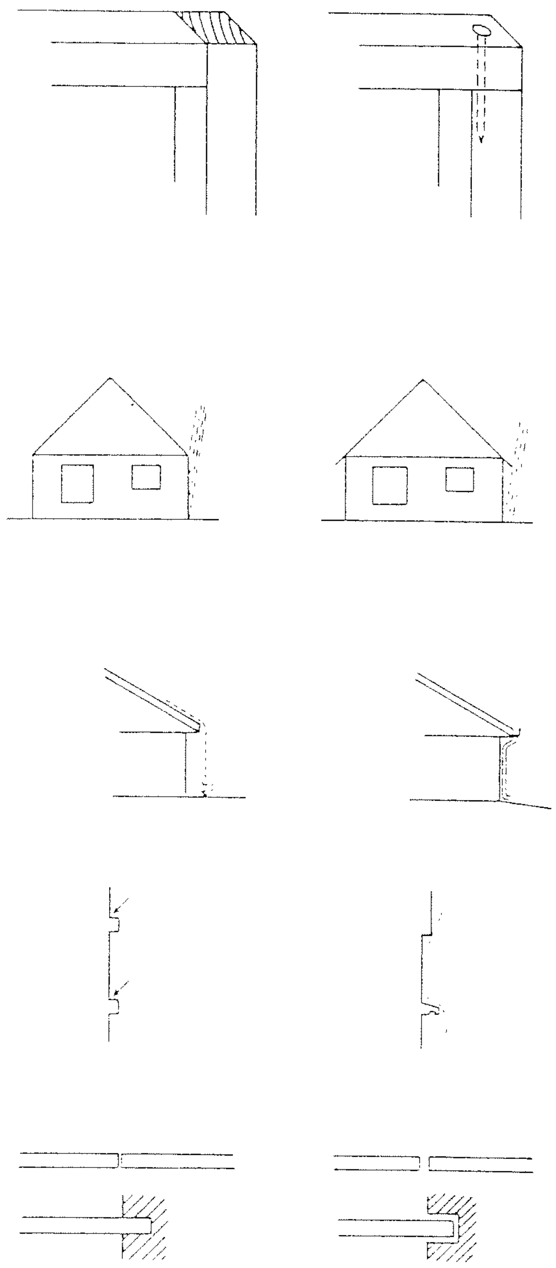
Les connaissances des Romains en cette matière étaient aussi très poussées. Il faut ajouter que ceux-ci étaient particulièrement habiles à assimiler les connaissances des civilisations qu'ils conquéraient (Gille, 1978). Ceci leur permettait donc d'avoir une bonne vue sur les propriétés du bois et de l'utiliser à bon escient. Ces connaissances les faisaient observer strictement les principes de préserver le bois par des moyens de construction. Citons, comme exemple, Vitruve (Vitruvius: De Architectura, IV, 7) qui recommande de laisser un espace de 5 cm entre une colonne et la sablière par moyens de tenon et mortaise. Si on renonçait à cette espace, disait-il, l'air ne pourrait pas circuler et le bois pourrirait vite.

Au Moyen Age, les traditions de saine construction en bois furent largement perdues (Hösli, 1982). Ainsi à l'époque de XVe siècle à

Paris, plus de maisons étaient détruites par la pourriture que par le feu (Roux, 1973). Cependant les constructions inadaptées au bois n'étaient pas seulement dues à l'ignorance des usages des Romains. Si l'on veut tracer une parallèle avec la situation actuelle, certaines propriétés fondamentales importantes du bois étaient volontairement ignorées, la quantité primant souvent sur la qualité. Ceci était particulièrement vrai pour la construction navale. Mentionnons qu'un seul navire de guerre (et on en construisait beaucoup) exigeait plus de deux milles arbres de chêne. On en vint donc à utiliser de plus en plus de bois non convenablement préséché, de qualité inférieure, et provenant même d'essences indésirables. Plusieurs auteurs sont d'avis que les Etats-Unis sont devenus indépendants plutôt grâce aux destructeurs biologiques du bois que grâce à la puissance de l'armée américaine.

CONCLUSION

Le bois devient susceptible à la destruction biologique seulement si un certain nombre de conditions favorables sont réalisées. Parmi celles-ci l'humidité joue un rôle primordial car elle délimite le développement des champignons, qui sont à considérer comme les plus importants destructeurs biologiques. Elle peut être largement controlée par des techniques de construction adéquates, c'est-à-dire par des moyens qui empêchent la réhumidification du bois principalement provoquée par l'attraction ou la condensation capillaire de l'eau. A cet égard, les constructions traditionnelles sont relativement bien protégées. Dans les constructions modernes, par contre, on trouve trop souvent des vices architecturaux fondamentaux qui tôt ou tard défavorisent l'emploi du matériau bois. Les fautes de construction ne peuvent d'ailleurs pas être toutes éliminées par l'utilisation de bois préservé artificiellement. Ce moyen ne contribue pas à solutionner le problème de la destruction biologique mais retarde seulement son apparition. La préservation chimique ne peut donc pas remplacer les techniques de construction adéquates mais uniquement les compléter.



gauche:

La section transversale donne un accès facile à la pénétration de l'eau dans le bois; le joint sert de trappe d'eau.

droit:

Le clou peut donner accès à l'eau dans les parties inférieures de élément de bois non preservé.

Un avant-toit de 30 cm au-dessus d'un mur de 10 m peut dévier jusqu'à 90% de l'eau de pluie.

Les éclaboussures peuvent créer de bonnes conditions pour le développement de pourriture.

Le profil d'une fenêtre doit être fait de manière à ce que des réservoirs d'eau ne puissent se former.

Les joints trop étroits peuvent créer des réservoirs d'humidité qui ne sèchent pas facilement par la suite.

Fig. 1. Exemples de préservation du bois par des moyens de construction.

Tableau 1. Résistance relative à la pourriture du bois parfait[1] (tiré de MULLINS et McKNIGHT 1981)

Résistance élevée ou très élevée	Résistance moyenne	Résistance inférieure ou nulle
Thuyas	Douglas taxifolié	Aune
Cerisier tardif	Févier à trois épines[2]	Frênes
Châtaignier	Mélèze occidental	Tilleul d'Amérique
Cyprès	Pin blanc	Hêtre
Genévriers	Mélèze d'Amérique	Bouleaux
Févier épineux		Nover cendré
Mûrier rouge[2]		Orme
Chêne à gros fruits		Pruches
Chêne blanc		Caryer
Sassafras		Érable
Noyer noir		Chêne rouge et chêne noir[2]
If occidental		Pins (autres essences)
		Peuplier
		Épinettes
		Saule

[1]Déterminé par le U.S. Dept. Agric., Forest Serv., Forest Prod. Lab. Tech. Note 229. mai 1961.
[2]Ces bois ont une résistance à la pourriture plus élevée que celle de la plupart des autres essences de leur catégorie.

Tableau 2. Coefficients de perméabilité (Darcy)

	Longitudinal	Tangentiel	Radial
Pin	4.5 (2800x)	16.10^{-4} (3x)	5.10^{-4}
Hêtre	4,7 (47000x)	1.10^{-4} (1x)	$1,5.10^{-4}$

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ABSTRACT

PREVENTION OF WOOD DETERIORATION IN BUILDINGS

J.P. Hösli and Y. Fortin

For a variety of reasons, wood has always been one of the most important construction materials. It can be transformed from its original state with simple tools and a minimum of energy; it provides good insulation and is visually attractive. Throughout history, man has sought to preserve this material and gradually the techniques for doing so have become more sophisticated. The use of appropriate building techniques, the selection of durable species and the development of chemical preservatives have all contributed to this preservation process.

Construction techniques in recent years have at times caused us to neglect certain principles such as the properties of wood, and have led to an over-enthusiasm for wood preservatives, and the over-insulation of buildings. The concept of preserving wood by using proper construction techniques is based on two princples: using dry wood and keeping it dry. The effects of humidity, capillary action, condensation and temperature are all important considerations for wooden buildings - their architectural design, as well as their preservation. In this paper, the authors provide a brief historical overview of wood as a building material since neolithic times, through Rome and the Middle Ages. This permits a good summary of wood as a building material and the problems associated with wood when it is used improperly in different eras.

In conclusion, they note that wood only becomes a victim of biological deterioration if conditions are favourable. Humidity is the primary cause, and for this reason, the techniques of construction must ensure that the wood is protected. In this regard, older buildings are often better than modern ones, since their architectural detailing is more precise. Chemical preservatives are no substitute for good design; however, they do contribute to protecting the wood.

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22404

RESTAURATION DE LA CHAPELLE DU SACRE-COEUR DE L'EGLISE NOTRE-DAME DE MONTREAL

Denis Lamarre

INTRODUCTION

Afin de donner un aperçu de l'histoire de la chapelle du Sacré-Coeur, il faut d'abord faire référence à l'église Notre-Dame de Montréal, dont la chapelle est une annexe.

L'église Notre-Dame est la plus vaste d'Amérique: sa taille se compare à celle de Notre-Dame de Paris ou de l'abbaye de Westminster. Elle contient 4500 places assises et autant debout. Commencée en 1823 selon les plans de l'architecte James O'Donnell, elle fut pratiquement terminée en 1828. Il est intéressant de noter que jusqu'à cette époque il ne s'était pas construit d'édifice néo-gothique au Québec. Nos architectes de tradition s'inspiraient plutôt des édifices classiques de la renaissance française ou italienne.

Un problème de conception persistait dans cette église Regency, avec son chevet plat, percé d'une immense fenêtre (elle mesurait 34 pi. de largeur par 64 pi. de hauteur - 10,36 m par 19,50 m). Cette fenêtre était orientée au sud-est, et à l'heure des messes le soleil éblouissait les fidèles. Les journaux de l'époque rapportent qu'on a cherché par plusieurs moyens d'atténuer la lumière qui y entrait trop abondamment. Ils racontent que l'on avait peint d'abord le verre en bleu, puis qu'on le gratta pour y peindre des stores, ensuite qu'on y remit du bleu pour finalement faire faire des vitraux, ou plutôt des verres peints d'un bleu sombre et représentant les saints patrons du pays.

Le problème était tel qu'on fit préparer quantités de projets par les architectes de l'époque et en 1869 on adopta une solution de l'architecte Victor Bourgeau qui fermait la grande fenêtre complètement. L'intérieur de l'église fut entièrement redécoré entre 1870 et 1880 sensiblement comme nous le connaissons aujourd'hui, sans trace de la grande fenêtre.

Mgr Maurault, auteur d'une excellente histoire de cette église, rapporte qu'en 1888, on avait besoin d'une plus grande sacristie, de bureaux pour la fabrique et surtout d'une chapelle, pour les cérémonies intimes telles les mariages. Il ajoute regretter que l'on n'aie pas dégagé le chevet de l'église, mais qu'on y ait plutôt adossé la chapelle.

Je crois que c'est justement ce que le curé de l'époque, Alfred Léon Sentenne voulait faire. Autant l'église était belle à l'intérieur, autant la grande fenêtre murée en brique devait être laide à l'extérieur. Il profita à mon avis de l'occasion pour cacher la fameuse fenêtre.

L'ANCIENNE CHAPELLE

L'architecte en titre de Notre-Dame, le prolifique Victor Bourgeau étant mort au printemps 1888, on lui donna rapidement des successeurs en nommant Messieurs Perrault et Mesnard.

Ils préparèrent les plans de la chapelle à l'été 1888 et en septembre on entreprit les travaux. Elle fut inaugurée en décembre 1891, mais terminée qu'en 1895, alors qu'elle recevait son dernier tableau.

Cette chapelle était grande comme une église, elle mesurait 90 pi. de longueur (27,43 m) par 85 pi. de largeur (25,9 m) au transept, et 55 pi. de hauteur (16,76 m).

Elle pouvait contenir 700 personnes dans la nef et les jubés. On disait qu'elle était toute en bois du pays (c'est-à-dire en tilleul) cependant nous avons trouvé beaucoup de pin jaune et de cèdre dans les vestiges.

En plan, la chapelle empruntait la forme d'un T et avait la particularité de n'avoir aucun mur extérieur, sauf dans sa partie supérieure. Elle était flanquée de part et d'autre par un musée et par une magnifique sacristie d'inspiration Tudor.

C'est son intérieur entièrement en bois, extrêmement orné, très éclectique, qui attirait et étonnait les 250 000 visiteurs qui y venaient annuellement. En coupe, la chapelle comportait quatre niveaux:

1. Les bas-côtés à colonnes romaines qui supportaient une galerie sur des arcs surbaissés. Les murs

des bas-côtés étaient composés d'appliqués en arabesques. Les plafonds des bas-côtés étaient également en appliqués en arabesques avec un caisson central surélevé.
2. La galerie empruntait la forme des triforiums gothiques, mais en plus profond. Une balustrade très ouvragée la bordait ainsi que des triforiums à tympans ajourés de deux modèles. Tout cela était couronné par une frise. Mentionnons ici les quatre trompes qui permettaient le passage d'une galerie à l'autre. Le travail de sculpture qu'on y trouvait était tout à fait exceptionnel.
3. La galerie était surmontées d'une large bande de tableaux d'inspiration biblique ou racontant des scènes de la vie du Christ. Ces tableaux avaient peu de valeur artistique, étant donné que c'étaient soit des copies soit des oeuvres naïves de jeunes peintres. Mais sur le plan historique, leur valeur était très grande. Ces jeunes peintres furent expressément envoyés en Europe par le curé Sentenne pour y travailler. Ils acquirent du métier à cette oc- casion et devinrent par la suite les maîtres de l'école de peinture du début du XXe siècle au Canada.
4. Les fenêtres et la claire-voie. Seule la partie supérieure de la chapelle était propice à l'éclairage. Elle y était percée de fenêtres en ogive. Une claire-voie de même forme et parallèle aux fenêtres était supportée à chaque travée par des consoles. L'espace entre deux était comblée par une passerelle.

L'arrière comportait deux escaliers baroques d'une belle tenue et les portes principales étaient magnifiques. Toutefois, la superposition d'arcs et d'éléments hétéroclites était un peu curieuse. Par contre à l'avant, le rétable était d'une bien meilleure composition et comportait des statues et une toile intéressantes. Par la richesse de son ornementation et la quantité de dorure qu'il comportait, le retable avait un aspect d'orfèvrerie. Dans son ensemble donc, la chapelle dégageait une atmosphère chaleureuse, doucement lumineuse et toute en tons de bois naturels. Sa décoration surchargée, empreinte d'inspirations diverses, lui donnait un air "fin du grand siècle" qui finalement plaisait beaucoup.

LA RESTAURATION

Le 7 décembre 1978 la chapelle brûlait presqu'entièrement. Des quatres niveaux que nous avons décrits, seuls une partie des bas-côtés, sont épargnés.

Dès que mandatés, nos premiers gestes furent de protéger les parties épargnées des bas-côtés et la sacristie. Nous avons également fait dégager des décombres toutes les pièces susceptibles de servir de modèles à une éventuelle reconstitution.

A l'aide des photos de l'Inventaire du ministère des Affaires culturelles du Québec, nous avons rassemblé une travée entière de vestiges à l'exception de la claire-voie, du plafond et des tableaux dont il ne restait rien. D'autre part, aucun plan ou dessin ayant servi à la construction de la chapelle n'a pu être retraçé.

Avec l'aide de l'architecte-conseil, Victor Depocas, nous avons commencé à étudier toutes les facettes du problème de reconstruction et demandé au professeur Laszlo Demeter de l'université de Montréal de préparer un rapport sur les théories de la reconstitution. Parallèlement à cette démarche nous engagions un processus de consultation auprès du ministère des Affaires culturelles et des nombreux organismes ayant juridiction. Plusieurs solutions devaient surgir de nos recherches:
1. Reconstruire complètement et fidèlement la chapelle;
2. Reconstruire partiellement et compléter le volume original avec des formes de rappel;
3. Reconstruire partiellement et compléter par une construction nouvelle;
4. Enlever les vestiges et faire une construction nouvelle dans l'esprit de l'ancienne;
5. Construire un lieu nouveau de type musée-auditorium avec projection, photos et exposition des éléments intacts de la chapelle;
6. Ne faire aucune construction, sauf les travaux nécessaires pour raccorder et imperméabiliser les parties du bâtiment qui subsistaient.

De ces six solutions, les deux dernières out été éliminées d'emblée par la fabrique parce que la chapelle servait encore beaucoup. On y célébrait 200 mariages annuellement et quelques 250 000 touristes venaient la visiter.

Les deuxième et quatrième solutions étaient inacceptables sur le plan théorique, elles impliquaient de faire du néo-gothique en 1980!

Nous avons donc approfondi deux solutions: la reconstitution complète et la reconstitution partielle sous un abri moderne. C'est cette dernière qui a finalement été retenue considérant que la chapelle ne remplissait pas toutes les conditions pour justifier une reconstitution complète. De plus le manque de documentation en général et de vestiges en particulier, dans la partie supérieure, n'aurait pas permis une reconstitution fidèle.

LA SOLUTION RETENUE

Ayant décidé de reconstituer les deux niveaux inférieurs, bas-côtés et galerie des triforiums, nous avons tenté d'abord de faire une voûte vitrée appuyée sur les vestiges. La rencontre des éléments structuraux modernes, acier ou béton avec les vestiges en bois ne nous apparaissait pas acceptable. D'autre part, une grande voûte vitrée est plus propice à un hall des pas perdus qu'à un lieu de culte.

Nous avons alors imaginé de changer la direction de la porté structurale: c'est-à-dire, de porter longitudinalement plutôt que transversalement et de faire une voûte autoportante opaque.

C'est cette solution que nous devions adopter car elle offre l'avantage de prolonger les vestiges visuellement sans y toucher. La nouvelle voûte, lambrissée sobrement de panneaux de bois met en valeur l'ornementation des vestiges.

Quant au problème que posait l'éclairage, il a été résolu par des lanternaux que nous avons placés audessus des vestiges de même que par un grand lanterneau semi-circulaire éclairant le nouveau rétable en bronze.

LA CONSTRUCTION

Les travaux ont été exécutés en gérance de projet ce qui nous a permis de construire à mesure que les plans étaient préparés. De plus, un atelier d'ébénisterie fut mis sur pied pour refaire les vestiges pendant les travaux du gros oeuvre.

Le gros oeuvre comportait particulièrement des arcs de béton, à l'avant et à l'arrière de la chapelle pour recevoir la voûte autoportante en acier. Celle-ci a été assemblée au sol, puis mise en place d'une seule pièce.

Pendant qu'on effectuait ces travaux et que l'on terminait les toitures et les systèmes électromécaniques, les ébénistes s'affairaient à la réfection des vestiges. Nous avons fait réparer tout ce qui pouvait l'être et fait refaire le reste conformément aux modèles retirés des ruines.

Toutes les pièces: colonnes, chapiteaux, balustrades, consoles, frises, etc. ont été peintes, teintes et dorées selon le cas, puis empaquetées et numérotées suivant un code de pose. Elle ont été entreposées au sous-sol de l'église Notre-Dame au fur et à mesure de leur fabrication. Cette méthode a permis l'installation des pièces rapidement après le gros oeuvre et presque sans travaux de peinture, de teinture ou de dorure sur place. Seuls les lambris et les plafonds des bas-côtés endommagés ont dû être refaits à la chapelle de même que les escaliers circulaires, dont la taille n'a pas permis qu'on les transportent en atelier.

La chapelle est maintenant terminée, à l'exception du nouveau retable de bronze, qui ne sera mis en place qu'à l'automne prochain.

Il ne reste qu'à espérer que la nouvelle chapelle du Sacré-Coeur redevienne ce lieu prévilégié de méditation et de paix dans la douce ambiance des tons de bois.

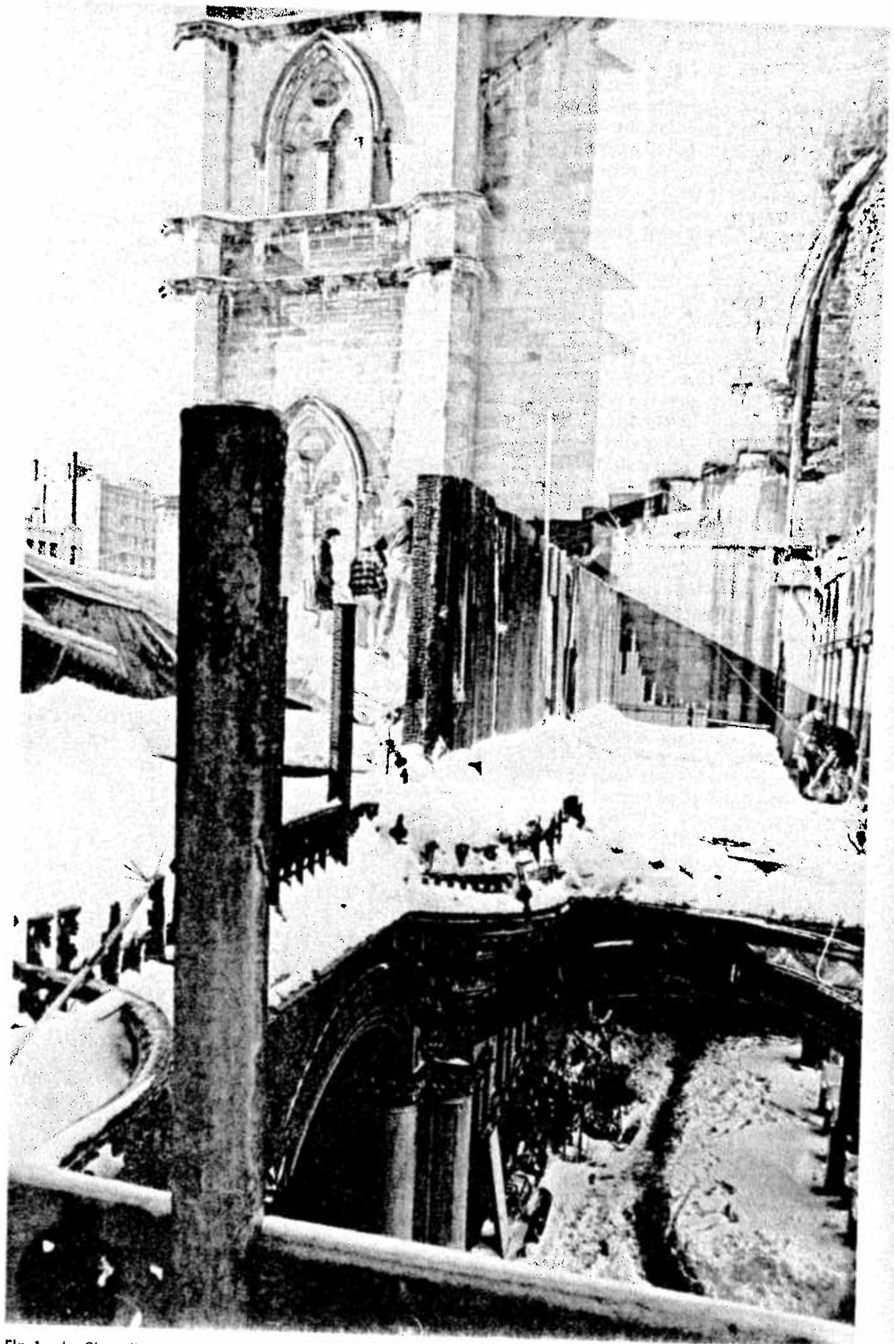


Fig. 1. La Chapelle après le feu.

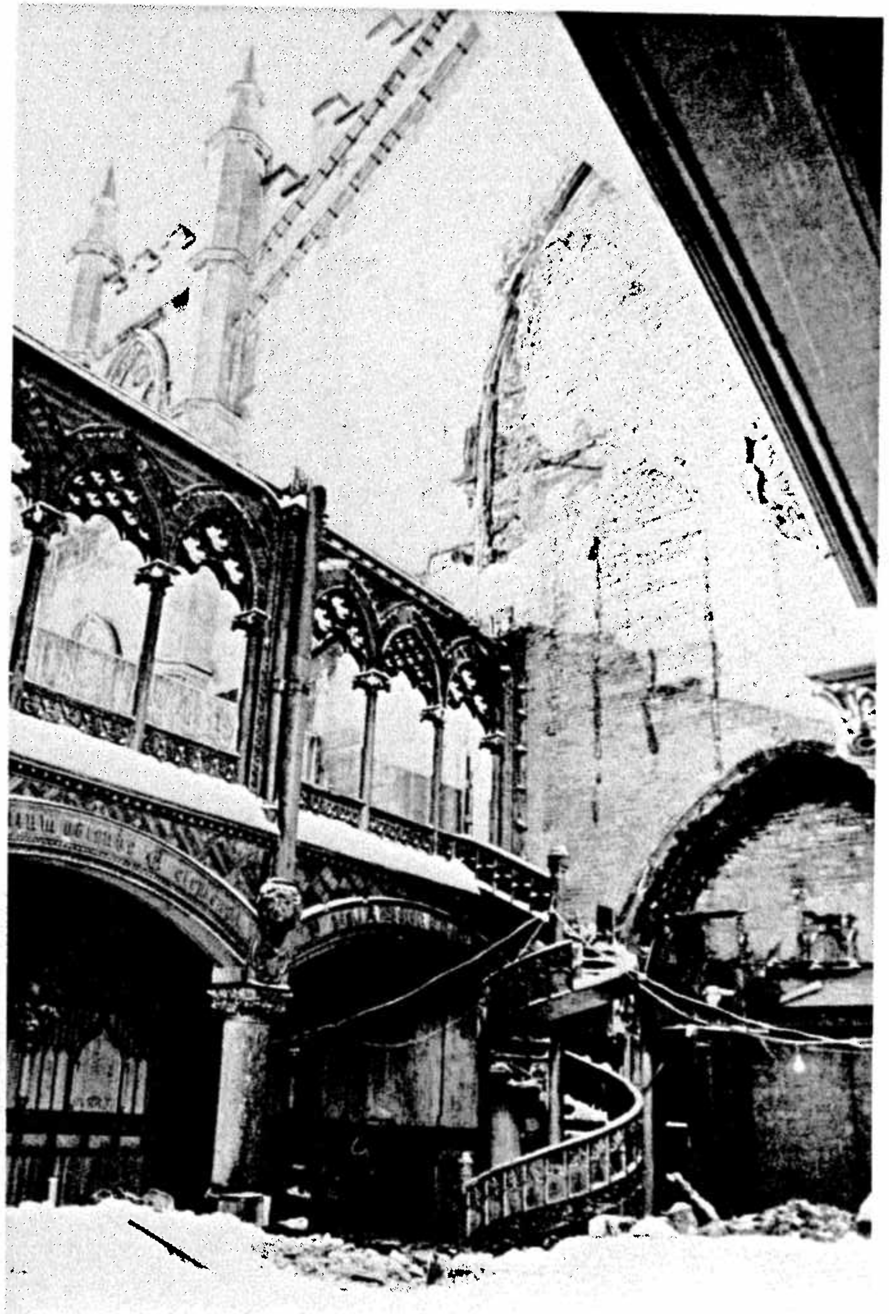


Fig. 2. Vue générale de la Chapelle après le feu.

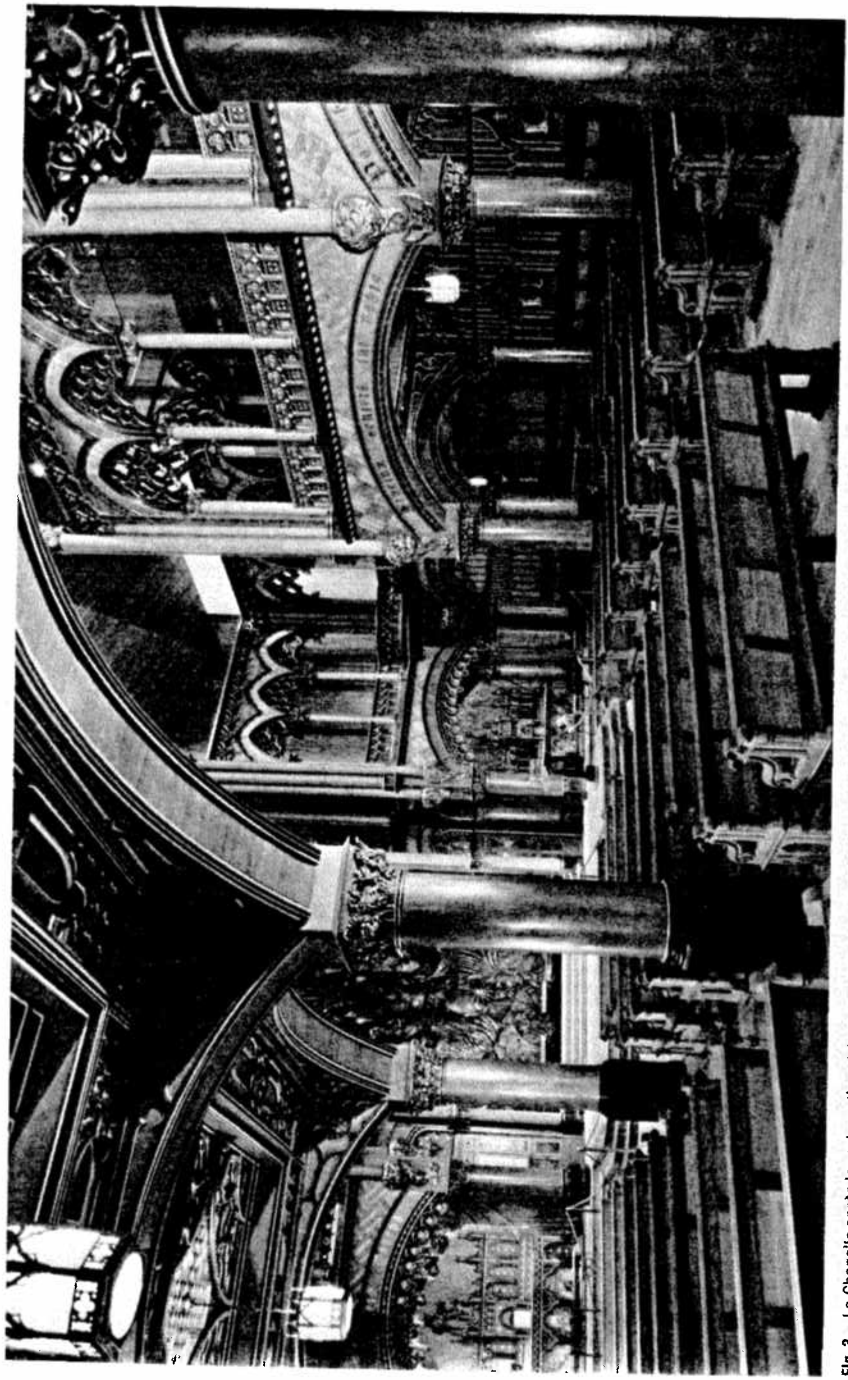


Fig. 3. La Chapelle après la restauration. (photo par: Photographix).

Fig. 4. La Chapelle après la restauration. (photo par: Carl Valiquet).

ABSTRACT

RESTORATION OF THE CHAPEL OF SACRE-COEUR AT NOTRE-DAME CATHEDRAL IN MONTREAL, QUEBEC

Denis Lamarre

Notre-Dame Cathedral in Montréal, built between 1823 and 1828 according to the architectural design of James O'Donnell, was the first Neo-gothic structure in Québec. It is comparable in size to its European antecedents - Westminster Abbey in London and Notre-Dame Cathedral in Paris. Several additions and alterations, such as the redecoration of the interior during the 1870's, have changed the original design over the last century and a half.

In 1888, plans were made to construct a chapel for intimate ceremonies and in December, 1891 the chapel was inaugurated. This chapel was as large as many churches in itself and could accommodate up to 700 people. The ornately decorated interior was covered entirely in wood. Eclectically designed, it incorporated forms inspired by various periods - romanesque columns, a gothic gallery, paintings which depicted Biblical scenes and baroque staircases.

A tragic fire destroyed most of this chapel on December 7, 1978. A portion of it was salvageable and so the architectural firm of Lamarre et al. was hired to begin an extensive restoration program. Discussions concerning the appropriate philosophical approach for the project led to the decision to reconstitute the building fabric within a modern shell.

During construction, a cabinet maker's workshop was established on the site while the major structural work to stabilize the structure was underway. As far as possible, all parts of the building which could be repaired were retained and the remaining portions of the building were recreated, based upon the vestiges which were systematically catalogued to facilitate the process.

DENIS LAMARRE est né à St-Lambert, Québec en 1933, et il a été diplômé en architecture à l'Ecole des Beaux Arts à Montréal en 1956. Deux ans après, il était membre fondateur de l'agence Jodoin, Lamarre, Pratte et Associés, architectes. Depuis lors il à été responsable de nombreuses réalisations, y compris des collèges, des universités aussi bien que le réaménagement du Petit Séminaire des Sulpiciens à Montréal et la restauration de la chapelle du Sacré-Coeur de l'Eglise Notre-Dame à Montréal. M. Lamarre est membre de l'Institut Royal d'Architecture de Montréal, de l'Association des Architectes d'Ontario, et de l'Association des Architectes en pratique privée du Québec.

22405

WOOD PRESERVATION IN CANADA

Dr. John N.R. Ruddick

INTRODUCTION

Wood is one of the most versatile and useful construction materials known to man, and in the growth of new trees, nature demonstrates a capacity to replenish a valuable resource on a scale and at a rate seldom achieved with other materials. However, an important part of this continuous cycle in the forest is the biological degradation of the old material, which has outlived its usefulness, to provide nutrients for the next generation of trees. The principal agencies of this destruction are bacteria, fungi and insects, and it is these same agencies which are responsible for the biodeterioration of wood used by man for constructional purposes (Fig. 1).

The role of bacteria in decaying wood has not been extensively studied, although recent investigations suggest that it may be much more important than previously thought. For example, bacterial attack of wood treated to quite high retentions of preservative has recently been observed. It is also possible that bacterial degradation of preservatives may occur, thereby detoxifying them and allowing fungal colonization of the wood to take place. In Canada, the economic importance of insect damage to processed wood products is small. The Pacific damp wood termite, which is found in western Canada's coastal regions, is known to inhabit decaying wet wood, while in Toronto, subterranean termites are a major problem for householders. However, in general, the principal agencies of biodeterioration of wood in Canada are fungi.

How do fungi grow and how can they be prevented from decaying wood? Fungi need the same basic elements to maintain growth as man, namely, an adequate supply of air, water and food, and a moderate temperature (Fig. 2). The elimination of any one of these requirements will prevent fungal growth. Although kiln-drying wood kills any fungi present in the wood prior to drying, the protection is not permanent, since if the wood becomes wet in service, fungal attack will then take place. For many end uses, it is often very difficult, if not impossible, to eliminate the influence of air and moisture on wood used outdoors. Thus, chemical treatment of wood, making it either unpalatable (or toxic) to fungi, or perhaps unrecognizable as a food source, is the most widely-used method for protecting wood used in biologically hazardous situations.

WOOD PRESERVATIVES USED IN CANADA

In Canada, as in many other countries, transportation provided the major impetus to the early development of wood preservation. At the beginning of the present century, the building of a transcontinental railway was considered to be vital for the continued economic growth of Canada. It was the construction of this railway, with its concomitant demand for creosote treated railway ties and bridge timbers, which led to creosote pressure treating plants being built in Nova Scotia, Manitoba and British Columbia; and with the building of these plants, the wood preservation industry in Canada became established. Other uses of treated products then quickly followed. For example, in 1915, Vancouver had the largest area of treated wood-block pavement in Canada (approximately 23 miles), most of which was paved with wood blocks, pressure impregnated with creosote. Even today, in some of the old large warehouses, creosote treated block floors remain in service.

Although creosote was the first preservative to become established in Canada, others have since followed and there are now four principal preservatives in use. These preservatives may be divided into two categories: those which are oilborne and those which are waterborne. However, this terminology is rather loose, since, for example, creosote is itself a mixture of oil liquids and is frequently used without further dilution, while the solvent used for one of the waterborne preservatives is not water, but is actually ammonium hydroxide solution.

Five oilborne preservatives are described in the Canadian Standard for wood preservation using pressure processes (CSA-080 Wood Preservation). They are creosote, pentachlorophenol, bis(tributyltin)oxide, copper-8-quinolinolate and copper naphthenate. However, in the commodity section of the same standard, copper naphthenate is not specified and copper-8-quinolinolate is included solely for the protection of wood which will come into contact with foodstuffs. Neither are currently used by commercial pressure treaters. This is also the case with bis(tributyltin)oxide which is restricted by the standard to the treatment of wood to be used out of ground contact. Of the five preservatives, only creosote and pentachlorophenol are widely used.

Creosote is produced by the high temperature carbonization of bituminous coal in the absence of air. The principal product of the process is coke, with one of the by-products being coal tar. Although this tar has, itself, found some use as a wood preservative, it is more usually distilled to produce creosote. Thus, unlike other preservatives, creosote is neither a pure compound nor a well-defined mixture of compounds. It is instead a complex mixture, the composition of which varies from one source to another, being also greatly influenced by the coking process. Indeed, many of the minor components in creosote remain unidentified. In order that the quality of the creosote solution can be maintained, the standard specified the physical properties of the solution, e.g. the percentage components at various distillation ranges, and the attendant specific gravities. Also, since the chemical composition of creosote is unknown, it is not possible to base the quality control methods for the treated wood upon chemical analysis. Instead, the wood sample is extracted with organic solvent and the weight loss of the sample (after correction for the amount of water present) is equated to the creosote content. Obviously, such methods are prone to large errors, particularly when the sample volume is small or the treated wood has been in service several years. For freshly treated wood, the industry prefers to monitor the treatment by determining the amount of creosote absorbed by a known volume of timber, and the standards seldom specify quality control by assay.

Creosote is still the principal preservative used for railway ties in Canada and is also the most widely-used preservative for marine piling and timbers. Its usefulness for the protection of other commodities has been much reduced during the last decade, with the waterborne preservatives in particular replacing creosote in many end uses. The future supply of creosote is also uncertain, following the implementation of technological advances in the gasification of coal and the recognition of coal as a valuable alternative source of phenolic and aromatic chemicals currently produced from petroleum.

Pentachlorophenol is a pure crystalline organic compound with a melting point of 190.2° C and a solubility in water of 0.0018% at 27° C. It is very soluble in organic solvents such as benzene (24.5% at 50° C). Pentachlorophenol is produced commercially by the chlorination of phenol, using an aluminum chloride catalyst. The technical grade used by industry contains several impurities, which are for the most part composed of other chlorinated phenols, including tetrachlorophenol. However, recently, dioxins, which are present as a minor impurity, have attracted much attention, principally because one member of the dioxin family (2,3,7,8 tetrachlorodibenzo-p-dioxin) has been shown to be very toxic. The adverse publicity has continued to stimulate a growing concern over the future use of chlorinated phenols. In Canada, the principal end use involving pressure impregnation with pentachlorophenol is the protection of utility poles and fenceposts. It is also the only preservative specified by name in the Canadian standard for the dip treatment of window joinery. (The sodium salt of tetrachlorophenol is widely used commercially for the prevention of mould and stain on unseasoned lumber. Since such treatments are generally carried out by non-pressure processes and their aim is short-term rather than long-term protection, they will not be discussed further in this review of wood preservation practices in Canada.)

Considering now the water-borne preservatives, there are two fundamental types. The first of these, chromated copper arsenate (CCA), is available in three formulations, referred to as types A, B and C. These formulations differ principally in the proportions of arsenic and chromium present in each formulation. CCA-type A was dev-

eloped by Kamesam in 1938 and was originally referred to as Greensalt. It was accepted by the American Wood Preservers' Association (AWPA) for inclusion as a wood preservative in the AWPA standards in 1953. Composed of salt-type materials, it has a composition of 56% $K_2Cr_2O_7$, 33% $CuSO_4.5H_2O$, and 11% $As_2O_5.2H_2O$. Subsequently in 1969, the AWPA specified all CCA preservatives on an oxide basis and the formulation then was described as 65.5% CrO_3, 18.1% CuO and 16.4% As_2O_5. A liquid concentrate of CCA-type A can be prepared from chromic acid, copper carbonate and arsenic acid. CCA-type B, frequently referred to as Boliden K-33, was accepted by the AWPA in 1964. It was prepared as a paste which contained 27% CrO_3, 15% CuO, and 42% arsenic acid. In 1969, the type B formulation was specified on an oxide basis and was described as being composed of 35.3% CrO_3, 19.6% CuO, and 45.1% As_2O_5.

The inclusion of CCA-type C in the AWPA standard was prompted by a desire by the AWPA to amalgamate preservatives of similar composition. The CCA-type C formulation approximated the mean component contents of the types A and B, and also was similar in composition to that of the CCA preservatives Celcure A and Tanalith C which were in use in Britain. In 1969, a standard was adopted by the AWPA, and CCA-type C was formulated as 47% CrO_3, 19% CuO, and 34% As_2O_5. Although CCA-type C can be prepared in three forms, i.e. as a dry mix, as a paste or as a liquid con- centrate, the increasing trend towards minimal worker exposure to chemicals has resulted in almost exclusive use of the liquid concentrate form.

In principle, all three types of CCA could be used in Canada, but in practice, since the introduction of CCA into the Canadian standards, only the types B and C have found extensive use. However, during the past five years, the situation has changed such that the type C formulation is now almost universally favoured by CCA treaters. This has been brought about by several factors, including the adoption of CCA-type C by a major chain of CCA-type B users. Also, there has been a desire by treaters to use a preservative with a lower arsenic content. Since leaching of preservative from wood freshly treated with CCA-type C has been reported to be lower than that of CCA-type B, the change to the former preservative is beneficial, although in both cases, the preservative is well-fixed and the amount of chemical which leaches is very small.

In CCA solution, the three components (copper, chromium and arsenic) are all water-soluble. When the solution is impregnated into wood, a series of complex chemical reactions takes place, during which the chromium reacts with the wood sugars and is reduced, producing insoluble chromium, copper and arsenic complexes. Consequently, when the wood is placed in service, the CCA will not leach out.

The second waterborne preservative which is widely used in Canada is ammoniacal copper arsenate (ACA). Unlike CCA, the ammoniacal preservative is not marketed as a prepared formulation, a fact which no doubt has hindered its adoption by some treaters who do not wish to be involved in the necessary mixing of the preservative components. Originally, it was prepared at the treating plant by mixing a copper chemical (usually a basic copper carbonate) with arsenic trioxide in ammonium hydroxide. The ratio of the copper (expressed as oxide) to arsenic (expressed as arsenic pentoxide) was 1:1. Air was passed through the stirred mixture. Because of the components used, the preservative was incorrectly called ammoniacal copper arsenite. However, in the mid-1970's, it was realized that this was erroneous, since during the mixing process, the air oxidized the arsenic to the pentavalent form. Thus the name was changed to ammoniacal copper arsenate. Recently, the production of ACA has been modified, with arsenic acid concentrate replacing the arsenic trioxide. Following impregnation of the ACA into the wood, the ammonia in the solvent evaporates. This, in turn, causes a breakdown of the chemical complexes which keep copper and arsenic solubilized in solution. Insoluble complexes are then produced in the wood, which will not wash out when the treated wood is placed in service.

The use of waterborne preservative has increased dramatically during the last decade (Fig. 3). Although for some uses, for example, telephone poles, pentachlorophenol is still the main preservative employed, the waterborne preservatives are gaining acceptance by some utility companies. However, it is the growth of CCA and ACA preservation of lumber and plywood that has been most dramatic. Clearly, this growth is related to the acceptance of the preserved wood foundation

(PWF) building system, where the only two preservatives allowed for the treatment of the lumber and plywood used are CCA and ACA.

PRETREATMENT PROCESSES

Although the preservatives themselves are of major importance in extending the service life of treated products, of equal importance are the various processes employed both in preparing the wood for treatment and also during the actual impregnation phase.

Wood is not a simple homogeneous medium. It is made of many different kinds of cells, held together by intercellular material which is phenolic in nature (Fig. 4). These cells, which are tube-like in structure, allow preservative to flow along them, passing from one to another by way of openings in the cell wall. The walls of the cells are composed of polymeric chemicals called cellulose, hemicellulose and lignin. In freshly cut timber, the cell cavities in the sapwood are filled with water (containing chemicals produced by the tree) and before they can be filled with preservative solution, the water must be removed. Thus, drying is an important first stage to preservative treatment. During drying, 'free' water present in the cell cavity is removed first. Further drying then removes water present in the cell wall and this takes place when the moisture content of the wood falls below the fibre saturation point (approximately 30%). When water is lost from the cell wall, a reduction in the volume of the cell wall occurs, creating stresses which eventually lead to separation of some of the wood fibres, producing cracks (or 'checks') in the wood surface. If drying is performed badly, this checking can be severe, penetrating deep into the timber, resulting in a lower grade of wood. The formation of minor checks during drying, prior to the treatment of the wood, is very important, since if they form after the preservative impregnation, they may penetrate beyond the outer shell of treated wood, exposing the untreated wood beneath (Fig. 5). When this happens, the effectiveness of the preservative treatment has been greatly reduced. For oilborne preservatives, the removal of the water from the cell wall is also necessary, to ensure good cell wall penetration by the preservative.

When roundwood or timbers are pressure treated, it is unusual for the preservative chemical to penetrate the material completely. Instead, the wood treater aims to provide the commodity with a shell of treated wood, which completely encloses the untreated core (Fig. 6). The continued protection of this untreated core is dependent upon the ability to maintain the integrity of the shell of treated wood, which in turn must have received sufficient chemical to withstand fungal and insect attack. Thus, in addition to the adequate drying described earlier, it is also advisable whenever possible to prepare the wood ready for subsequent use before treatment. If it is not possible to complete all the cutting and boring prior to the preservation phase, then any surfaces of the treated wood which are cut must be liberally coated with an effective concentrated preservative solution, to restore the integrity of the treated shell.

For roundwood with a substantial width of sapwood, the creation of a shell of treated wood is relatively simple, since sapwood when dried is usually easily penetrated by preservative solution. However, in timbers composed mainly of heartwood, the depth of penetration of the preservative from the surface will generally be quite small, since heartwood is not easily penetrated. In this case, even minor checks would then penetrate beyond the treated shell. To overcome this problem, advantage is taken of the fact that movement of preservative solution along the wood cells is far superior to movement in a radial or tangential direction. Incisions are therefore made in the surface of the wood (prior to preservative impregnation) to a depth equal to the required depth of penetration of the preservative. They are cut parallel to the longitudinal direction to minimize strength losses in the wood (Fig. 7). During pressure treatment, the preservative solution rapidly penetrates the wood via these incisions to the required depth. It then continues to penetrate the wood mainly through longitudinal movement. By offsetting the rows of incisions to form a staggered pattern (Fig. 8a), it is possible to overcome the limited tangential penetration of preservative in heartwood and to create a substantial outer shell of treated wood. It should be noted, however, that while incising has proved useful in helping to treat the heartwood of wood species which do not treat easily, for those where the heartwood is very resistant

to penetration, incising is generally unable to overcome the treatment problem, and such material should not be used for preservative treatment.

In some commodities, the quantity of preservative required for adequate protection is high, an example being marine piling. In this case, the material is often incised with a 'diamond' spacing (Fig. 8b). Here, the role of the incising is not to overcome a resistance to penetration of preservative, but is instead designed to maximize the preservative content throughout the treated zone.

METHODS OF TREATMENT

1. Brush Treatment

Perhaps the best known, and certainly the simplest, method of applying preservative to wood is with a brush. Although some degree of protection can be given to the wood by a brush treatment, it will usually be quite small and will certainly be totally inadequate for wood used in ground contact situations. In addition, in order to be effective, it must be repeated at frequent intervals, and often the part of the structure most in need of protection is inaccessible for treatment (for example, the interface between decks and their supporting cross-members). However, for those above-ground structures which are already in place and where decay has been considered likely, due either to poor design or construction or through the use of inadequately treated material, then a brush application with a suitable diffusion-type preservative can be of some value.

2. Immersion

A more effective simple treatment of timber can be achieved by immersing it completely in preservative solution. The principal disadvantages of such a method are the limitations on the size of material that can be easily treated in this way, and perhaps more importantly, the fact that wood which is not easily penetrated will not be well-treated. Thus, the method is better suited for roundwood than sawn material, which may have a substantial quantity of heartwood which would resist treatment. In Canada, the simple immersion process is used for the treatment of window joinery, although several privately-owned treating facilities also preserve posts using this method.

3. Thermal Treatment

Several treating plants in Canada use a thermal process to preserve roundwood such as utility poles. In this process (sometimes referred to as the hot and cold open tank process), wood is first immersed in hot preservative solution and then subsequently placed in a bath of cold preservative solution. During the first stage, the air in the wood cells (which in seasoned wood could constitute up to 70% of the volume) expands, forcing some to be lost from the wood surface. In addition, the vapour pressure of the water present in the wood increases. Upon being placed in the cold bath, the remaining air contracts and the vapour pressure is reduced, creating a partial vacuum, which results in preservative being taken up by the wood. Obviously, to obtain the maximum effect of the process, the change from the hot to the cold bath must be made as quickly as possible. This is usually achieved, in practice, by draining the hot preservative solution from the tank and replacing it with cold solution. As with the simple immersion treatment, the hot and cold bath is most effectively used for roundwood which contains substantial sapwood. In Canada, therefore, this method is used primarily for the preservation of utility poles and fenceposts, with oil-borne preservatives such as pentachlorophenol. It is however not widely used, since there are only four plants currently in operation.

4. Pressure Processes

Examination of the different types of wood preserving plants in Canada shows that the pressure processes are the preferred method of treatment (Fig. 9). In pressure impregnation, the preservative is forced into the wood by applying relatively high pressures to the solution. In this way, a more effective treatment is possible (when compared with the methods described earlier), since not only can the preservative be placed deeper in the wood, but also a more uniform distribution of the chemical is achieved. In addition, the amount of preservative placed in the wood can be controlled, allowing different preservative retentions to be used for different commodity end uses. The components of a pressure treating plant do not vary greatly between one facility and another. The actual treatment takes place in a long cylinder called a retort, which is capable of with-standing the high pressures (up to 1000 kPa) used in the process. In modern plants, the door of the retort is sealed with only one or two latches (Fig. 10), compared to the 30 to 40 bolts often found on old retorts (Fig. 11), thus greatly reducing the cylinder loading and unloading time. The retort is usually placed on a concrete base, containing a perimeter drain designed to catch any accidental leakage of preservative solution which may occur, particularly at the door of the retort during unloading of the treated wood. The preservative solution is stored in large tanks and is pumped to the retort during treatment. Other pumps evacuate the retort and also apply pressure during the various stages of the treating cycle. Depending upon the preservative being used, some treating plants use a small additional tank to produce the preservative solution, either by mixing the components, as is the case with ACA, or by dissolving the solid preservative in solvent, as is often done with pentachlorophenol. However, with the increasing concern for the environment and also for worker safety, treating plants increasingly prefer to receive preservative solution in the form of bulk concentrate, which can easily be pumped into storage tanks with the minimum of worker exposure. Other equipment needed includes bogies for loading the timber into the retort, chains for fastening the timber to the bogies to prevent it from floating during impregnation, and various gauges and recorders to enable the operator to monitor the progress of the treatment.

In most modern treating plants, the treating cylinder and storage tanks are often covered with a roof to prevent rainwater from being collected. Without this protection, such water must either be retained for future use during dilution of preservative concentrate, or treated to remove any contaminants before being discharged as waste water. In addition, government environmental protection agencies are demanding that a covered area with a sealed surface must be available to ensure that preservative solution which drains from freshly treated wood is collected and retained, either for reuse, or for disposal by approved procedures.

Considering now the actual processes used in Canada, there are two basic types, the full cell process and the empty cell process. In the full cell treatment, the object is to maximize the uptake by the wood so that the cell cavities in the treated part of the wood are filled with preservative solution. The full cell process is divided into three phases. In the first, after the wood is loaded into the retort (Fig. 12), a vacuum is created in the retort and maintained for about 30 minutes. This removes some of the air from the surface of the wood. The preservative is then introduced into the retort and pressure is applied, forcing the solution into the wood (Fig. 13). The magnitude of the pressure depends upon the wood species, but can be as high as 1000 kPa. The duration of the pressure depends upon the commodity as well as the wood species, but can vary from a few hours for lumber to over 30 hours for some utility poles. Finally, following completion of the pressure cycle, the solution is drained from the retort and a short final vacuum is applied to remove any excess chemical (usually about 10% of the gross absorption) from the wood surface. The door of the retort is then opened and the wood removed. The full cell process is always used for treatment with waterborne preservatives and is also used for oilborne preservatives when high retentions are required.

Although similar to the full cell process in the second and third phases, the empty cell process differs from it in the first stage, in that no initial vacuum is applied to the wood. In one empty cell process, known as the Lowry Process (Fig. 14a), the timber is loaded into the retort, after which the preservative solution is immediately pumped into the retort and the pressure increased. Consequently, in this process, the air trapped in the wood is compressed as the preservative solution penetrates the wood. When the pressure is removed upon completion of the cycle, the air in the wood expands to its original volume, forcing some of the preservative out of the wood. Thus, the object of the empty cell process is to coat the wood cell walls with preservative, rather than to fill the cell cavities with solution. The reason for this is that excessive treatment with oil leads to 'bleeding' of oil and preservative after treatment, resulting not only in possible environmental contamination, but also in loss of fungicide.

An alternative variation of the empty cell process is the Rueping Process which, like the Lowry Process, does not have an initial vacuum. However, whereas, in the Lowry Process the preservative solution is introduced into the retort while it is at atmospheric pressure, in the Rueping Process the air pressure in the retort is first increased to about 100 kPa. Then, while maintaining the pressure at this level, the preservative solution is introduced into the retort. Obviously, such a procedure requires special equipment. As the solution is forced into the retort at a pressure slightly in excess of the air pressure, the air is 'bled' into an equalizing (Rueping) tank. Once the retort is filled with solution, the pressure is increased and the process continues, as described earlier for the full cell process.

Both the Lowry and Rueping Empty Cell Processes were originally designed for use with creosote and pentachlorophenol. Because of the more complex equipment required by the latter process, it has now fallen into disuse. The Lowry Process is still widely used in Canada, particularly for the treatment of utility poles with pentachlorophenol.

5. Liquefied Gas Process

A process which has found limited use in Canada is the liquefied gas process. In this treatment, the preservative pentachlorophenol is dissolved in a small amount of co-solvent which is then mixed with liquefied gas. In Canada, the gas used is methylene chloride. The actual treating schedule used is based on the full cell process. Initially, a vacuum is created in the retort, which is then purged with an inert gas.

The vacuum is again created, after which the preservative solution is introduced into the retort. The temperature is raised, causing some of the liquefied gas to vaporize, thus increasing the pressure. At the end of the pressure cycle, the solution is returned to the storage tank and the remaining solvent is evaporated from the wood under vacuum. The two principal advantages claimed for the process are that the material is 'dry' immediately following treatment, and that penetration by the gas solvent is superior to that achieved by other solvents. Its detractors claim that the absence of oil allows the pentachlorophenol to vaporize and form crystals on the wood surface (a process called 'blooming') and that the effectiveness of the pentachlorophenol in liquefied gas is inferior to that found for pentachlorophenol in oil.

DECAY IN WOODEN STRUCTURES AND THE USE OF PRESERVATIVE TREATED WOOD DURING NEW CONSTRUCTION AND RENOVATION

It has been estimated that decay now costs the Canadian homeowner in excess of $90 million annually. Previously, because of relatively low material and labour costs, the decayed wood was removed and replaced with new wood. However, as both costs (particularly the labour component) have escalated dramatically during the last decade, homeowners have become more aware of the advantages provided by wood preservatives in lowering maintenance costs.

Many of the exterior elements of a domestic dwelling are subjected to biodeterioration, and although physical weathering such as the delignification of wood by sunlight is important, it is the biological agencies which are generally the most destructive. They can act in many ways. Some fungi destroy cellulose and lignin, the structural components of wood. Others attack the wood to feed on the soluble wood sugars and in so doing, they may make the wood more permeable and susceptible to weathering.

In the Vancouver area, the life of a western red cedar shake roof may be as short as 15 years. Many factors contribute to such a short life, including the construction of roofs with a shallow pitch, resulting in a relatively slow run-off rate for rainwater. Studies at the Forintek Laboratories suggest that pressure treatment of the shakes with CCA or ACA may substantially increase their service life. Obviously, the life of the roof will be governed by the time it takes any one of the components to fail. Because CCA and ACA corrode metal fixings, it is equally important that the correct type of nail should be used. The Canadian standard for western red cedar shingles and shakes (CSA 0118.1) recommends that stainless steel nails or their equivalent be used with CCA- or ACA-treated shingles or shakes.

Wooden gutters are naturally subjected to conditions of high moisture and for this reason, it is advisable that they should be pressure treated. This is particularly true if they are 'boxed' with a decorative fascia board, since any rainwater leakage may not be noticed for some time, at which point substantial decay of the rafter headers and even the ends of the roof trusses may have taken place. Even if other materials are used for the gutters or downspouts, they should be chosen with care. Frequently, in the first six months to one year after installation, a slight amount of preservative may leach from treated wood. This can be corrosive in nature and may lead to deterioration of certain metals.

As a result, widespread decay of wooden window joinery has occurred. This acceleration in the deterioration of window joinery has been particularly aggravated during the last five years by a strong desire in Canada to make domestic houses as energy-efficient as possible. Thus, large quantities of insulation have been added to walls and attics. Fireplaces have often been removed and windows no longer opened. The net result is a much lower movement of air from the inside of the home to the outside. Since Canadians are now using larger amounts of water in their homes for showers, dishwashers, etc., it was inevitable that severe condensation problems would be encountered. Thus, wooden windows are now under an even greater risk of decay. While it is important to educate the general public to accept that some loss of air from a home is not only beneficial, but necessary, decay problems in wooden window joinery could be greatly reduced through effective preservative treatment.

With increasing acceptance of the value of using preservative treated wood, its use has expanded. A considerable volume of the western red cedar siding used on houses during the past five years has been pressure treated with CCA. In addition to the benefits of decay prevention, the green colour imparted by the treatment eliminated the need for subsequent staining of the wood until it has been in service for many years. However, it must be recognized that the decay potential is quite low, so that pressure treatment of siding with CCA may be regarded by some as being cosmetic.

An extremely serious problem, which has emerged during the past decade, has been the occurrence of decay in glued laminated beams. Following their widespread acceptance in Canada, many buildings have been designed which, while making full use of the artistic potential of the glued laminated beam, have unfortunately often exposed the beams to a high decay risk. An example of this is the use of glued laminated beams which project beyond the walls of the building, either supporting flat roofs or more usually being the main structural supporting unit in an A-frame construction. In the latter construction, the beam is bolted into a supporting 'shoe', usually supported on a concrete plinth. Since the beams are usually exposed to direct rain action, rainwater tends to run down the beam and then be drawn back up from the cross cut end by capillary action. This wetting action is often enhanced by poorly designed shoes which trap the rainwater. The result is rapid decay of the lower end of the beam. When detected in the early stages, some remedial action is possible, but even so, repairs are extremely costly. In some cases, the occurrence of excessive decay has caused concern that the whole building may have to be replaced.

An interesting facet of this problem is that even today, for many end uses, no acceptable preservative treatment exists for the protection of glued laminated material. The use of waterborne preservatives on glued laminated beams has been restricted by the Canadian Standard (CSA-080.28) for fear that excessive checking in the material would occur. Although the same standard allows the laminates to be treated with waterborne preservatives prior to gluing, no Canadian treating company performs this operation. According to Canadian Standard CSA-808.28, only creosote or pentachlorophenol are acceptable preservatives for treatment of large size 'glulam' beams. However, for many uses, neither preservative would be considered suitable, particularly if the treated beam were to be exposed on the inside of the building.

Perhaps the most interesting development by the wood preserving industry in Canada during the past decade has been the Preserved Wood Foundation (PWF) system (Fig. 15). Although originally developed in Canada over 20 years ago, it was not until the 1970's that it became accepted by most municipalities as a standard building style. The dramatic increase in the acceptance of the PWF system is graphically illustrated by the fact that, although prior to 1976 only 2000 PWF houses had been constructed, in the five-year period from 1976 to 1981 this number rose to 30,000. Currently, about 8000 PWF houses are being constructed annually in Canada. The PWF system is essentially a carefully engineered system comprised of a foundation wall of preservative treated plywood, which is fastened to a preservative treated stud wall. The foundation walls are constructed on a compacted gravel fill base, which includes a specially designed drainage system. Only two preservatives, CCA and ACA, are allowed for the treatment of the lumber and plywood, and the retentions specified by the Canadian standard are higher than the requirements normally specified for lumber and plywood in ground contact, to help ensure a long life for the foundation. Many advantages have been cited for the PWF system. These include the possibility of rapid house construction in regions of Canada where concrete is not readily available, or where the cold climate restricts its use. It has also been suggested that, since the same persons (i.e. the carpenters) are involved in building the foundation and the remaining part of the house, there are fewer delays and a possible cost saving. The fact that concrete basements usually need a wooden framework to make them habitable, whereas in the PWF system the foundation wall becomes the basement wall and requires only insulating and finishing with internal sheathing material, also means a cost benefit to the homeowner. In order to ensure that the rigorous treating standards are adhered to, only treating plants approved by the Canadian Standard Association can use the CSA stamp of approval for treated wood for the PWF system.

If the growth in the use of preservative treated wood is to continue, it is becomingly increasingly important that it be readily available to the homeowner, as well as to the professional builder. It is also equally important that both are fully educated in its proper use and handling. To some extent, the needs of the homeowner have now been recognized and two wood-preserving organizations market wood for use on home construction projects, such as decks and patios. However, there remain problems related to the lack of awareness by the homeowner regarding the limitations of this material (which generally is treated for above-ground use only).

Since the treating industry argues that incising lowers the customer acceptance of treated wood, the process has been waived for the material which is available at the local lumberyard and which is to be used by the homeowner for his construction projects. Consequently, preservative penetration varies greatly and can be minimal in lumber prepared from some wood agencies. Field testing is in progress at Forintek to determine the limitations of such material and to provide guidance for its use by the general public.

FUTURE WOOD PRESERVATION RESEARCH NEEDS

As with most other technologies, the needs of the wood preserving industry have changed markedly during the past decade, and they are continually being changed by the development of new products which make better use of Canada's forest resources. The development of new products, coupled with governmental pressures for less toxic preservatives or industrial demands for chemicals with alternative properties, has created a need for new preservatives. Already, waferboard has expanded the usable wood fibre base in Canada, and is being used in place of plywood in many applications. However, whereas plywood can be effectively protected with existing preservatives and processes, waferboard may not be so easily preserved. It is produced mainly from aspen and research at Forintek has suggested that aspen is susceptible to decay from soft-rot fungi, even when treated with CCA. Composite material for lumber and wood poles, using species such as spruce and aspen, and the acceptance of alternate wood species for use as utility poles, will all place greater demands on wood preservation technology. As new chemicals are developed, so must testing methods also be created to allow the vital information on their effectiveness to be generated as soon as possible. The current reliance on field tests, which may often last in excess of ten years, is no longer acceptable to the industry. Consequently, there is an urgent need in Canada for the development of a testing facility which would allow accelerated biological testing of large size material. The feasibility of constructing such a system is now being investigated by Forintek.

It is widely predicted that by 1990, Canada will be unable to produce the volume of timber needed to sustain even the current requirements. Two potential solutions exist to prevent this eventuality. Firstly, large quantities of wood species which are available in Canada are grossly underutilized. If they were to be made usable through technological development, the demands being placed on the other prime wood species, such as western red cedar and Douglas fir, would be eased. Secondly, much of the wood which is being produced is used wastefully. Clearly, wood preservation has a key role to play in both solutions. Through effective preservative treatment, non-durable woods such as aspen could be employed in end uses currently restricted to preferred softwoods such as cedar. Secondly, by greatly extending the service life of wood that has been processed, the resource may be stretched and used more effectively. 'Conservation through Preservation' is one of the keys to the future growth of Canada's forest products industry.

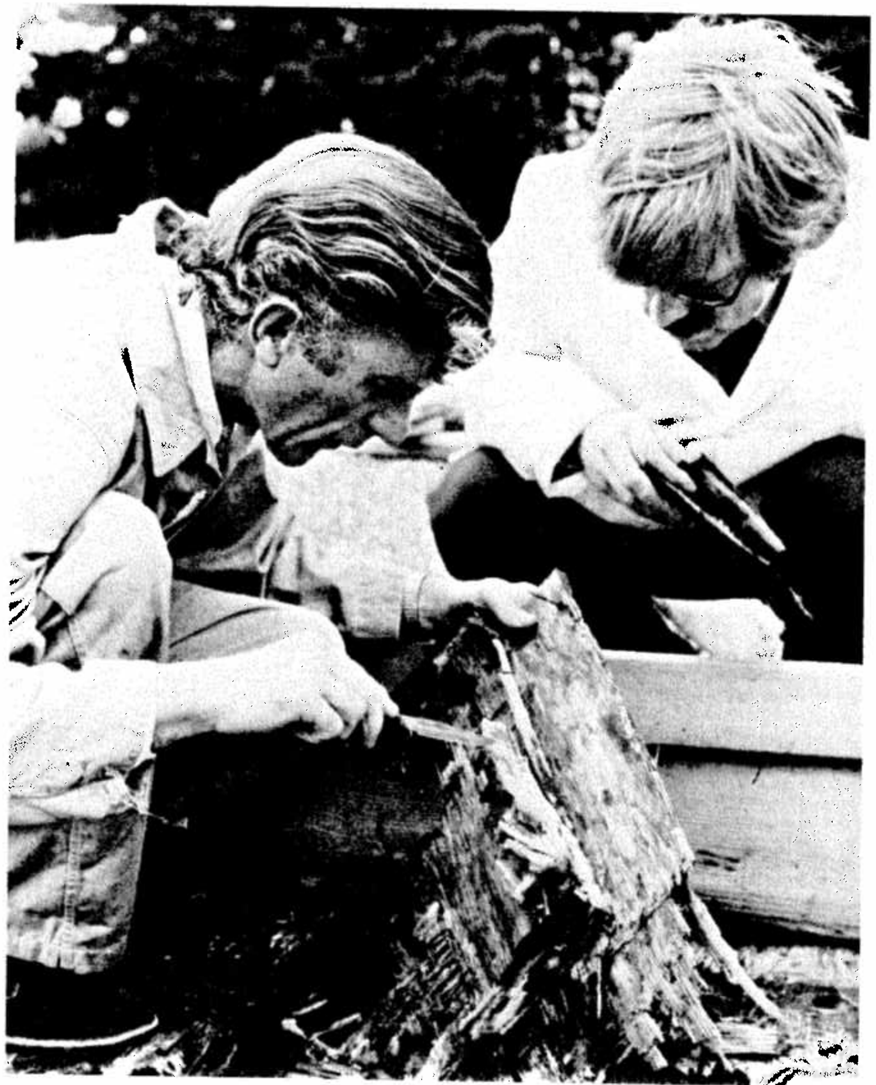


Fig. 1. Plywood decayed by wood destroying fungi.

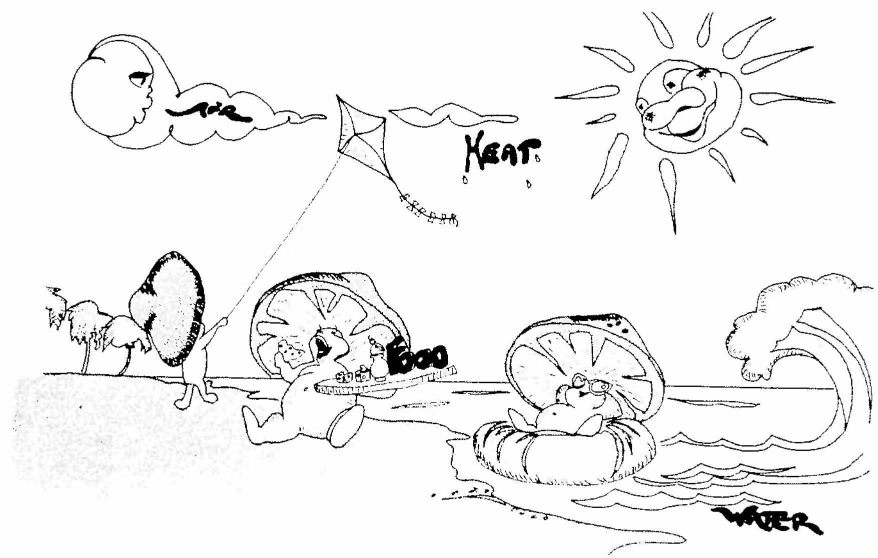


Fig. 2. Fungi require air, water, food (wood) and a moderate temperature to maintain growth.

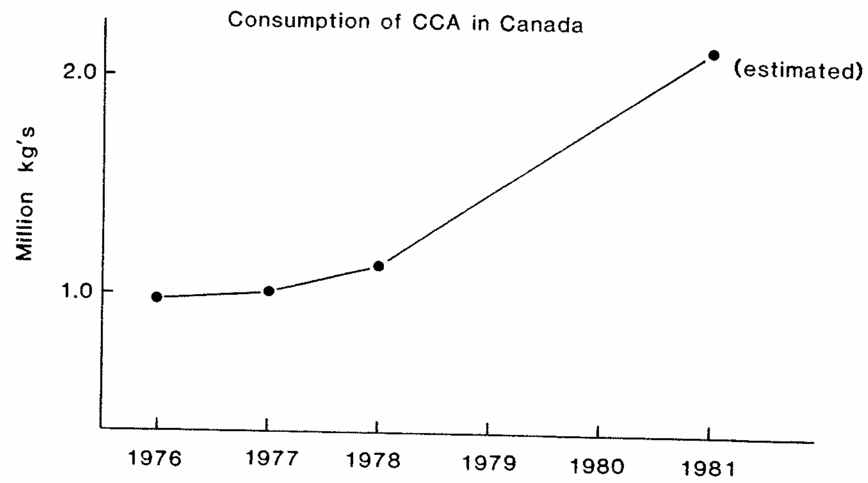


Fig. 3. The use of waterborne preservatives (particularly CCA), has grown rapidly during the 1970's.

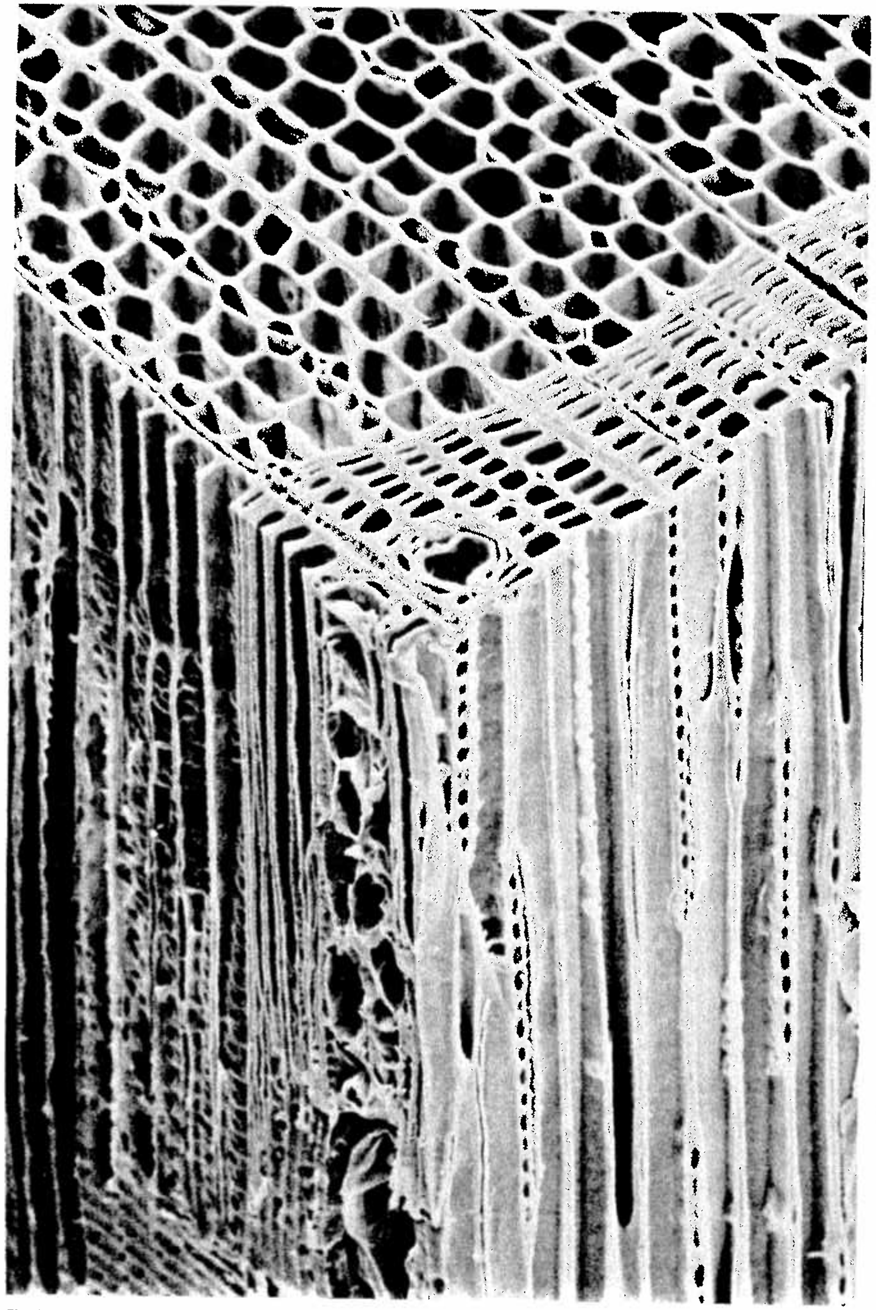
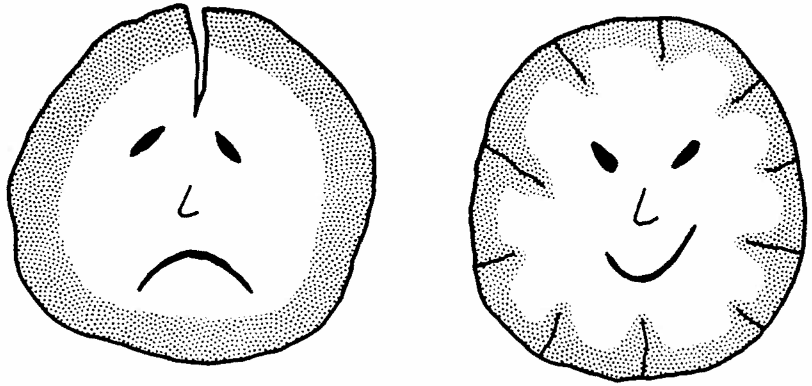


Fig. 4. Wood is not a simple homogeneous medium. It is composed of many tubular cells bonded together and through which preservative solution can flow, passing from one cell to another by way of openings in the cell wall.



A. Wood too wet before treatment; subsequent checking has passed through treated shell and exposed untreated wood.

B. Wood properly dried prior to treatment; see that checks are well treated.

Fig. 5. Adequate drying of wood prior to preservative treatment is essential.

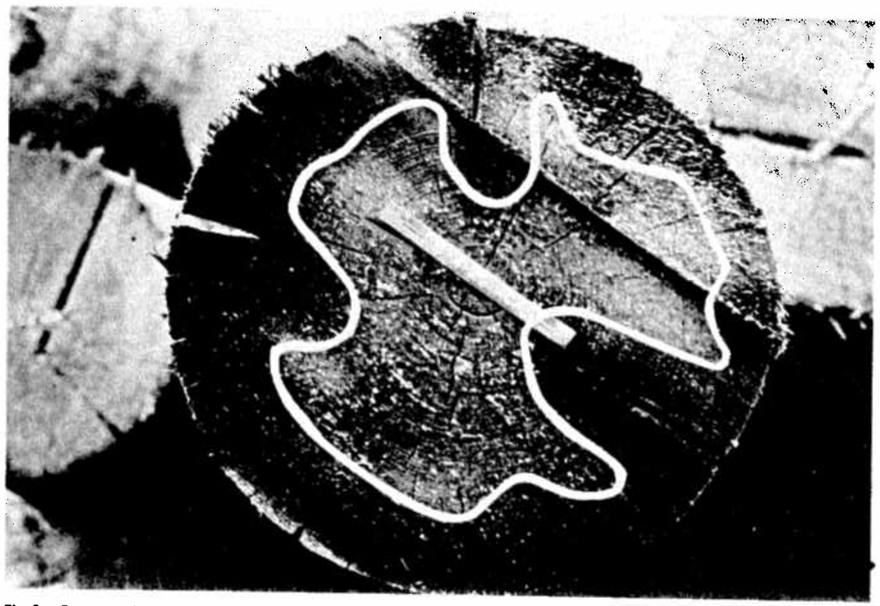


Fig. 6. Preservative penetration in roundwood and timbers is seldom complete. Instead a treated shell surrounds the untreated core.

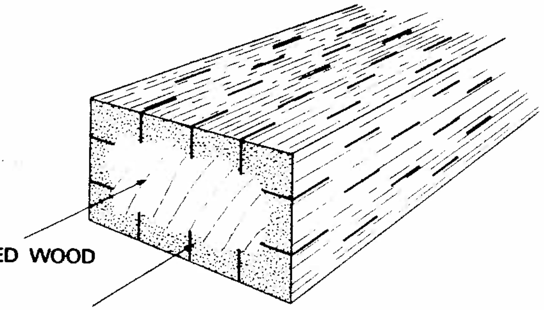


Fig. 7. For wood species not easily penetrated, incising enables a uniform shell of treated wood to be created which protects the untreated core.

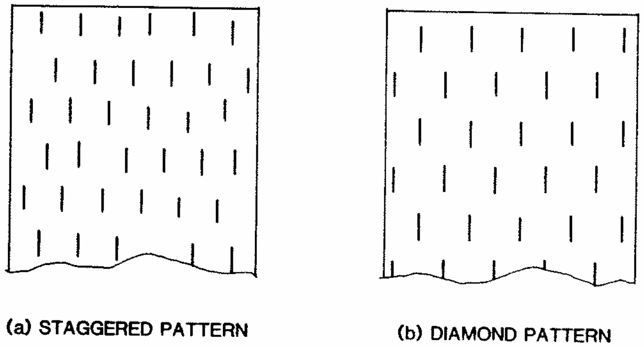


Fig. 8. Two basic types of incising patterns are used by the Canadian wood treating industry.

TREATING PLANTS IN CANADA

54 – pressure

27 – non-pressure (simple dip treatment)

4 – thermal

Fig. 9. Composition of woodtreating plants in Canada.

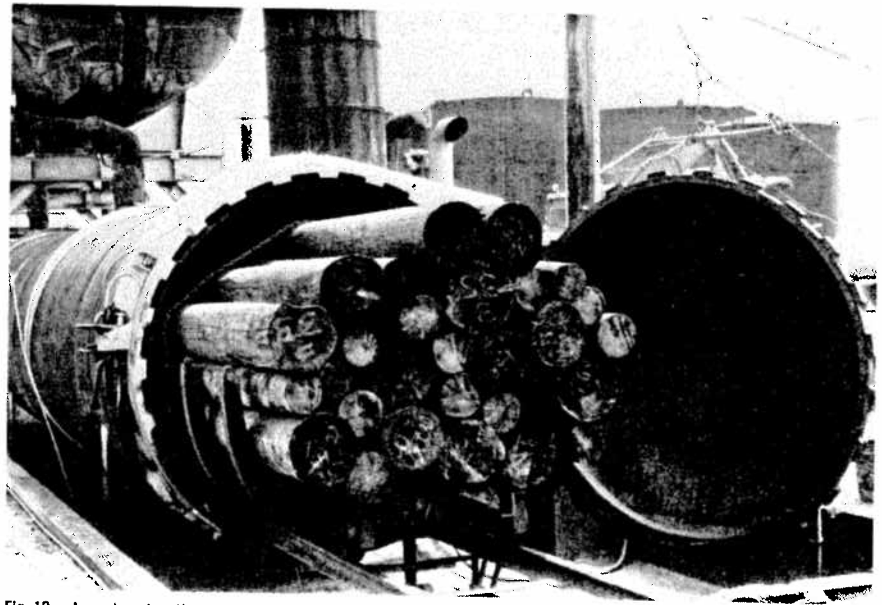


Fig. 10. A modern treating retort, with a rapid closing door.

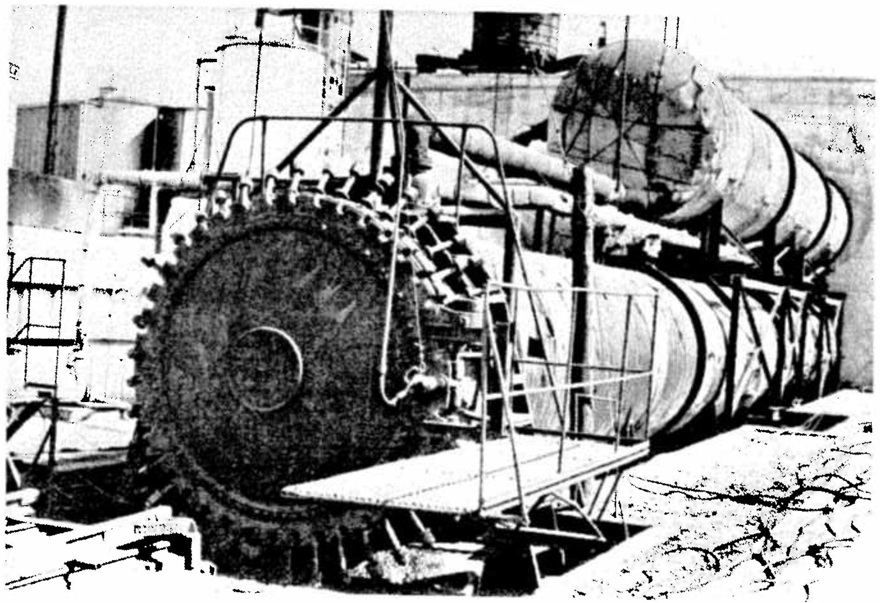


Fig. 11. An older example of a treating retort, where the door is fastened by many bolts.

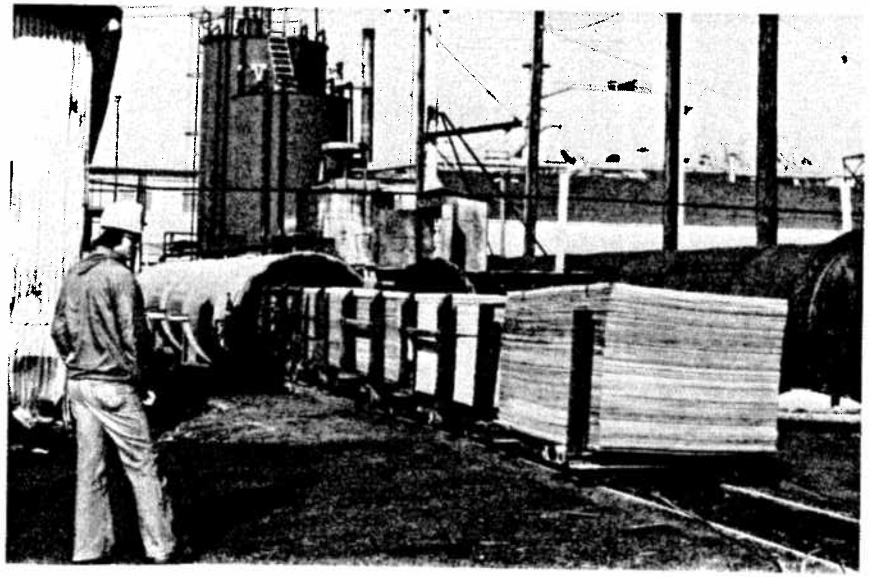


Fig. 12. A retort being loaded with plywood prior to pressure treatment.

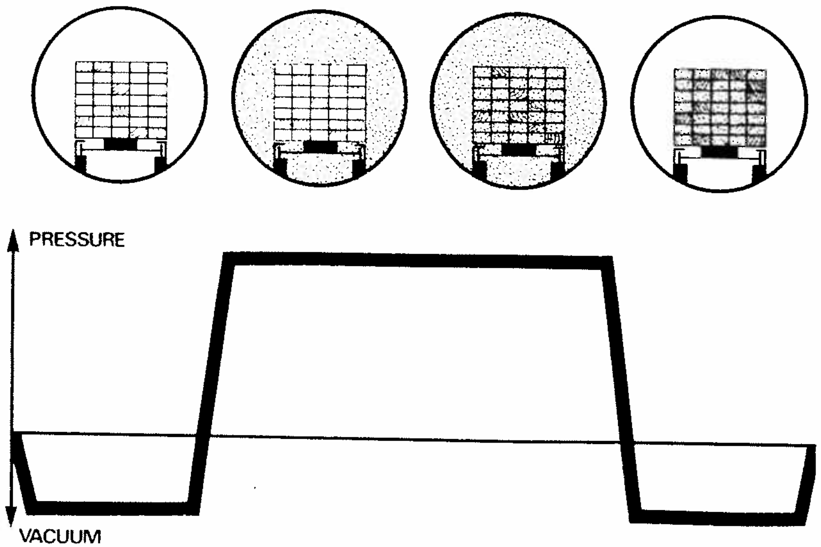
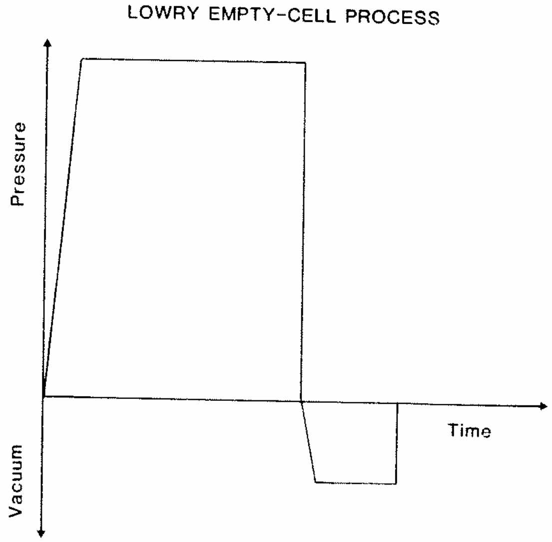


Fig. 13. The full-cell process is used for the pressure treament of wood with waterborne preservatives.



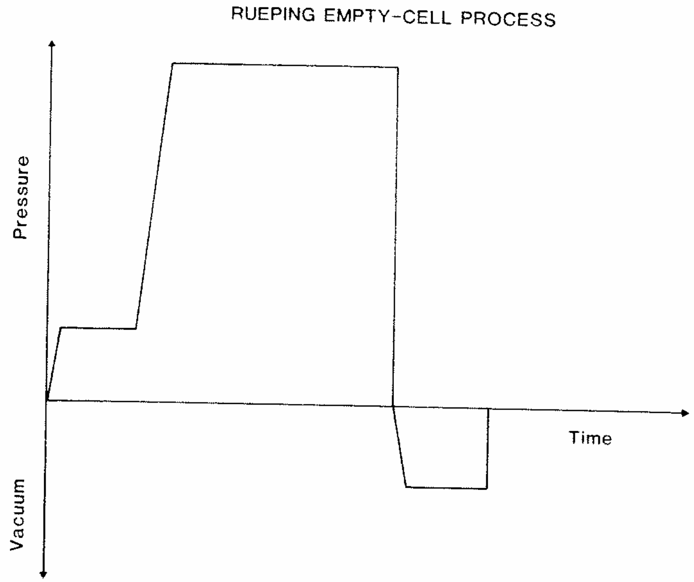


Fig. 14. The two empty cell processes used in North America are a) the Lowry Process and b) the Rueping Process. Both were designed specifically for treatment with oilborne preservatives.

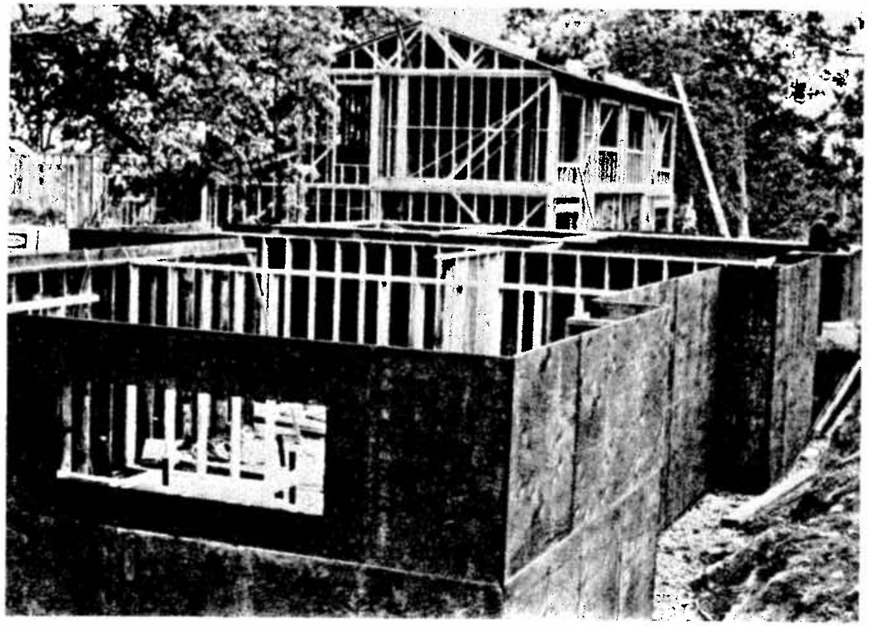


Fig. 15. The Preserved Wood Foundation (PWP) system is now rapidly gaining in popularity. The foundation is constructed for CCA or ACA pressure treated lumber and plywood.

ABSTRACT

LA PRESERVATION DU BOIS AU CANADA

Dr. John N.R. Ruddick

Ces mêmes champignons, bactéries et insectes qui préservent le cycle biologique de la forêt causent des dommages au bois de construction se montant à $90 millions par an.

Les champignons sont les principaux agents de pourrissement au Canada. Les deux types de produits qui ont été mis au point dans notre pays pour lutter contre les champignons du bois sont solubles dans l'eau et solubles dans l'huile.

La créosote qui est le premier produit de préservation mis au point au Canada pour traiter les traverses de chemin de fer est remplacée par des agents hydrosolubles comme l'arséniate de chrome et cuivre (CCA) qui n'exsude pas du bois.

Plusieurs méthodes ont été trouvées pour appliquer les produits de préservation: le badigeonnage, l'immersion, des procédés employant la chaleur, la pression ou le gaz liquéfié. Aucun produit de préservation ne pénètre complètement les bûches, le bois scié ou le contre-plaqué. En effet, le produit de préservation forme une enveloppe qui protège le coeur du bois. Pour que cette enveloppe ne soit pas détruite, il faut appliquer le produit sur le bois bien sec. Les fentes qui se forment quand le bois sèche peuvent être traitées au moyen de produits de préservation.

Le coût du bois et de la main-d'oeuvre encourage les propriétaires à employer davantage de ces produits pour diminuer les frais d'entretien. Les problèmes de conception et de construction, les différences régionales, les économies d'énergie et les techniques nouvelles font que ces produits sont de plus en plus demandés.

A l'avenir, de nouveaux produits seront fabriqués à partir d'espèces sous-employées en utilisant des agents de préservation moins toxiques.

DR. JOHN N.R. RUDDICK, a native of England, studied chemistry at the University of Newcastle-upon-Tyne, following which he completed an M.Sc. degree and received his Ph.D. from the University of London in 1970. Upon moving to Canada in 1971, he became a Teaching Fellow at the University of British Columbia in Vancouver, where he is now an Adjunct Professor. He is presently a research scientist in the Wood Production Department of Forintek Canada Corporation. His research in wood preservatives has earned him an international reputation and he is the author of over 45 publications in the field. He is cofounder of the Canadian Wood Preservation Association and currently serves as a Director and Secretary of the Association.

LES TRAVAUX DE RESTAURATION DES ELEMENTS DE CHARPENTE ET DE MENUISERIE DANS LE CADRE DU RECYCLAGE DE QUELQUES BATIMENTS DU FIEF DE LA CHEVROTIERE

Denis St-Louis

AVANT-PROPOS

Les diverses interventions physiques effectuées depuis 1978 sur trois bâtiments anciens situés dans l'enclave immobilière de l'ancien fief de La Chevrotière doivent être perçues dans le contexte d'une réanimation culturelle et économique du secteur.

Le projet initial de mise en valeur reposait essentiellement sur le postulat qu'une réanimation du secteur à court terme devait être fondée sur un objectif de réinsertion fonctionnelle des bâtiments dans le cadre d'un projet global de recyclage.

Afin d'éviter l'écueil de la restauration sans réanimation et participation du milieu, une approche globale de mise en valeur fut définie dès le début et transposée dans un Plan général de mise en valeur.[1]

Parallèlement à la préparation de ce plan d'orientation, une structure de direction et de gérance de projet fut mise en place pour coordonner les diverses interventions, encadrer la consultation et orienter le projet selon les objectifs du concept de mise en valeur retenu.[2]

L'objectif du plan général était "de recycler les bâtiments en leur prêtant une vocation qui saurait animer, stimuler et impliquer la population et ainsi contribuer de nouveau à un épanouissement de la vie socio-culturelle, éducative et artisanale de la collectivité."[3]

Le moyen privilégié par la direction du projet pour atteindre un tel objectif fut la création "d'un centre de services éducatifs et culturels dans les domaines artisanaux du fer, du bois, de la pierre et des autres métiers traditionnels à valoriser et à transmettre aux générations futures par le biais d'un apprentissage concret."[4] L'idée maîtresse, ayant servi à définir la stratégie de sauvegarde et de mise en valeur, était la réintégration utilitaire de bâtiments anciens dans leur milieu.

CADRE DES INTERVENTIONS CONCEPTUELLES ET DE REALISATION

Contrairement à certaines approches de restauration monumentale, celle qui a été retenue pour la conservation et à la mise en valeur de ces trois bâtiments demeure essentiellement fondée sur la réintégration utilitaire des édifices dans le respect de leur intégrité architecturale significative et de leur authenticité.

La toile de fond, ayant présidé à la mise en valeur de ces trois bâtiments, est constituée de certains paramètres qui ont influencé l'exercice des activités de conception et d'exécution des travaux.

Ces paramètres ont tous un lien étroit avec l'objectif global de mise en valeur défini au Plan général et se résument sommairement ainsi:

- la participation directe du milieu à toutes les principales étapes d'orientation, de conception et d'exécution des travaux;
- l'exécution des travaux généraux de charpente, de menuiserie et de finition intérieure par des apprentis artisans encadrés de maîtres-artisans;
- la diffusion et la prise de connaissance des diverses approches et techniques de restauration et de réhabilitation par l'information accessible et transmise à l'occasion d'un projet spécifique et l'expérimentation concrète *in situ*;
- la continuité de la diffusion des approches et de l'acquisition progressive des techniques de restauration et de réhabilitation grâce à un recyclage orienté vers la transmission des techniques artisanales et techniques de préservation.

COORDONNEES HISTORIQUES SOMMAIRES DES BATIMENTS RESTAURES ET REHABILITES

Les principales étapes de l'implantation immobilière progressive d'une partie de l'ancien fief figurent sur la carte de la page ci-contre (illustration 1).

Par ordre d'ancienneté, les bâtiments ayant fait l'objet d'interventions, de restauration et/ou de réhabilitation sont les suivants:

- **le moulin à farine banal de 1766-67** (identifié 8 sur la carte) dont la restauration partielle a permis un aménagement en atelier de forge pour le déroulement des cours pratiques du travail du fer selon les techniques traditionnelles prévalant au cours du XVIIIe, XIXe et au début du XXe siècles au pays.
- **la maison du forgeron** (identifiée 17 sur la carte) datant probablement du milieu du XVIIIe siècle dont les travaux de mise en protection et de restauration partielle ont débuté à l'hiver de l'année dernière.
- **le moulin à farine banal de 1802** (identifié 9 sur la carte) dont la restauration partielle et la réhabilitation intérieure ont permis l'aménagement d'un centre de formation multi-fonctionnel logeant les ateliers de menuiserie, les salles de cours, les locaux de services aux étudiants et au public, les bureaux administratifs du personnel et l'aire d'accueil et d'information.

COORDONNEES ARCHITECTURALES ET STYLISTIQUES SOMMAIRES

Les trois bâtiments reflètent une architecture dont l'influence française demeure le caractère dominant, malgré leur différence de conception structurale.

L'architecture des bâtiments est extrêmement sobre et dépouillée; l'absence d'avant-toit galbé, de mouluration sophistiquée, de perron ou porche en bois ouvré et mouluré sont autant d'indications du caractère sobre et utilitaire de ces bâtiments dont certaines modifications ultérieures avaient considérablement nui au maintien de leur intégrité architecturale.

Le moulin à farine banal de 1766-67 est celui des trois bâtiments dont il ne restait d'original qu'une partie des murs d'enceinte en maçonnerie de moëllons et de pierres calcaires grossièrement équarries. La structure du toit, des planchers et les cloisonnements intérieurs avaient complètement disparu lors de la prise en charge de ce bâtiment.

Le curetage architectural du bâtiment et l'étude des documents anciens ont permis d'établir le niveau d'occupation ancien du plancher, le périmètre d'implantation du bâtiment et de la voie d'eau, l'emplacement de la plupart des ouvertures et la hauteur du fruit des murs extérieurs en maçonnerie.

Quant à la charpente du toit, sa forme originale n'a pu être déterminée ni par l'étude des documents anciens, ni par les évidences qu'ils pouvaient en rester, compte tenu de sa complète disparition. L'angle du toit a par contre pu être déduit approximativement à partir de photographies de la fin du XIXe siècle.

Le concept de mise en valeur du bâtiment s'est donc limité à la restauration de l'enveloppe du bâtiment d'après les évidences déduites des recherches archéologiques et historiques et à certaines adaptations au niveau des ouvertures en regard de l'utilisation des espaces intérieurs.

La maison du forgeron est celle des trois structures dont il semble demeurer le plus d'éléments dans un état de conservation relativement sain, variant de récupérable à passable.

Cette structure semble avoir été construite initialement en carrés de madriers agencés en coulisse à des poteaux d'huisserie. La charpente du toit, relativement légère, est probablement d'origine et constituée de fermes à pannes contreventées par des entretoises.

Le revêtement de brique date du début du XXe siècle[5] et il demeure possible que le bois fut laissé exposé directement à l'air extérieur pendant une certaine période, compte tenu de l'absence de trace de revêtement autre que la brique sur le parement extérieur des carrés de madriers.[5]

La structure du plancher du rez-de-chaussée et le pontage de bois sont anciens; le revêtement des plafonds et la mouluration datent d'une période de transformation ultérieure, probablement de la fin du XIXe siècle. Quant à la fondation en pierre servant d'appui aux murs extérieurs en carrés de madriers, son épaisseur reste difficile à expliquer si ce n'est dans l'hypothèse que le sol actuel, au pourtour du mur, a été considérablement abaissé lors du nivelage ultérieur d'une bonne partie du terrain adjacent.

Le moulin à farine banal de 1802 se situait à mi-chemin de l'état de conservation entre les deux autres bâtiments.

Les évidences architecturales et les recherches historiques ont permis de restaurer l'enveloppe et la structure du bâtiment et une partie des espaces intérieurs.

Le réhabilitation de la majeure partie des espaces intérieurs fut envisagée et privilégiée afin de répondre aux exigences minimales de sécurité du public, de flexibilité d'utilisation et de respect de l'authenticité du bâtiment.

Tous les éléments architecturaux ou structuraux qui ne nuisaient pas à l'intégrité de la perception du bâtiment restauré et qui pouvaient contribuer à son recyclage ont été conservés. Ce fut le cas d'une partie de la voie d'eau intérieure construite en béton vers 1935, les supports et mécanismes d'une partie du système de transmissions des forces hydrauliques de l'ancien moulin à eau, ainsi qu'une moulange et un crible (ou tamis). Tous les éléments structuraux récupérables furent conservés ou réutilisés pour compléter d'autres systèmes structuraux similaires.

PARAMETRES GENERAUX DES TRAVAUX DE MENUISERIE ET DE CHARPENTERIE EXECUTES AU BATIMENT PRINCIPAL (MOULIN DE 1802)

Condition physique des éléments structuraux

De façon générale, les éléments de charpenterie apparents ou dissimulés étaient dans un état variant d'irrécupérable à passable.

L'intégrité du système structural des planchers était rompue tant horizontalement que verticalement. En effet, les poutres franchissant des portées libres de 43 pi. et certainement appuyées originalement à des colonnes ou cloisons à mi-portée étaient toutes attaquées par la fourniture sèche à leurs extrémités et certaines s'étaient effondrées. La présence d'étaiements temporaires et de quelques colonnes ont permis à certaines d'entre elles de conserver leur position initiale.

Le platelage en bois d'oeuvre franchissant les portées entre les poutres et les entraits des fermes du toit était disparu à environ 60% et ce qu'il en restait était irrécupérable. Au niveau des fermes du toit, toutes les extrémités étaient sévèrement attaquées au tiers du triangle d'appui à partir de la sablière elle-même irrécupérable sur tout le pourtour au dessus du mur de pierre.

Quant à la condition des menuiseries de finition des ouvertures, des plafonds et des escaliers, l'état en était irrécupérable due à une exposition trop sévère et prolongée à l'humidité incontrôlée, et au vandalisme. Toutes les pièces de bois servant d'appui ou de composante aux mécanismes de transmission de l'énergie hydraulique étaient disparues ou amputées et l'intégrité du mécanisme original était inexistant. Les quelques pièces d'appui qui témoignaient de la présence de l'ancien mécanisme étaient situées au sous-sol.

De façon globale, les membrures structurales du système des planchers n'étaient récupérables qu'à environ 50% et le platelage irrécupérable. Au niveau des fermes de toit environ 60% des membrures semblaient récupérables et l'intégrité de la charpente semblait pouvoir être maintenue en conservant un niveau d'authenticité acceptable. En ce qui a trait à la menuiserie de la couverture, celle-ci était irrémédiablement compromise, incluant les lucarnes.

LE CONCEPT DE RESTAURATION ET DE REHABILITATION DES ELEMENTS DE CHARPENTE ET DE FINITION EN BOIS

Le concept de mise en valeur du bâtiment fut axé sur la restitution de l'intégrité de l'enveloppe du bâtiment et de son ossature, tout en conservant les éléments évolutifs significatifs des différentes périodes.

En ce qui concerne l'organisation spatiale de l'intérieur du bâtiment et le traitement des composantes qui la définissent, l'approche à la mise en valeur favorisa nettement la réhabilitation à titre de moyen privilégié pour satisfaire aux objectifs d'une utilisation fonctionnelle et en harmonie avec le programme de réanimation.

Le principe directeur encadrant toutes les décisions de conception et d'exécution relatives au traitement de l'enveloppe et de l'ossature était d'assurer au maximum la conservation des éléments sains et de rétablir l'intégrité des systèmes auxquels ils appartenaient par des méthodes à caractère traditionnel devant être appliquées par des apprentis sous l'encadrement de maîtres-artisans du milieu.

La mise en valeur de l'ancien moulin banal de 1802 par la restauration partielle de son enveloppe et de sa structure selon des méthodes et procédés traditionnels ne peut se justifier que pour des motifs de formation en vue d'assurer une continuité aux méthodes et pratiques anciennes pour la restauration d'édifices significatifs.

C'est donc dans un optique de formation en métier traditionnel que furent élaborés les plans, programme d'essais et devis d'exécution des travaux. Dans un autre contexte et objectif de mise en valeur, l'expression de recyclage de ce bâtiment aurait certainement été très différente, particulièrement au niveau du traitement de la charpente et certainement de l'enveloppe.

SOMMAIRE DES PRINCIPAUX TYPES D'INTERVENTION

Charpenterie et menuiserie de l'enveloppe

Tous les éléments de charpenterie et de menuiserie des ouvertures furent exécutés selon les profils et modèles traditionnels en adaptant l'outillage contemporain aux nécessités de la réplique à l'identique. Les croisées, palétrage, chambranle, tablettes et seuils furent ainsi exécutés, de même que les plinthes de plancher et revêtement de plafond à caisson.

En ce qui a trait au recouvrement du toit, la technique de taille à la main du bardeau fut utilisée à titre d'exemple seulement. Le bardoisage fut réalisé à l'aide de bardeaux coupés industriellement et traités au préservatif sous pression (méthode en autoclave).

CHARPENTERIE D'OSSATURE STRUCTURALE

Le principe adopté pour la conservation et la restitution de l'intégrité des systèmes structuraux de plancher et de toiture fut celui de la technique des greffes structurales à l'aide de méthodes d'assemblage traditionnel appuyées, si requises, par des techniques d'appui contemporain.

Principaux types de greffes utilisées

(voir illustrations 8 à 10)

Les types d'assemblages utilisés pour la restauration des fermes des toits et des poutres de plancher furent choisis en fonction de leur propriétés structurales et de leur conformité aux techniques d'assemblage traditionnel.

- **Assemblage sifflet à talon**: ce type d'enture fut retenu pour la restauration des fermes des toits dont les extrémités des arbalétriers au tiers de leur appui étaient pourries et irrécupérables.

Les interfaces du joint furent solidifiées à l'aide de boulons métalliques et d'injection de colle à l'époxy afin de prendre soin des efforts de tension qui peuvent se développer aux arbalétriers suite aux poussées asymétriques.

-**Assemblage d'enture à trait de Jupiter**: ce type d'enture fut retenu pour la restauration des poutres de plancher et du tirant principal compte tenu de ses propriétés structurales à résister aux efforts de traction et du caractère technique traditionnel de sa conception.

Des colonnes ou poteaux furent ajoutés aux étages à mi-portée des fermes et des poutres de façon à soulager ce type de joint des charges mortes et vives dont le coefficient de sécurité devait répondre aux normes publiées de bâtiments. La décision d'ajouter des colonnes intermédiaires était en continuité historique avec une pratique similaire déjà existante dans une partie du bâtiment.

Plancher de charpente

Tout le revêtement de plancher original en platelage de bois embouveté fut remplacé, étant complètement irrécupérable. Un nouveau plancher de charpente en madrier embouveté fut érigé sur les poutres, et deux modules de planche métallique creuse furent logés le long de chaque mur périphérique longitudinal. Les planches creuses métalliques servirent à ficher le filage électrique requis à l'éclairage et à l'alimentation électrique des équipements.

Essais de chargement structuraux

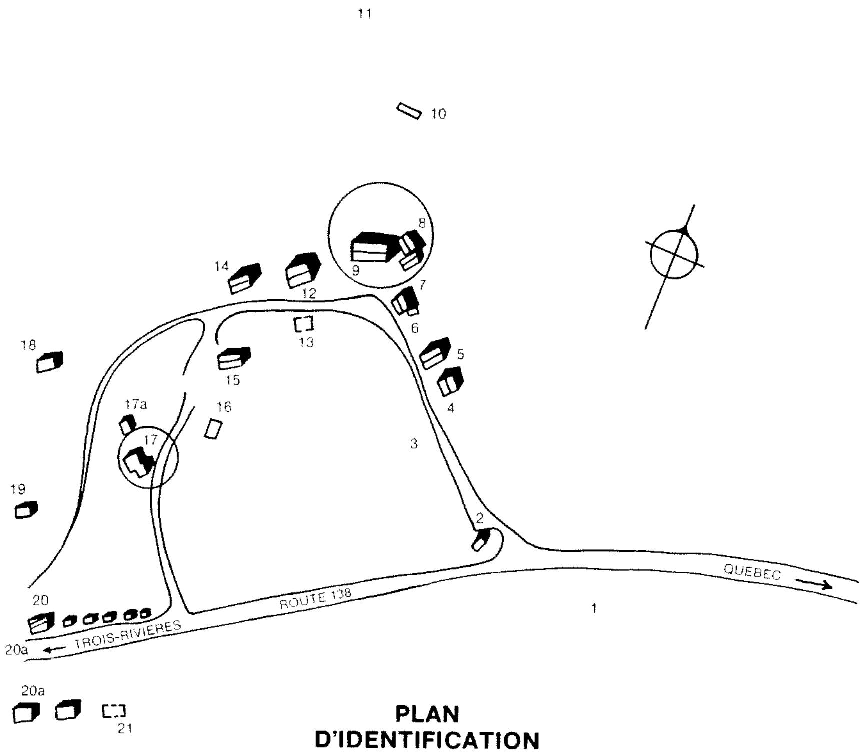
(Consulter l'annexe 1, pour le cahier de charge des essais et interprétation des résultats.)

Une série de six (6) essais de chargement fut réalisée sur les deux types d'enture mentionnés précédemment.

- Essais 1 à 3: ces essais furent exécutés sur un joint d'assemblage en sifflet à talon avec ou sans appui à mi-portée, de façon à mesurer sa résistance aux efforts de chargement admissibles.
- Essais 4 à 6: les essais furent exécutés sur un joint d'assemblage

d'enture à trait de Jupiter avec ou sans appui à mi-portée de façon à mesurer sa résistance aux efforts de chargement admissibles.

Les essais, à l'exception d'un seul, furent réalisés sur le chantier en présence des ouvriers qui eurent à exécuter plus tard les divers détails d'enture. Un rapport fut préparé par le Laboratoire de construction du Québec inc.[6] et remis aux ingénieurs-conseils[7] qui établirent les détails définitifs des assemblages à exécuter.



PLAN D'IDENTIFICATION

1 — Emplacement hypothétique de la chapelle (1702) (disparue)
2 — Magasin de souvenirs (1951)
3 — Emplacement du moulin à carder (1823 à 1904) (disparu)
4 — Maison de François Gauthier (ca 1832) (ancienne maison d'école) (1833) (disparue)
5 — Anciens bâtiments de ferme (milieu du XIXe siècle)
6 — Emplacement hypothétique de la maison de Louis Gariépy (ancienne maison d'école) (1833) (disparue)
7 — Maison de Georges St-Pierre (ca 1882) (ancienne maison du meunier Octave Gariépy)
8 — Moulin à farine banal de 1766-1767
9 — Moulin à farine banal de 1802
10 — Chaussée du moulin à farine
11 — Emplacement des moulins à scie (ca 1783 à ca 1895) (disparus)
12 — Maison de Guy Nadeau (manoir seigneurial de Louis Gariépy (1823) et ancien magasin général (au sous-sol))
13 — Emplacement hypothétique de la maison et boutique de forge de Joseph Pagé (XIXe siècle) (disparue)
14 — Maison d'Antoine Laflamme (première moitiée du XXe siècle)
15 — Maison Arcand (ca 1950)
16 — Emplacement hypothétique de la beurrerie et fromagerie (début du XXe siècle) (disparue)
17 — Maison de Jacques Beaupré (début du XIXe siècle ?)
17a - Ancien bâtiment de ferme (XIXe siècle)
18 — Maison de Narcisse Paquet (ca 1823)
19 — Maison de Johanne Genest (fin XIXe siècle)
20 — Maison
20a - et motel de Lauréat Paquet (1951)
21 — Ruines de l'ancien manoir seigneurial (milieu du XVIIIe siècle)

Fig. 1.

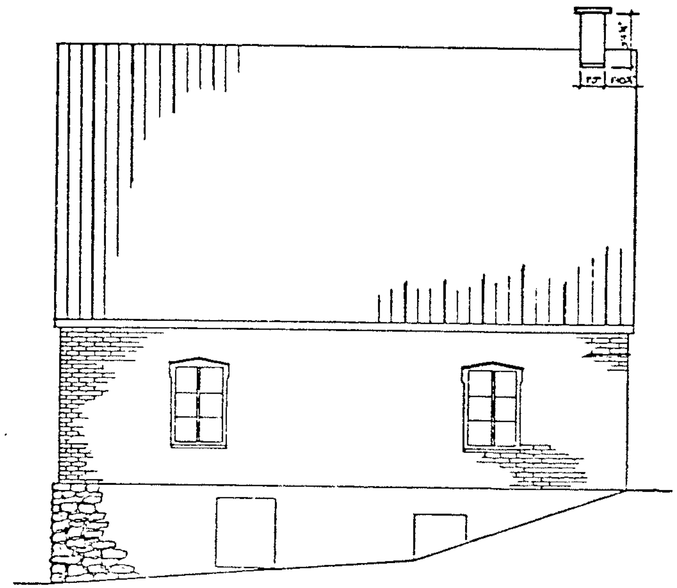


Fig. 2. Elévation nord.

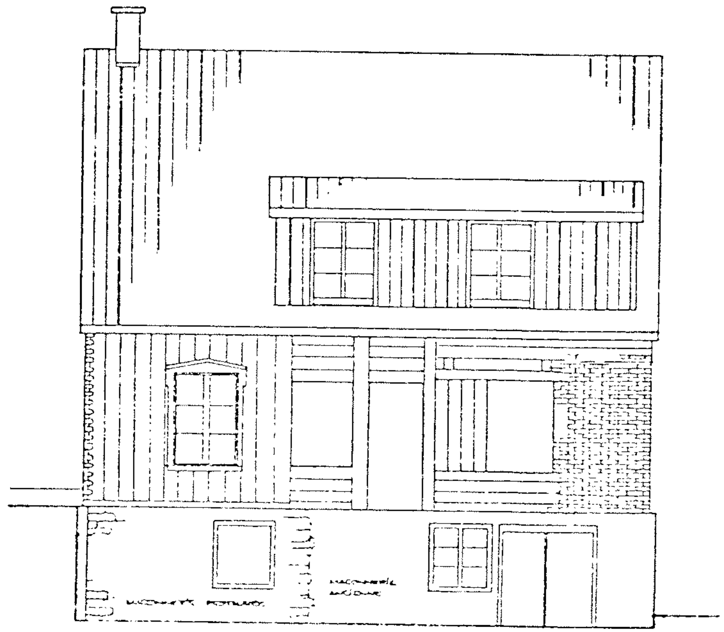


Fig. 3. Elévation sud.

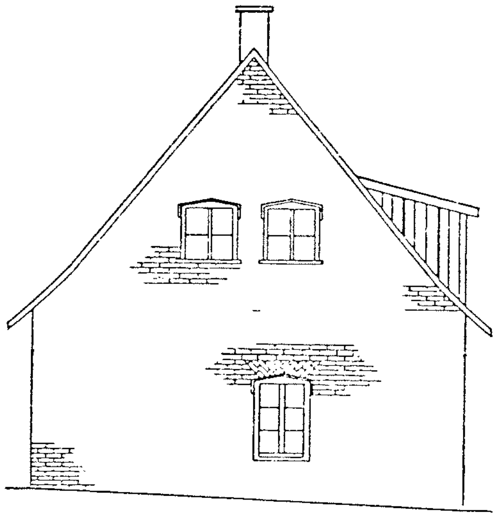


Fig. 4. Elévation ouest.

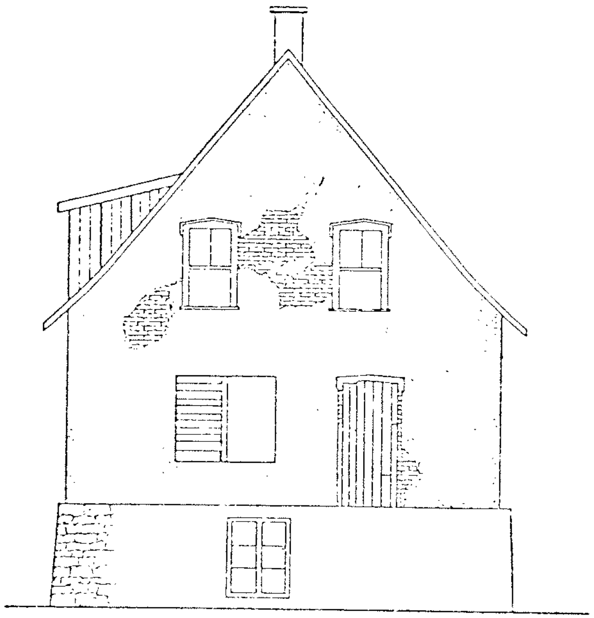


Fig. 5. Elévation est.

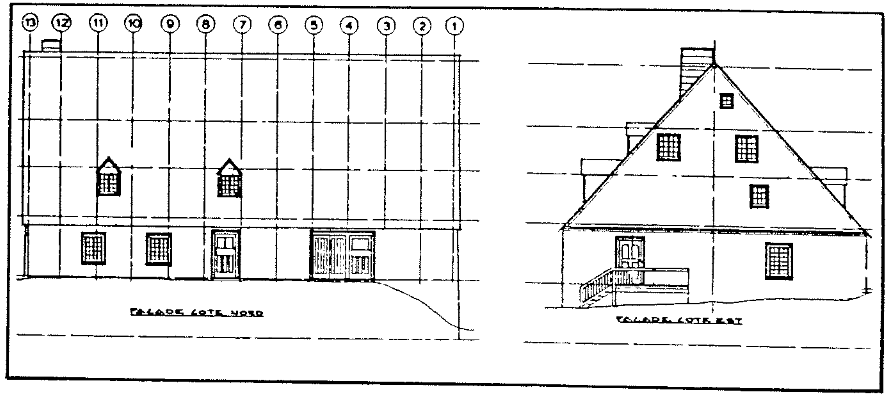


Fig. 6. Facade cote nord; Facade cote est

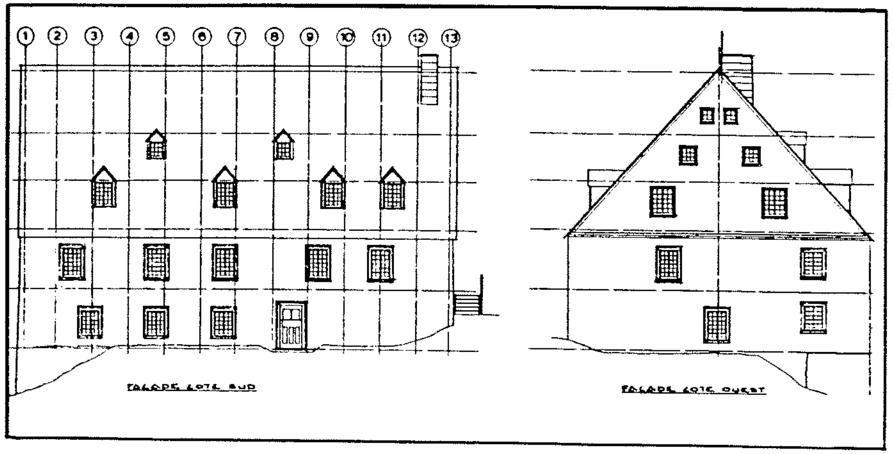


Fig. 7. Facade cote sud; Facade cote ouest

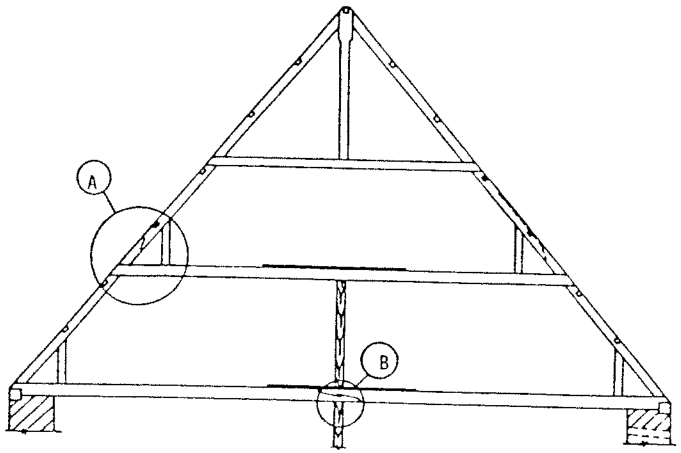


Fig. 8. Elévation type d'une ferme de toit.

légende :

- A_1 : arbalétrier (partie saine)
- A_2 : arbalétrier (partie greffée)
- **B** : entrait (partie greffée)
- **C** : jambe de force
- D_1 : tirant (partie saine)
- D_2 : tirant (partie greffée)
- **E** : poteau
- **F** : goujon métallique

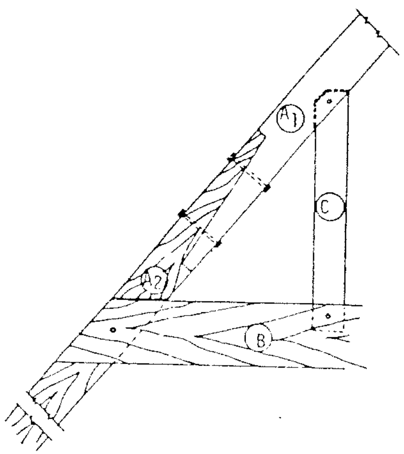


Fig. 9. Detail A. Assemblage sifflet à talon (boulonné et collé).

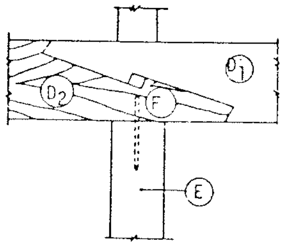


Fig. 10. Detail B. Assemblage enture à trait de jupiter (clef simple).

ANNEXE 1: CAHIER DE CHARGES DES ESSAIS DE CHARGEMENT

Laboratoire de construction du Québec, Inc.

ESSAI NO 1 ET ESSAI NO 2

Sur l'esquisse no 8, nous avons donné les conditions de chargements pour cet essai. Une poutre de 8 po. par 10 po. par 12 pi. 1/8 po. de longeur est simplement appuyée aux deux extrémités et au centre de la portée.

Les charges concentrées ont été appliquées avec des vérins hydrauliques gradués.

A l'essai no 1, le joint dans la poutre, au centre de la portée, était renforci par quatre (4) boulons de ½ po. de diamètre. Pour cet essai, les charges ont été appliquées graduellement et les résultats sont donnés dans ce qui suit:

Charges livres	Déflections mesurées à 18 po. chaque côté du centre de la portée d_1	d_2
0	---	---
3000	1/32 po.	1/16 po.
6000	3/32 po.	1/8 po.
8000	5/32 po.	5/32 po.
10500	7/32 po.	1/4 po.
11875(charge de l'essai)	7/32 po.	1/4 po.

A l'essai no 2, les quatre boulons renforcissant le joint ont été enlevés et le chargement a été fait par étape jusqu'à la charge maximale de l'essai de 11 875 livres, soit 2,5 fois la valeur des charges concentrées de 4750 livres. La déflection de la poutre à l'endroit des charges concentrées n'a pas été supérieure à celles de l'essai données précédemment.

La déflection maximale de ¼ po. est inférieure à la déflection calculée à partir de L/360, L/180.

Le joint de la poutre, tel que réalisé au support du centre de la portée, s'est comporté d'une façon acceptable.

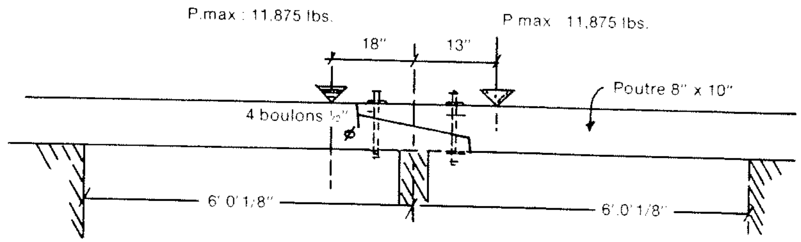


Fig. 8 — Essais nos. 1 et 2

N.B. A l'essai n° 2, les 4 boulons au joint ont été enlevés.

ESSAI NO 3

La poutre ayant été utilisée pour les essais no 1 et no 2 a servi à cet essai. Le support au centre a été enlevé et les vérins ont été placés au tiers de la portée.

Les boulons au joint dans le centre de la poutre sous la charge s'enfonçant dans le bois, c'est alors que l'on ajouta des rondelles de 2¼ po. de diamètre à chacun des quatre boulons. Les résultats sont donnés dans ce qui suit:

Charge à l'essai - livres	Déflection au centre
0	---
2000	1-1/4 po.
3000	1-9/16 po.
4000	voir note

NOTE: On ne peut augmenter la charge sur les vérins n'ayant plus de rigidité.

Si l'on considère que la déflection maximale acceptable est calculée à partir de L/180, la déflection maximale acceptable est de 0,808 po. La déflection à 2000 livres est déjà trop importante.

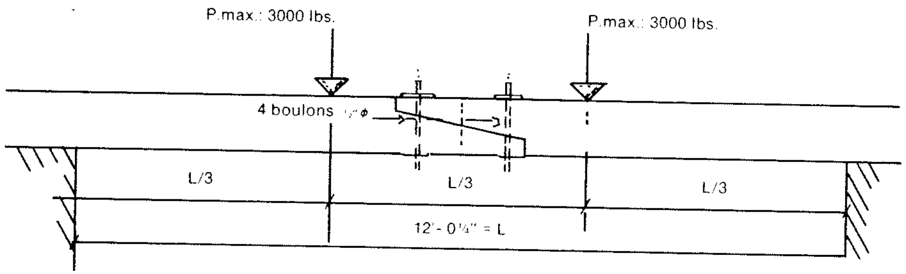


Fig. 9 — Essai n° 3

ESSAI NO 4

Une nouvelle poutre de 9¼ po. par 10¼ po. est mise en place pour subir l'essai de chargement.

Les vérins sont placés au tiers de la portée de 9 pi. 0 po. et la déflection est mesurée au centre de la poutre. Les résultats sont donnés dans ce qui suit:

Charge appliquée sur chaque vérin - livres	Déflection au centre de la portée
0	---
2000	1/4 po.
4000	9/16 po.
6000	1 po.
6900	1-1/4 po.
0	1/8 po.

Un autre essai fut réalisé sur la même poutre après avoir enlevé les quatre boulons au joint. La charge maximale que l'on a pu atteindre avant déformation permanente a été de 3800 livres. Par après, la poutre s'est déformée sous la poussée des vérins et les déformations sont montrées aux photos.

Lors de l'essai no 4, si l'on calcule la déflection maximale acceptable comme L/180 = 0,6 po., nous pouvons interpoler la charge à laquelle cette déflection a été obtenue. Une charge de 4100 livres sur chacun des vérins a causé cette déformation de 0,6 po. En tenant compte du facteur de sécurité de 2,5 et en prenant pour acquis que le rétablissement de la poutre aurait été acceptable, cette poutre dans les conditions de l'essai peut supporter deux charges concentrées de 1640 livres chacune.

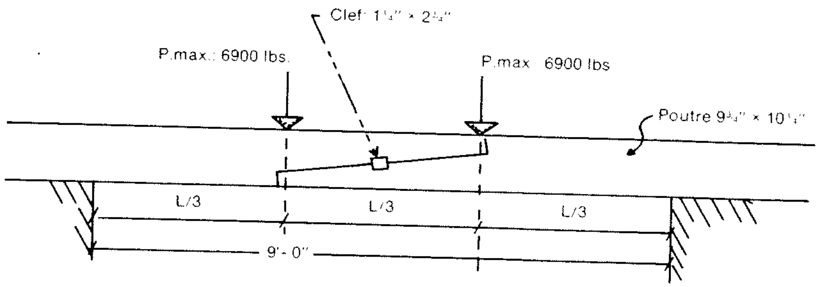


Fig. 10 — Essai n° 4

ESSAI NO 5

Une nouvelle poutre de 6-3/4 po. par 8-5/8 po. avec une portée de 9 pi. 3/4 po. a été mise en charge par deux vérins au tiers de la portée. Sur l'esquisse no 3, on aperçoit le joint et la position des charges. Les résultats sont donnés dans ce qui suit:

Charge appliquée par chacun des vérins	Déflection au centre
0	---
2000	7/8 po.
4000	1-1/4 po.
5000	poutre cède

NOTE: Charge à la rupture: 5000 livres
Charge prévue: 6900 livres

La déformation à 2000 livres étant trop élevée, nous ne pouvons pas trouver la capacité réelle de la poutre.

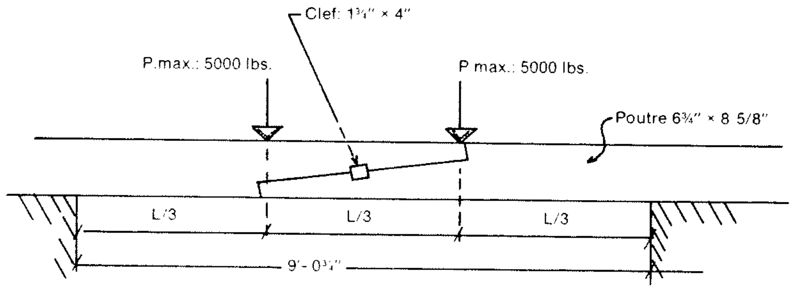


Fig. 11 — Essai n° 5

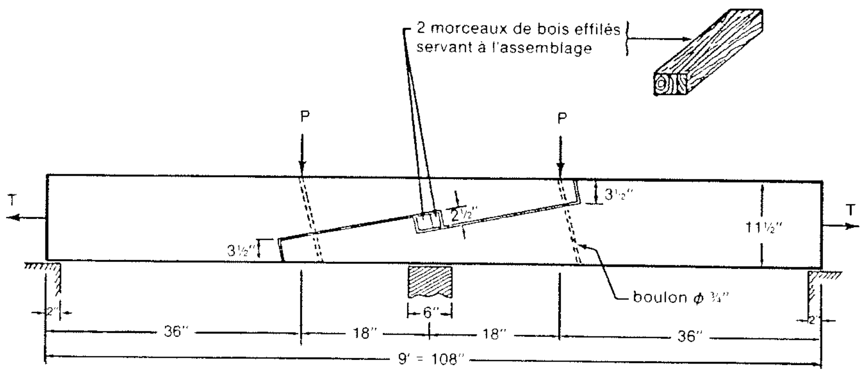


Fig. 12. — Vue schématique de la poutre en bois et du mode de chargement.

ESSAI NO 6

Selon l'entente originale, la poutre en bois mise à l'essai a été four- nie par le Laboratoire de Constructions, Inc. Il s'agissait d'une poutre de section rectangulaire de dimensions nominales 10 po. par 12 po. (dimensions réelles: 9½ po. par 11½ po.) et, selon les information fournies, la poutre était en bois B.C. Fir, catégorie A.

La poutre, d'une longueur de 9 pi., était constituée de deux pièces, tel qu'indiqué sur la figure 12. Les deux pièces furent assemblées à l'aide de deux petits morceaux de bois effilés. En introduisant ces morceaux de bois dans l'espace laissé libre par l'imbrication des deux pièces, on comprime les faces verticales du joint ce qui produit le serrage de l'assemblage.

BUT DE L'ESSAI

Le but de l'essai était de mesurer la résistance de la poutre en bois soumise à un moment fléchissant et à un effort tranchant dus à deux charges con- centrées verticales (P) et à un effort normal de traction (T), tel qu'in- diqué schématiquement sur la figure 12. La poutre était appuyée en trois points, soit au centre et aux deux extrémités.

RESULTATS DE L'ESSAI

L'objectif premier de l'essai était de vérifier si la poutre pouvait résister à deux charges concentrées (P) égales à 17 215 livres chacune et à un effort normal de traction (T) égal à 17 125 livres. Considérant, tel que recommandé, un facteur de sécurité de 2,5, ces charges ultimes donnent des charges de service, P = 6885 livres et T = 6850 livres.

Les forces P et T furent augmentées simultanément jusqu'à 17 215 livres et 17 125 livres respectivement, et la poutre a supporté ce chargement sans rupture. Le moment fléchissant maximum en travée était alors de 91 800 livres/po. sous les charges concentrées et -172 125 livres/po. au-dessus de l'appui central. Sous ce chargement la poutre a subi un allongement de 0,038 po. ($D_1 + D_4$) et la flèche verticale au centre des travées a atteint 0,278 po. (D_2) et 0,234 po. (D_3). Au niveau des charges de service (P = 6885 livres et T = 6850 livres), l'allongement de la poutre était d'environ 0,009 po. et la flèche verticale a atteint 0,091 po. (D_2) et 0,065 po. (D_3).

Après le déchargement complet de la poutre, on a enlevé les quatre boulons traversant le joint (voir photos A et B, et figure 1). On a ensuite chargé de nouveau la poutre jusqu'à P = 17 215 livres et T = 17 125 livres. Encore une fois, la poutre a supporté ce chargement sans rupture.

On a ensuite augmenté la force T à 22 000 livres en gardant les deux charges concentrées (P) constantes à 17 215 livres chacuns. La poutre a supporté ce chargement sans rupture.

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ABSTRACT

THE RESTORATION AND RENOVATION OF THREE BUILDINGS IN THE FIEF OF LA CHEVROTIERE, QUEBEC

Denis St-Louis

Since 1978, three historic mills, located on the property of the former fief of La Chevrotière, 60 kilometers from Québec City, have been rehabilitated. Depending on the building's condition and its new use, various degrees of intervention were undertaken, and these should be seen within the context of cultural and economic revitalization.

Le Moulin à Farine Banal, built between 1766 and 1767, was partially restored and converted into a blacksmith's workshop, to teach traditional methods of ironwork. Another building, **La Maison du Forgeron** (the blacksmith's house), dating from the mid-19th century, was restored; and **Le Moulin à Farine Banal**, built in 1802, was converted into a multi-purpose educational centre with carpentry workshops, classrooms, a display area and administrative offices.

Historical research and archaeological investigations revealed useful information on the buildings' designs and stages of development. When the restoration process began, this information was carefully considered. For the interiors, the emphasis was on rehabilitation, rather than restoration, so that functional requirements could be incorporated as well.

In all cases, the conservation of sound portions of the buildings was emphasized. Apprentices working on the site used traditional methods of construction. The rehabilitation of the 1802 Mill, in particular, was viewed as an educational project, to teach ancient methods of construction and to experiment with various conservation techniques. This, of course, influenced the rehabilitation and its overall design, which would have differed had the educational aspects not been stressed.

Documentation on the physical condition, various forms of intervention, a detailed explanation of the structural framework and experiment results for the main building (the 1802 Mill) are all included in this paper.

DENIS ST-LOUIS a étudié à l'Université de Sherbrooke et il a un baccalauréat en architecture de l'Université de Montréal. Il a aussi étudié à l'ICCROM à Rome en 1972 et à Cornell University en 1973. Entre 1976 et 1977, il a travaillé pour le département des Affaires indiennes et du nord, Services de restauration à Ottawa et à Québec. De 1977 à 1980, M. St-Louis était le gérant de secteur, Parc national naturel et district historique dans le bureau régional de Parcs Canada à Québec. En 1980, il entrait en pratique privée et il est maintenant co-directeur de Bilodeau St-Louis Architectes. Il est membre de l'Ordre des architectes du Québec, de l'ICOMOS CANADA, du Conseil des Monuments et Sites du Québec et de l'Association pour la préservation et ses techniques.

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USE OF RENEWABLE RESOURCES FOR MANUFACTURING PRESERVATIVES, COATINGS AND STABILIZERS

Paul Stumes, P.Eng.

Ever since biblical times, when Noah smeared pitch on the timbers of his ark to protect it from decay during the forty days of the flood, wood and chemistry have walked hand in hand.

In the course of the past 30,000 years, mankind has learned that wood deteriorates; therefore, it must be protected. Eventually, a wide range of substances were developed for wood conservation. Historically, about 85% of these originated from renewable resources, like the resins of trees, animal fats and other extracts from fauna and flora.

In the last 200 years or so, the rather questionable benefits of the industrial revolution changed all this. From the late 18th century on, these renewable resources were replaced gradually by chemicals, produced from non-renewable hydrocarbons, chiefly petroleum and coal derivatives. Today, about 80% of all chemicals associated with wood are derived from fossil hydrocarbons.

Ladies and gentlemen, while we are here today to express our concern over the preservation of humanity's architectural heritage - a heritage which is fabricated of wood - it would be unethical to neglect completely our other type of heritage: the natural resources of this earth. The ethics of conservation demand that we search for new sources of chemicals for wood preservation. We must find alternative sources among the **renewable resources** of the earth, in order to conserve our diminishing heritage of fossil hydrocarbons.

The hydrocarbon which I would recommend for closer scrutiny is a common agricultural product, known to all of us - sugar.

Sugar is an annually renewable material, low in cost, which can be produced without major capital investment on practically all arable land on this globe.

Sugar, the familiar white crystal, is a so-called di-sacharide: the combination of two simpler sugars - glucose and fructose. This substance is known to chemists under the name of sucrose, and the science which studies this material is aptly called sucrochemistry.

Sucrose, as a chemical, consists of only three elements: oxygen, hydrogen, and carbon. However, a close examination of sugar discloses a complex molecular structure. This structure makes possible the synthesis of an astronomical number of sucrose derivatives. For example, there could be 16 million octa-substituted sugar derivatives, theoretically at least.[1]

Surely among the 16 million there must be a few which could have practical application for wood conservation!

In all likelihood, the most important chemicals used for the conservation of wood are fungicides, insecticides and other pesticides. They are used either by themselves or mixed with paints, stains, sealers, etc. to improve their resistance to decay.

One of the most frequently used group of pesticides are the so-called organometallic derivatives, manufactured from petroleum by-products.

At Queen's College, University of London, an effective organometallic pesticide has been produced, based on sucrose; it is organostanyl sucrose phthallate, an organic tin derivative.[2]

The biological effectiveness of this was tested against certain fungi, molluscs and bacteria, with results demonstrating that sucrose-based organometallic pesticides are as effective as other similar pesticides, while the metallic tin content is only 1/3 to 1/2 of butyl- or methyl-based pesticides.

A notable property of the sucrose-based organometallic pesticides is that they are biodegradable. When digested by micro-organisms, the organic groups will break down to carbon dioxide and inorganic tin.

The widespread use of tin-plated food containers indicates that inorganic tin compounds are **NOT** toxic. Conservationists, who are concerned about the accumulation of poisonous substances in the environment, should advocate the use of sucrose-based biodegradable pesticides for the conservation of timber.

After pesticides, the most common method of preservation is the encapsulation of wood, to make it inaccessible to the agents of deterioration; that is, to cover it with paint or varnish, or to saturate the surface cells with sealers.

Probably no paints are as widely used as the so-called oil paints. Oil paints were originally produced from processed vegetal matters, such as linseed oil. Today, natural oils have been substantially replaced on the market by the so-called alkyd paints, manufactured from petrochemicals.

Experiments have proven that it is entirely feasible to replace petroleum-based alkyds, and manufacture wood sealers, paints and varnishes from sucrose esters of unsaturated fatty acids.[3]

Comparison has shown that sucrose-based oil paints are equal to petroleum-based alkyds in resistance to weathering, film-hardness, elongation and adhesion to wood surfaces. The tensile strength of these paints is less than that of alkyds, but still four times more than linseed oil paints.

Another sucrose derivative, with great potential in the field of wood preservation, is the so-called sucrose acetate isobutyrate ester - SAIB for short.[4]

This compound, when added to other chemicals, has far-reaching effects on the host material.

- First, it increases water resistance if mixed into paints. At the laboratory, wood specimens were coated with alkyd paint, blended with SAIB. When the specimens were immersed in boiling water for 96 hours, at the end of the experiment the water absorption was only 0.3%.
- Secondly, it was discovered that SAIB is extremely responsive to solvents. The addition of 10% of some common organic solvent induces a 100-fold reduction of viscosity. This makes it eminently suitable as a deep-penetrating vehicle for pesticides, sealers and other wood preservatives.
- Thirdly, its viscosity is radically effected by small changes in temperature. While its viscosity is 100,000 cps at 25° Celsius, it is only 1,000 cps at 68°. This temperature range has little effect on wood, consequently sucrose acetate isobutyrate should have an important role in developing hot-melt adhesives and heat-seal paints for aged wood.

A rather frustrating, and still unresolved problem, is the loss of structural strength in decayed timber, when some of its constituents are consumed by fungi or insects. Such timbers cannot carry loads anymore. If we wish to utilize them under stress, then either we must cut out the damaged parts and splice in new pieces, or we must reinforce them with high-tensile inserts, as is done with the familiar BETA or Wood Epoxy Repair systems.

Neither splices, nor the BETA or W.E.R. systems are truly compatible with the principles of historic preservation. Any of these methods will destroy some part of the original historic fabric, and none of them can make the decayed wood **itself** strong again.

Various compositions were tried to replace the cellulose, hemicellulose or lignin which had been consumed by the pests. Salts, waxes and other substances were used. Lately, polyethylene glycol is favoured nearly exclusively, especially with waterlogged timber.

While all of these are more or less suitable for dimensional stabilization, none of them is capable of lending appreciable strength to weakened wood. Furthermore, all of these will leach out as time passes, even under normal environmental conditions.

As you can expect, among the many materials tested for timber stabilization, we found sugar as well.

Probably the best known are the successful experiments of Grosso, of the Pacific Northwest Conservation Laboratory in the United States. He used ordinary table sugar, dissolved in water, as a bulking agent for waterlogged wood. He claimed in his 1981 report - and I wholeheartedly agree with him - that sucrose is as good as - and maybe better than - PEG as a bulking agent.[5]

However, while Grosso succeeded in stabilizing the dimensions of the wood, his method still could not restore the original load-bearing capacity.

We have experimented with a number of different polysacharides, besides ordinary sucrose. I found two polysacharides which are more suitable - in my opinion - for the stabilization of waterlogged wood, mostly because they impart more strength. However, I do not wish to elaborate on this issue, since the main subject of our conference is historic architectural timber, and not waterlogged wood.

The question which is asked most frequently by conservationists is this: "How can the original load-bearing capacity be restored to decayed architectural timber?"

I believe that the final answer - or as close to the final answer as is humanly possible - could be a sucrose-based true polymer, which I am presently investigating on behalf of Parks Canada. This substance has basically three components:

- a sucrose-based modified polyol,
- an amino-resin pre-cursor,
- and an acidic catalyst.[6]

These three components represent the final product in a pre-polymer stage. These can be mixed together and dissolved in water, retaining a nearly infinite shelf life.

For practical application in wood stabilization, a pre-polymer solution is prepared, with a resin content of 25% to 30%. The viscosity of this liquid is only around three centistokes. Such a solution can penetrate and thoroughly saturate construction grade pine. For less porous specimens, naturally a lower viscosity is suggested; while for badly decayed timber, higher concentrations are recommended.

Wood can be saturated with this solution either by immersion and extended soaking, or by vacuum - or pressure - impregnation.

After the wood is saturated, it is heated until the water evaporates. This heat will cause the monomer to polymerize inside the cells of the wood. The temperature of this treatment can be as low as 60° Celsius. This temperature is certainly not above the tolerance of aged timber.

According to the latest test reports I have received, the compressive strength of wood, treated with this sucrose-based polymer, is up to **7% higher than new, sound timber.**

This treatment is permanent. The polymer will not leach out and the surface of the wood is only slightly darkened. The wood can also be painted.

To avoid exposing deteriorated, aged wood to heat, during my investigations, I will look into the feasibility of other techniques of inducing polymerization. Among the possibilities are catalysts which require much lower heat application and a two-stage saturation technique, where first the wood is saturated thoroughly with the pre-polymer and then with the catalyst.

The testing and development work is still in progress, but I hope that, if we are able to secure the necessary funds, at the next meeting of the ICOMOS Wood Committee I can present you with a solution to a problem which has long eluded the community of conservators: we might have found a substance which can truly restore the structural strength of decayed wood.

In the meanwhile, I beg your patience; you will understand that I am not permitted to disclose more details until our testing program is completed.

Ladies and gentlemen, these were just a few examples of the products of sucrochemistry: paints, pesticides, stabilizers, and others. I strongly believe that some of these are as good as, and many are even better than, the traditional chemicals.

I am certain that it will not be detrimental to the conservation of our architectural heritage, **IF** by using renewable resources, we try to contribute to the conservation of our globe's fossil hydrocarbon heritage as well.

ABSTRACT

L'UTILISATION DES RESSOURCES RENOUVELABLES POUR LA FABRICATION DES PRESERVATIFS, DES ENDUITS ET DES FIXATIFS (DU BOIS)

Paul Stumes, Ing.

Un large éventail de produits ont été historiquement mis au point pour assurer la préservation du bois. A l'origine, 85% de ceux-ci furent des dérivés de substances naturelles, comme les résines ligneuses, le gras animal et autres sous-produits de la faune et de la flore.

Depuis la révolution industrielle, ces produits naturels furent graduellement remplacés par des produits chimiques dérivés de ressources non renouvelables d'hydrocarbures, pétrole et charbon. Actuellement près de 80% de tous les produits chimiques associés au bois sont des dérivés d'hydrocarbures fossiles.

L'auteur fait valoir que la préservation du patrimoine architectural de l'humanité, en bonne partie constitué de bois, exige que nous profitions encore de cet autre héritage que constituent les ressources naturelles renouvelables.

L'éthique de la conservation exige que nous trouvions des sources alternatives dans les ressources naturelles renouvelables pour pallier la diminution des ressources fossiles non renouvelables.

Il recommande, entre autres choses, d'utiliser un produit agricole commun, renouvelable annuellement, peu coûteux et produit sur toutes les terres arables du globe: le "sucre."

La sucrose composée de trois éléments: l'oxygène, l'hydrogène et le carbone, a une structure moléculaire complexe qui permet de produire en nombre astronomique des éléments de synthèse. On peut ainsi produire quelque 16 millions de substituts dont plusieurs peuvent avoir une application pratique dans la préservation du bois.

Ainsi les fongicides, les insecticides et les pesticides utilisés pour eux-mêmes ou mélangés aux peintures, teintures ou scellants sont généralement des sous-produits du pétrole. Or, au Queen's College de l'université de Londres, on a mis au point un pesticide efficace à base de sucrose. Ce pesticide testé en laboratoire est aussi efficace que les autres et a de plus l'avantage d'être biodégradable et non-toxique.

Des expériences ont aussi démontré que des huiles aussi efficaces que les dérivés pétrochimiques pour imperméabiliser, peuvent aussi être produites à base de sucrose.

Un autre dérivé important pour la préservation du bois est l'acétate de sucrose qui, additionné à d'autres produits chimiques, a des propriétés scellantes pour le bois.

La sucrose serait encore un excellent fixatif de la cellulose du bois et permettrait de restaurer des pièces endommagées par la pourriture.

Pour la stabilisation des propriétés du bois, des solutions de pré-polymer contenant de 25% à 30% de résine sont préparées. Ces solutions permettent par immersion ou imprégnation (à vide ou par pression) de saturer le bois. Après que le bois est saturé, il est chauffé jusqu'à ce que l'eau s'en soit évaporée. Ce traitement amène la polymérisation à l'intérieur des cellules du bois.

La force de compression du bois traité par ce polymer-sucrose est de 7% supérieure à celle du bois neuf. On peut utiliser des catalyseurs pour accélérer la vitesse de réaction.

Les travaux de recherche et de développement permettent d'espérer d'autres progrès dans la restauration des qualités structurales du bois altéré.

PAUL STUMES, a professional mechanical and civil engineer, is the Special Projects Engineer at Parks Canada in Ottawa. He is in charge of the development and implementation of special methods, systems and materials for the preservation of historic structures. He has lectured widely at universities in Canada, the U.S. and Europe, and has written several publications on the preservation of wood. He is an active member of a number of professional organizations, including the Association for Preservation Technology, ICOMOS CANADA, and the Engineering Institute of Canada.

WOOD EXTRACTIVES AS WOOD PRESERVATIVES

Norman R. Weiss & Frances R. Gale

A permanent facility for research in the conservation of historic architectural materials was created in the Graduate School of Architecture and Planning, Columbia University, in 1980. This presented an opportunity for an expansion of studies in several new directions, including non-conventional methods of wood preservation. Our paper is a summary of a preliminary literature search in the area of biocidal properties of wood extractives, a subject recognized by remarkably few scientists to have applicability to the conservation of wooden structures (1).

Extractives are the soluble fraction of wood. Although many authors discuss them as "extraneous" or "minor" components (2), they represent up to 15 to 20% by weight of some tropical hardwoods such as teak and mahogany. Extractives are partially or largely responsible for such properties as color and odor. More importantly, their role in decay resistance was recognized by wood scientists as early as 1924, when the subject was discussed by Hawley *et al* (3).

Current commercial utilization of extractives is varied. Among the more familiar products are maple syrup, tanning compounds, tall-oil fatty acids, and rosin. In some instances, extractives serve as chemical intermediates; one example is toxaphene, a chlorinated insecticide manufactured from turpentine. But the role played by extractives (and their derivatives) in the wood preservation industry is surprisingly limited.

It appears that there are several explanations for this situation. The notoriously poor performance of wood-tar creosote as a preservative has generally discouraged research in wood-derived products. (Its use in the United States is so limited that current Federal and AWPA specifications for wood-tar creosote do not exist (4).) Isolation of the dozens of natural products of which a crude extract may be composed is difficult, as is the subsequent elucidation of the complex chemical structures of the individual organic compounds. Of these, only a few, in fact, are biologically active. Limited communication between the chemists who identify these compounds and the biologists responsible for bio-assay has further impeded progress.

Until recently, the acceptance of such preservatives as pentachlorophenol and CCA has made the search for alternative products unnecessary. In 1982, nearly 400 million pounds of these compounds were used in the United States (5). A re-examination of the environmental hazards posed by this widespread use has been prompted by concern with the critical issue of mammalian toxicity. More comprehensive study of the biocidal properties of wood extractives has become a timely issue.

A search of the wood chemistry literature proved to be useful in pointing out several classes of compounds that have been linked with durability. One such category is the phenolic stilbenes, identified as biocidal constituents in pine heartwood via the work of Erdtman in 1939 (6) and Rennerfelt in 1943 (7). Of these compounds, the most important is pinosylvin (trans-3,5-dihydroxystilbene), which can be isolated (along with its monomethyl ether) from the heartwood of *Pinus sylvestris*; its structure was confirmed by synthesis in 1941(8). A related compound is oxyresveratrol (2,3',4,5'-tetrahydroxystilbene), which was reported to be responsible for the decay resistance of Osage-orange wood by Barnes and Gerber in 1955 (9). This compound, which is both fungicidal and termiticidal, was also found in the heartwood extracts of white mulberry (10) and red mulberry; the latter - like Osage-orange - is among the very few U.S. trees with heartwood of "exceptionally high decay resistance" (11).

- Footnote numbers for this paper are noted inside brackets.

Members of a second category are found in the wood of western red cedar. Early studies of hot water extracts indicated some biocidal activity (12). Compounds of a second, more active, fraction (13) - the thujaplicins - were properly identified as isopropyl tropolones by Erdtman and Gripenberg in 1949 (14). Concentrations of up to 1.2% by weight were determined colorimetrically by MacLean and Gardner in 1956 (15). Three thujaplicin isomers were separated by paper chromatography in that same year (16) and more recently by gas chromatography (as TMS ethers) (17) Procedures for the preparation of commercial quantities of thujaplicins have been reported. One interesting method involved the formation of copper complexes on bronze screens placed in kilns used for the drying of western red cedar. The material collected can be dissolved in chloroform and reacted with hydrogen sulfide to yield the free isopropyl tropolones (18).

Studies have been made of a third category of extractives, the hydroxy-1,4-naphthoquinones. Carter *et al.* (19) recently identified 7-methyl-juglone as the principal termiticidal constituent of the wood of the common persimmon (*Diospyros virginiana*). This finding is perhaps related to the earlier work of Mandels and Reese (20), who reported metabolic inhibition of micro-organisms by extracts from the persimmon fruit at very low concentrations. The active component(s) of the extract was not identified. A better-known member of this group is juglone (5-hydroxy-1,4-naphthoquinone), first isolated from the fleshy hulls of walnuts (*Juglans regia*) in 1856 (21). Juglone, characteristically found in the bark of trees of the family *Juglandaceae*, has a long tradition of use, particularly in the area of folk medicine (22). Although its toxicity to organisms affecting wood in service has not been demonstrated, juglone isolated from bark of the shagbark hickory was reported by Gilbert *et al.* to have deterred the feeding of the elm bark beetle *Scolytus multistriatus* (23).

Other examples of biologically-active bark extractives include catechol (from quaking aspen) (24), trichocarpin (from poplar) (25), and maclura-xanthone (from Osage-orange) (26). The latter, which is found in root bark, is termiticidal. An interesting case is that of dihydroquercetin (DHQ), which can be extracted from Douglas fir bark in very substantial quantities. It was found by Cserjesi (27) to be inhibitory to white-rot fungi at concentrations as low as 0.02%; he speculates that the sensitivity of the test organisms to DHQ is linked to their ability to degrade the compound enzymatically, producing substances of greater toxicity.

Studies such as these are of a highly specialized nature, typically without discussion of the feasibility of use in the wood preservation industry. For a few compounds, however, good extraction yields and high toxicity to wood-destroying organisms strongly suggest that wood extractives can be of commercial value in the not-so-distant future. This concept is clearly in line with current trends in complete-tree utilization.

Active material could be collected as crude extracts; purification might be necessary if preservation treatment with these mixtures is not cost-effective, or if some of the inactive compounds impart undesirable characteristics. It is well known that enhanced biosynthesis of extractives may be induced in some species by wounding. One instance is the stimulation by injury of the production of aporphine alkaloids in yellow-poplar, presumably as protection against fungi that might enter the wound (28). Stimulation of extractive production has been attempted by the Hercules Company; increased yields of rosin are expected from pine stumps that were injected with a plant toxin (Paraquat) (29).

Laboratory synthesis is another means of production for those biologically-active extractives whose structures have been determined. This is perhaps the only viable route to commercial marketing of rare or difficult-to-purify substances. In some cases, synthesis may be most efficiently carried out by derivatization of related natural products that are more readily available in purified form.

Feasibility of production is not necessarily the predominant factor in determining the marketing potential of wood-derived extractives. Tests of the effectiveness of these compounds in combatting wood-destroying organisms have shown some extractives to be highly specific in their action. For example, Cserjesi's data on white-rot fungi (see above) must be contrasted with his observation that DHQ (in concentrations of up to 1%) did not inhibit the growth of brown-rot fungi (30). Treatment with a selective biocide, while perhaps ecologically sound, might require sophisticated field testing to ensure successful use. The formulation of a 'broad-spectrum' preservative, on the other hand, could depend on the careful blending of several previously-isolated substances.

From an environmental standpoint, the biodegradability of natural products is a desirable property. It is paradoxical that this factor may limit the utility of preservative extractives, as retreatment may be necessary at very frequent intervals. Finally, no assumptions can be made concerning the safety of chemicals which occur in nature; many plant constituents are of extreme toxicity to animals and humans. All possible risks in the handling and use of wood-derived preservatives must receive critical evaluation before the basic analytical studies of so many individual researchers are translated into products for the marketplace.

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ABSTRACT

EXTRAITS DE BOIS UTILISES COMME AGENTS DE PRESERVATION DU BOIS

Norman R. Weiss et Frances R. Gale

Les scientifiques de l'Ecole supérieure d'architecture et d'urbanisme de l'Université Columbia à New York sont en train de chercher des méthodes originales pour préserver le bois.

Depuis les années 20, on sait que certaines extraits de bois ont des propriétés fongicides et insecticides. Toutefois, comme d'une part on avait l'habitude d'utiliser du pentachlorophénol et de l'arséniate de chrome et cuivre (CCA) et que d'autre part la créosote provenant du goudron de bois donnait de mauvais résultats, on n'a pas éprouvé le besoin de faire des recherches pour trouver d'autres agents de préservation du bois.

Etant donné que les pentachlorophénols et les dioxines délétères qui en sont dérivés constituaient un danger pour l'environnement, on s'est employé à accélérer les recherches dans le domaine des propriétés biocides des extraits de bois.

Les trois catégories d'extraits biocides sont les suivants: les stilbènes de phénol extraits du coeur de pin; des extraits de cèdre rouge de l'Ouest et des hydroxydes-1,4-naphtoquinones.

D'après les recherches effectuées, ces extraits peuvent avoir un effet spécifique sur les champignons et les insectes qu'ils attaquent; certains attaquent les champignons qui causent la moisissure blanche et non pas ceux qui causent la moisissure brune. Ces extraits ont l'avantage d'être biodégradables, mais il peut s'avérer nécessaire de retraiter fréquemment le bois. Il faudra faire faire davantage de recherches sur la toxicité que pourraient avoir ces produits pour l'homme et l'animal avant d'en entreprendre la production à l'échelle commerciale.

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LE BARDEAU TRADITIONNEL A LA MANIERE ET AU GOUT DES QUEBECOIS
Bref exposé sur les origines ainsi que sur les techniques et les utilisations de ce matériau ligneux

Michel Dufresne 22 409

PREAMBULE

On ne saurait parler du bardeau traditionnel et de son utilisation dans l'habitat québécois sans évoquer préalablement, même en peu de mots, le rôle important qu'a joué le bois dans notre architecture ainsi que dans le paysage et l'économie de ce pays ...rôle qu'il joue toujours d'ailleurs, bien que sous des formes et à des degrés différents. Cet éclairage étant donné, nous pourrons mieux nous pencher sur le sujet précis de cet entretien, soit le bardeau comme élément de revêtement des bâtiments traditionnels au Québec. Ainsi, nous aborderons tour à tour les questions relatives à sa fabrication, sa décoration, sa pose et son entretien. Nous étant tout d'abord interrogés sur sa provenance et son apparition de ce côté-ci du continent, nous nous intéresserons quelques instants, pour conclure, au retour qu'il semble opérer dans notre environnement contemporain.

LE BOIS DANS LES STRUCTURES ET REVETEMENTS TRADITIONNELS AU QUEBEC

Comme on le sait, la tradition de bâtir avec un certain souci de durabilité n'est, proportionnellement, pas très ancienne au Québec non plus qu'en Amérique du Nord en général. Ce n'est qu'avec la venue des premiers Européens qu'ont débuté véritablement l'organisation spatiale et l'aménagement permanent du territoire, impliquant le déboisement de lieux propices à l'habitat, le tracé de voies de communication terrestre et, surtout, l'érection des structures et bâtiments nécessaires aux diverses activités communautaires et privées.

Ce défrichage intensif exercé par nos ancêtres ainsi que les technologies de construction médiévales auxquelles ils étaient restés liés depuis l'Europe auront contribué, pour beaucoup, dans le choix d'un matériau souple et résistant tel que le bois. Matériau de revêtement, mais aussi de gros-oeuvre, on le retrouve évoqué couramment dans les archives iconographiques et notariales, aussi loin que l'on puisse évidemment remonter dans ces documents d'époque. Il s'agira tantôt de billot, de colombage ou de pieu, tantôt de rondin cordé, de pièce sur pièce ou de madrier, plus récemment de charpente à claire-voie; les structures ainsi constituées pourront être apparentes ou, ce qui semble être avant tout le cas chez nous, protégées par un second matériau, tel un enduit, de la brique ou du bois.

La maçonnerie de pierre, il est vrai, retient beaucoup plus souvent l'attention des amateurs et passionnés de patrimoine, en raison de l'impression de solidité qui s'en dégage et de la plus grande ancienneté que l'on a trop tendance à lui attribuer de façon générale. Or, il convient de répéter que ce fut dans les tout premiers temps le bois qui sut satisfaire aux besoins d'établissement de la majorité des habitants, la pierre exigeant de l'entrepreneur ou du colon plus de ressources à maints égards: argent, temps, main-d'oeuvre et, bien sûr, abondance et qualité quant au matériau proprement dit.

Cette observation, qui s'impose au niveau du carré des maisons, vaut davantage encore en ce qui a trait aux dépendances et aux toitures en général. On ne retrouve en effet que peu de bâtiments de ferme ayant leurs murs en pierre au Québec: quelques étables et écuries, de même que certains éléments d'accompagnement et des laiteries. Les toits de résidences aussi bien que de bâtiments secondaires, également, n'ont que peu connu l'emploi de la tuile et de l'ardoise et le bois, sous des formes encore ici variées, sera demeuré pendant longtemps le premier choix des couvreurs avant de devoir partager, puis céder la place en milieu de ville à la tôle et au goudron.

Mais ces différents revêtements de bois privilégiés chez nous traditionnellement, quels ont-ils été? La liste exhaustive en serait très longue, avouons-le, tant ont joué dans la diversification de ces modes et matériaux les influences extérieures et les comportements régionaux. Nous nous contenterons d'en énumérer les principaux, soit: (pour les murs aussi bien que pour le toit) la planche horizontale ou verticale, avec ou sans couvre-joint, chevauchante ou juxtaposée, laissée nue, chaulée, peinte ou badigeonnée d'ocre...et, bien entendu, le bardeau.

LE RECOURS AU BARDEAU, SA RAISON D'ETRE EN MILIEU QUEBECOIS

Le bardeau, comme on le voit, fera longtemps concurrence à la planche, à la fois pour le recouvrement des murs et celui des toitures. Il s'agit, en fait, d'un mode extrêmement ancien de revêtement dont on retrouverait des traces aussi loin que deux mille ans avant notre ère, en particulier dans les pays nordiques et de forêt tels que les états scandinaves et la Russie. Les colons de Nouvelle-France ont, pour leur part, adopté très tôt ce matériau qui leur était déjà connu du fait de son existence en Europe. Il semblerait, néanmoins, que son usage en fût limité tout d'abord aux toits de certains bâtiments (manoirs, églises ou maisons plus cossues), voire à certains versants de toitures uniquement...les plus exposés sans doute aux intempéries. C'est tout probablement ce haut degré de résistance à la vieillesse et aux intempéries, d'ailleurs, qui fera recourir au bardeau de plus en plus de constructeurs et d'habitants, si bien qui on le retrouve un peu partout sur les édifices et les bâtiments d'accompagnement dès le milieu du XVIIe siècle.

On doit préciser, cependant, que l'usage en sera restreint dans les villes au cours des décennies suivantes, en raison de son inflammabilité très grande et du danger de conflagration. Ce sera d'abord, en 1688, le Conseil supérieur et plus tard, en 1721 et 1727, les intendants Bégon et Dupuy qui se chargeront d'édicter les ordonnances en ce sens. Il en est, néanmoins, qui persisteront dans les villes à poser ce matériau prohibé, cependant qu'on en usera de plus en plus largement dans les campagnes, aux côtés du chaume et tout autant pour les façades et les pignons que pour les croupes et les versants des toits.

LA FABRICATION DU BARDEAU, GESTE ARTISANAL ET TECHNIQUE INDUSTRIELLE

S'il en fut produit au départ à partir de diverses essences ligneuses incluant le pin, le chêne et le noyer, nous pouvons par contre affirmer que c'est le cèdre ou thuya qui servit le plus à fabriquer le bardeau que nous connaissons. C'est, du reste, un bois durable et qui jadis abondait, facteurs qui ne sont sûrement pas négligeables lorsque l'on sait tout le travail qu'impliquent autant sa production que sa pose et son entretien.

Sur ce point, d'ailleurs, il est important de noter que deux périodes et deux modes assez différents de production se sont succédé, quoique le plus ancien des deux n'ait pas tout à fait disparu. C'est ainsi que, jusqu'au début du XIXe siècle, on ne parlera que de bardeau "fendu", procédé réclamant un outillage assez spécial en même temps qu'une certaine habileté de la part de l'artisan, qui devra s'assurer d'une taille égale au moment de fendre la bille de cèdre puis d'en amincir les planchettes ainsi obtenues. Pour lui faciliter sa tâche, ultérieurement, le "faiseur" de bardeaux bénéficiera d'un banc qui lui servira de siège et d'étau.

L'apparition soudaine, au XIXe siècle, de moulins d'un nouveau type introduit sur le marché ce que nous appelons le bardeau "scié", c'est-à-dire un bardeau qui n'est non plus façonné manuellement mais bien usiné suivant des formes et des gabarits préétablis. Cette industrialisation de la production du bardeau connaîtra par ailleurs un second souffle avec l'apparition vers 1860 de la scie dite à ruban, permettant de tailler dorénavant des paquets de bardeaux tout entiers. C'est probablement grâce à la scie, puis plus tard à la scie à ruban que s'est du reste amorcée la production de bardeaux décoratifs, auxquels nous allons maintenant nous intéresser quelques instants.

LA DECORATION PAR LE BARDEAU, MANIFESTATION D'UN ART POPULAIRE A REDECOUVRIR

Le bardeau décoratif ou géométrique, en effet, constitue sans aucun doute un mode un peu plus sophistiqué de recouvrement que le bardeau rectiligne évoqué jusqu'ici. Connu dans de nombreux pays d'Europe, il nous serait néanmoins venu par le biais des Etat-Unis, tout comme beaucoup d'autres apports technologiques et stylistiques au XIXe siècle. On en retrouve encore en plusieurs endroits du Québec, bien que surtout dans les

Cantons de l'Est et sur la rive sud du Saint-Laurent, plus spécialement dans certains des villages et des rangs de l'arrière-pays.

C'est ainsi qu'un inventaire effectué dans la localité de Saint-Apollinaire, non loin de Québec, a permis de répertorier pas moins d'une dizaine de motifs ou d'agencements de motifs originaux, dont des festons, des pointes et des polygones assez particuliers. Cette étude, évidemment limitée quant au territoire, aura malgré tout attiré l'attention sur un phénomène qui n'est pas que socio-économique ou matériel, mais aussi culturel...dans tous les sens où ce mot peut être entendu, à savoir historique, ethnologique et même artistique.

LA POSE ET L'ENTRETIEN DU BARDEAU, QUESTION TECHNIQUE ET FINANCIERE APPELANT DES SOLUTIONS

Réalité culturelle et matérielle, également technique et financière, ainsi se trouve exprimée la question du bardeau traditionnel et de sa conservation. Suite à la quasi disparition des derniers artisans producteurs et devant l'invasion trop peu contrôlée d'un nombre infini de matériaux nouveaux (vynile, aluminium et combien d'autres), on doit d'ores et déjà s'interroger sur les probabilités de voir survivre et se perpétuer ce procédé de recouvrement.

La pose et l'entretien du bardeau, tout autant que son achat, soulèvent en effet certains problèmes à la fois d'expertise et de coût face auxquels, on le comprendra, le propriétaire et le jeune artisan se trouvent assez souvent démunis. Doit-on choisir un bardeau sans noeud à sa base ou de moindre qualité? Comment peut-on le rendre imperméable et ignifuge ainsi que lui éviter le fendillement? Tous autant de points, de questions qui demandent évidemment des réponses et des solutions.

C'est sans doute un peu pourquoi nous faisons de plus en plus porter nos efforts, au ministère des Affaires culturelles du Québec, sur la mise au point d'outils techniques et de programmes d'aide à l'intention des organismes et individus désireux de s'impliquer dans la restauration d'ensembles à caractère historique ou d'immeubles anciens. Le Guide d'utilisation du bardeau de bois préparé grâce à la collaboration du ministère et des autorités de la municipalité de Saint-Apollinaire est un assez bon exemple, à notre avis, du genre de support que l'on devrait pouvoir accorder sur une infinité de thèmes et de sujets comparables en ce qui a trait à la conservation des matériaux traditionnels et plus spécialement du bois.

LE RETOUR DU BARDEAU, FRUIT D'UN CERTAIN ENGOUEMENT POUR LE RUSTIQUE ET LE PASSE

Peut-on clore, enfin, ce propos sans dire un mot de la réapparition du bardeau dans le bâti contemporain? Car il s'agit bien, depuis quelques années, d'un retour assez inattendu de ce matériau que l'on croyait désormais relégué aux toits des remises et des appentis. Bois de "grange" et bardeau de cèdre ont, en effet, pris d'assaut certains coins de villégiature et quartiers de banlieue, voire aussi certains intérieurs de nos maisons de ville et de nos centres commerciaux soi-disant les plus modernes. On peut y voir en bien des cas sans doute en usage abusif, attribuable à cet engouement renouvelé pour le rustique et le retour aux sources.

Il est toutefois étrange de constater que certains des nouveaux bardeaux privilégiés par le consommateur québécois lui viennent de l'extérieur, alors que notre province compte encore une cinquantaine de moulins qui en fabriquent, plus particulièrement dans l'Estrie, la Beauce et le Bas Saint-Laurent. La qualité du cèdre utilisé par nos producteurs en fait d'ailleurs un matériau très en demande en Nouvelle-Angleterre, où s'écoule environ 80% de nos stocks annuels.

On peut donc espérer que ce retour au bardeau sur certains de nos bâtiments publics ou privés s'opère en accord avec les règles de l'art et du bon goût, dans un souci de prolongement mais aussi de renouvellement de la tradition. Remettre à l'honneur un bardeau décoratif à motifs essentiellement géométriques est sans doute envisageable, en théorie du moins, mais savoir avant tout tirer profit de la texture et de la durabilité du matériau lui-même est sans contredit l'objectif à poursuivre.

En ce sens, il y a place encore au niveau de la recherche et de l'expérimentation, dans le but tout autant de prolonger la résistance et la beauté du produit que d'en faciliter la pose et l'entretien. L'architecte et l'aménagiste en général ont, de

même, un rôle à jouer face au défi d'intégration d'un tel matériau dans l'espace et le bâti contemporains. Dans le champ plus spécifique et plus immédiat de la restauration des monuments, enfin, les services et les pouvoirs publics ont le devoir d'assurer une expertise et un support techniques appropriés aux intervenants du milieu. C'est précisément ce qu'entend faire et ce qu'a d'ailleurs amorcé le ministère des Affaires culturelles du Québec, par le biais de sa Direction générale du patrimoine.

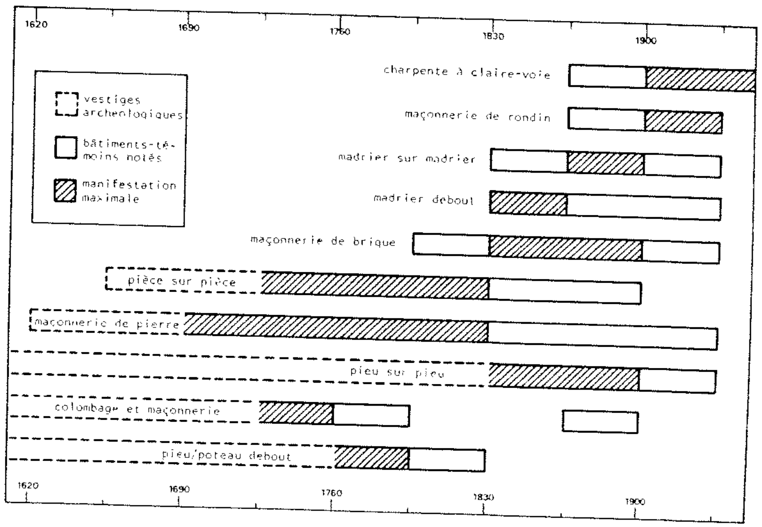


Fig. 1. Chronologie des principaux modes et matériaux de construction traditionnels au Québec (au niveau du carré).

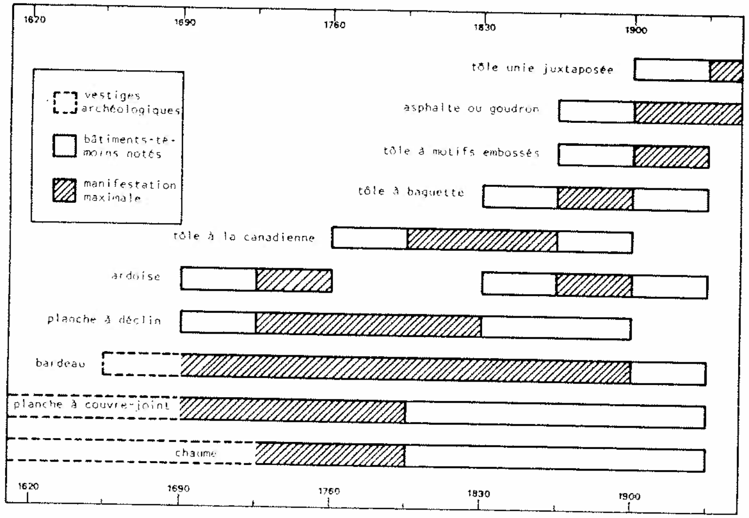


Fig. 2. Chronologie des principaux modes et matériaux de revêtement traditionnels au Québec (au niveau du toit).

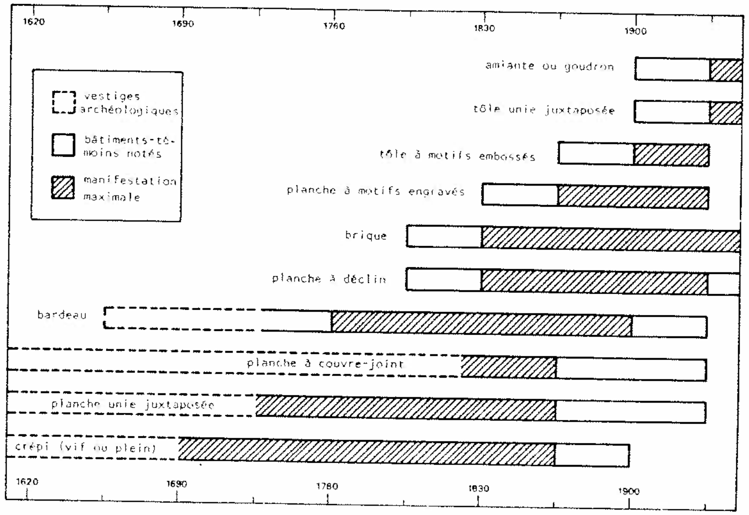


Fig. 3. Chronologie des principaux modes et matériaux de revêtement traditionnels au Québec (au niveau du carré).

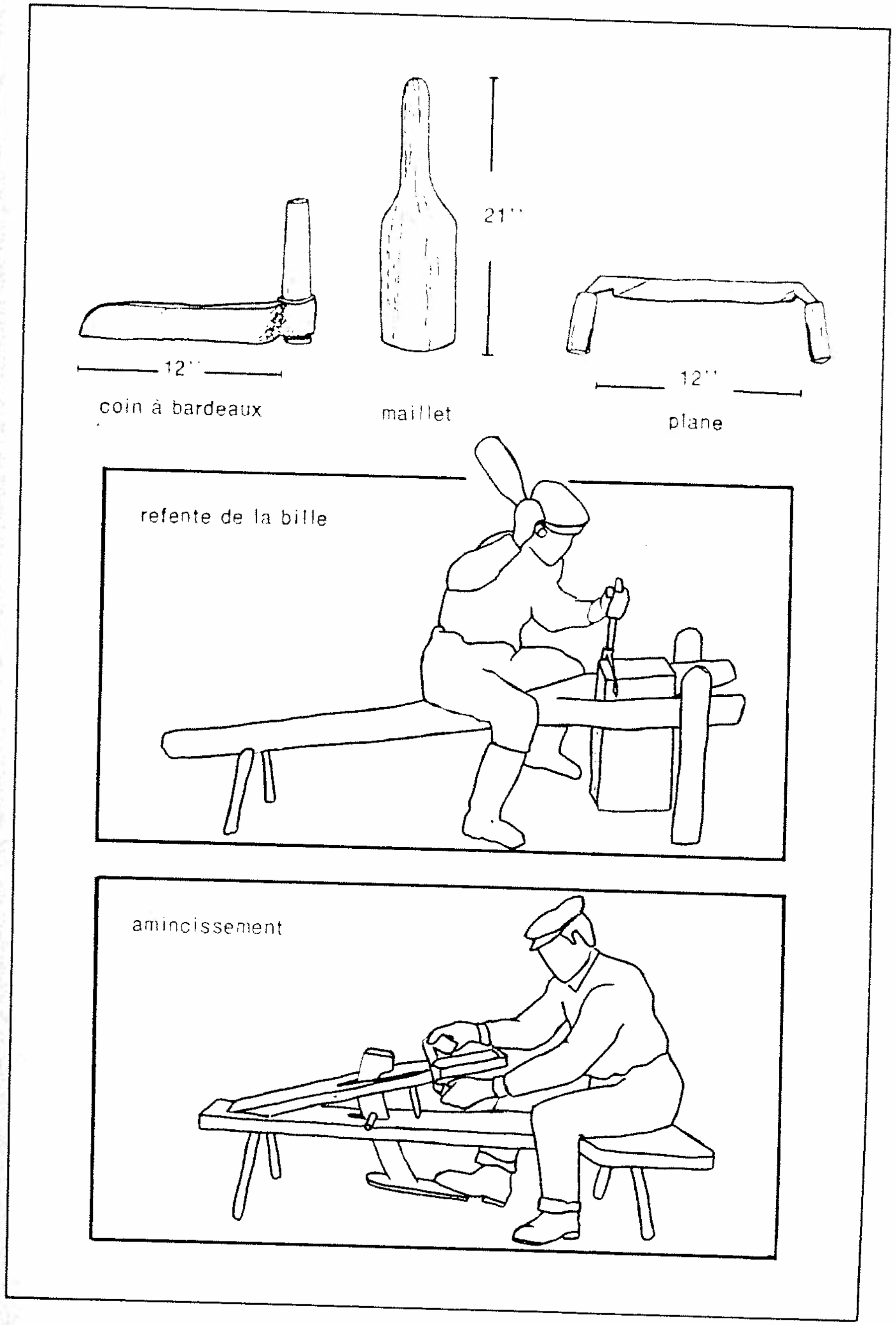


Fig. 4. Outillage et technique entourant la fabrication du bardeau.

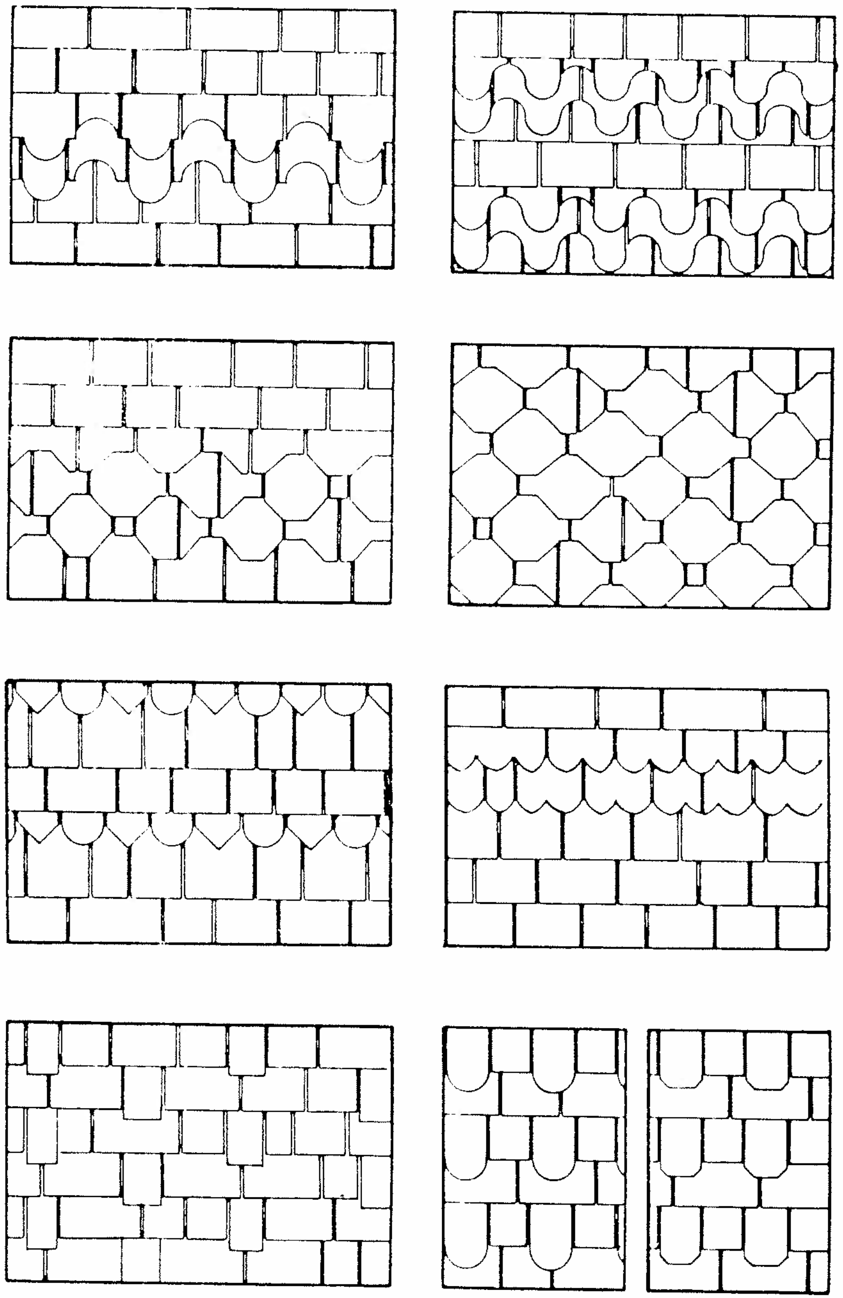


Fig. 5. Echantillon de motifs observés dans les revêtements de bardeau traditionnels à Saint-Apollinaire.

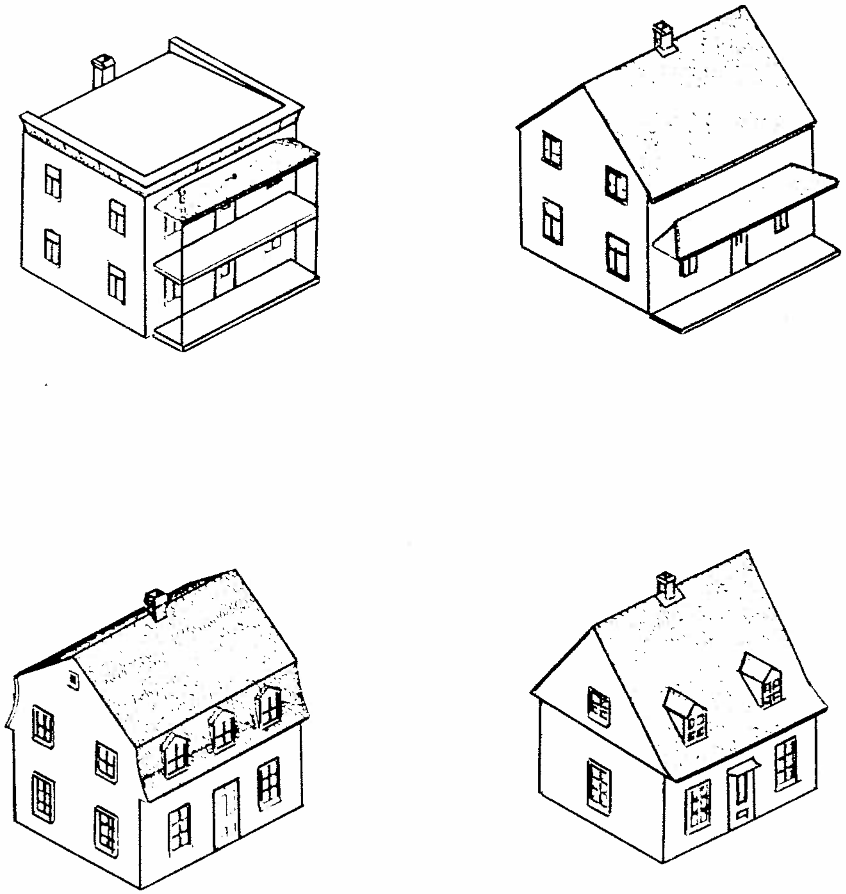


Fig. 6. Exemples architecturaux de l'emploi du bardeau de bois pour les revêtements de toitures et d'auvents (Saint-Apollinaire).

Enfin, je vous saurais gré de mentionner, que cet exposé sur le bardeau s'appuie sur des recherches et des relevés faits en collaboration avec messieurs Yves Laframboise et Jacques Dorion, de la firme Ethnotech Inc. (les illustrations 4, 5 et 6 étant de monsieur Jean-R. Caron, du même groupe-conseil).

ABSTRACT

THE TRADITIONAL SHINGLE...THE STYLE AND TASTE OF QUEBECOIS

Michel Dufresne

The tradition of building with wood has played an important role in Canada's historical development. Early settlers, who brought with them construction methods dating from the Middle Ages, chose wood as a primary building material due to its abundance in Canada. It was used in various ways: as an exterior wall-covering for log buildings, or in combination with another material such as brick or plaster.

As well, wood was used as a covering for interior walls and roofs, as horizontal or vertical planks; at times it was painted or left in its natural state and, of course, it was used for shingles. The use of shingles, similar in design to wall planks, can be traced as far back as 2,000 B.C. in Scandinavian countries and in Russia. In Québec, it was introduced by European settlers in the middle of the 17th century. Originally, shingles were used only on certain buildings: churches, manors and roofs exposed to bad weather; but later its durability led to a wider use for farm buildings. Due to the danger of fire, wooden shingles were soon prohibited in urban areas.

Various types of wood were used for shingles: pine, oak and walnut, and later on, cedar became popular. During the 19th century, there were two methods of production. At the beginning of the century, shingles were split by skilled artisans and this handmade shingle is known today as a "shake". The development of shingle mills later in the century permitted the mass production of shingles. Decorative shingles in triangular and circular shapes became popular and were artistically similar to European antecedents. These designs came to Québec via the United States. Unfortunately, the introduction of less expensive and more modern materials, namely vinyl and aluminum, during the 20th century caused a decline in the use of wood shingles. Maintenance requires skilled artisans to repair deteriorated wooden shingles, which compounds the problem. In response to the situation, the Québec Ministry of Cultural Affairs has initiated a program to encourage the restoration and maintenance of this important building material.

Recently, there has been a renaissance in the use of wooden shingles and, in some cases, an over-use. Due to the current desire for a "rustic look" on contemporary building in our urban areas, demand is now so high that approximately 80% of the province's wooden shingles must be imported from New England. In fact, it is due to the current popularity of wooden roofs that an interest in developing techniques to preserve this historic building material has developed.

MICHEL DUFRESNE est né à Québec en 1947. Géographe-urbaniste, il travaille pour le gouvernement québécois depuis déjà plus de dix ans et est actuellement responsable de la Division des études d'ensemble à la Direction générale du patrimoine du ministère des Affaires culturelles. Assisté de représentants des différents champs disciplinaires en ce domaine (archéologue, ethnologue, historien, géographe...), il a pour principaux mandats de fournir une expertise et de développer des outils d'analyse et d'évaluation devant faciliter la sauvegarde et l'amélioration des secteurs historiques et naturels. Auteur de quelques ouvrages et d'assez nombreux articles en rapport avec la conservation des biens culturels, il a collaboré par ailleurs, en tant que concepteur pédagogique, à l'élaboration d'un cours sur "le patrimoine québécois" (Télé-université, 1978).

CANADA'S FORESTS - PAST, PRESENT AND FUTURE

22410

Dr. Gustav A. Steneker

Canada is a forest nation, with an estimated growing stock of 19 billion cubic meters (7% of the total of the world's forests) and has the second largest forest reserves of softwood species in the world, after the USSR. We are the world's major exporter of forest products, with the 1980 output of the Canadian forest products industry worth more than $22 billion. One out of ten Canadian workers is supported directly or indirectly by Canada's forest resources.

Forest products exports in 1980 reached $13 billion, far exceeding the exports of other commodities such as oil, gas, agricultural products or minerals. At the same time, imports of forest products in 1980 totalled about $1 billion.

The greater part of Canada's 326 million hectares of forested land is owned by the public and administered by the federal and provincial governments. The provinces own and administer about 77% of the forest resource, the federal government 17% (mostly in the federal territories), and the private sector 5%.

The provinces are responsible for the management of their own forest resources, and not those owned by the federal government or those in private ownership.

The federal government is responsible for the forests in the Yukon and Northwest territories, Indian reserves, national parks, experimental stations and military bases.

Canada's position as a forest nation extends far back into the past when Canada's Indians made use of the forests and rivers for their source of livelihood. The west coast Indians used large logs for building construction and log boats. In the interior and the east, lighter frame structures were made from wood and animal skins. Birch bark was used in the manufacturing of birch bark canoes; and the sugar maple provided sap for the manufacture of syrup and sugar.

Other forest products used by the Indians and early European settlers included fuel, berries, vegetables, nuts, furs from forest animals and plants for medicine.

Today, although there have been great changes, there are still constant reminders of the forest and forest products in our everyday life.

It was the fur trade in the 1600's that was one of Canada's first major exports. Travel was both inexpensive and easy, with the vast network of waterways across the continent. Trading posts and forts dotted the country and a brisk fur trade was in effect. It was the same network of waterways that provided easy and cheap transport for logs which replaced the fur trade as Canada's major export, and provided a resource to help finance the development of the country.

Eastern Canada was once a well-forested area with large quantities of white pine, some measuring 80 meters in height and two meters in diameter. White pine is soft, easily worked, strong, light in weight and fairly weather-resistant. Its main uses are in construction and in the early days, particularly, for ship-building, masts and spars.

The bulk of the white pine came from the St. Lawrence and Ottawa drainage basins.

The large stands of white pine and red pine are no longer seen today. They were wiped out in part due to the demand created in Britain as a result of the Napoleonic wars. As a result of these wars, Britain's supply of wood from the Baltic had been cut off, so she turned to Canada.

Further reasons for the increased drain on Canada's wood resource included increased immigration, a growing demand for wood in the USA, and a demand for farmland.

The period of the white pine or square timber trade, from the 1700's to the early 1900's, was quite colourful, matching or exceeding that of the various gold rushes, and providing a substantial input into local folklore.

Living conditions in the bush were tough and primitive - men worked twelve hours a day or more. Salt pork, beans and potatoes were the order of the day and a cook could make or break a camp.

In those days, white pine logs were usually squared and put together at the main river, in the form of rafts, complete with living quarters. These rafts would head down a river, such as the Ottawa, and be broken down into smaller units at rapids or chutes, such as La Chaudière at Hull, close to where the city of Ottawa was founded. Upon arrival at Québec, these log rafts would be broken up and loaded on board the ships bound for Britain, the USA, the West Indies or other destinations.

Immigration increased from 1830 onwards and there was a push towards the west. USA metropolitan centres were expanding and the demand for wood continued to grow. Local demand for lumber and the building boom put a demand on the agricultural sector, and dairy products and wheat began to compete with timber as an important export.

The gold rush of the late 1850's resulted in the development of the Pacific Coast lumbering industry. Cedar, hemlock and Douglas fir were among the most heavily utilized species, and were used for lumber, pulp and paper products, and shingles.

Although the supplies of white pine declined, the lumber industry in the east continued with spruce, jack pine, red pine and hardwood species, particularly white oak, maple and birch. However, pulp and paper utilizing black spruce became the big industry from the 1880's onwards. Later, chip-board and particle-board mills also came into existence in the east.

The shift of lumber exports to the USA resulted in tariffs which favoured the import of sawlogs over lumber, in order to protect USA mills. These tariffs were met by Canadian imposed export taxes on logs to the USA, creating an incentive to move American mills to Canada. In 1898, Ontario imposed embargoes on sawlogs cut on Crown lands. This was followed by other provinces, but remained flexible due to the constraints of the pulp and paper industry.

The mid to late 1800's saw advances in technology and the introduction of new legislation. The advances of technology began to create changes in the forest economy. Smaller dimension logs were adequate for pulping and in fact local shortages occurred in many areas. Past and present mismanagement of the forest resulted in increased hauling distances and thus increased costs of production.

Fears of a future timber famine and the emerging attitude towards conservation brought new policies and regulations to the forest scene. The first Crown Timber Act was introduced in 1850 in Ontario and included regulations on logging-area size. A Royal Commission in 1897 recommended fire protection schemes in Ontario and a minimum log size. British Columbia, Québec and other provinces followed. In 1907, the first Faculty of Forestry was established in Canada at the University of Toronto.

The superb quality and size of B.C. timber, the railways and the development of the prairie area precipitated the shift of lumber production to the west. In addition, due to tariff changes in the USA permitting free entry for newsprint and woodpulp, the North American pulp and paper industry moved into eastern Canada and competed with the lumber industry for the available supplies of spruce and fir and for control of the forests. The completion of the Panama Canal in 1914 also opened the North Atlantic area and the eastern seaboard of North America to British Columbia timber.

Post World War I demands for wood allowed western lumber production to grow. The eastern industry was less stable and in fact gave the pulp and paper industry of the east a chance to obtain larger reserves of forest to back up their expansion.

The depression adversely affected the USA market; however, exports to the Commonwealth increased. Production, however, was low compared to that of the late 20's.

The development of forest land policies has resulted in varying patterns of ownership and tenure from province to province. The heavily settled areas of the eastern provinces and the southern parts of Ontario and Québec have resulted in a high degree of private ownership, compared with elsewhere where the Crown is the major owner.

Private companies where possible have purchased abandoned farmland, to be used for production; in other areas, licences have been granted for use of forested areas, owned by the Crown, to provide wood for the mills.

The evolution of forest policy and the implementation of legislation in most countries, including Canada, has been usually dictated by reaction to impending crises. In Canada, policies began with the collection of royalties for sawn timber. This was followed by the "Broad Arrow" policy, where pines were reserved for the Navy. Competition for logs precipitated the issuing of simple timber cutting licences, followed by the granting of timber concessions under licence.

As the forest resource continued to reel under the onslaught, a cry for conservation measures ushered in further legislation in the form of cutting restrictions, utilization standards, management plans and the creation of parks.

Despite all this, our timber resources are diminishing due to a lack of adequate regeneration. The main obstacles here are expense and absence of tenure. To counter this, various agreements, such as 20 year renewable licences, have been introduced with renewal dependent upon satisfactory stewardship of the licence area. As continued competition by differing users of the forest continue, the pressure is now directed toward efficient intensive forest management and adequate research to back it up.

The heavy exploitation and wasteful practices of the past have given way to more efficient management planning and the improved extraction and transportation methods of the present and future.

Numerous organizations and pressure groups have sprung up, promoting conservation, wildlife protection, pollution controls, environmental impact assessments and the like.

Governments and industry have taken notice and there is now a continuing state of change in forest policies. No longer is there a limitless amount of land and forests. We have to cope with a limited resource and to share this resource with industry and recreationists, as well as to provide for fish and wildlife and high water quality.

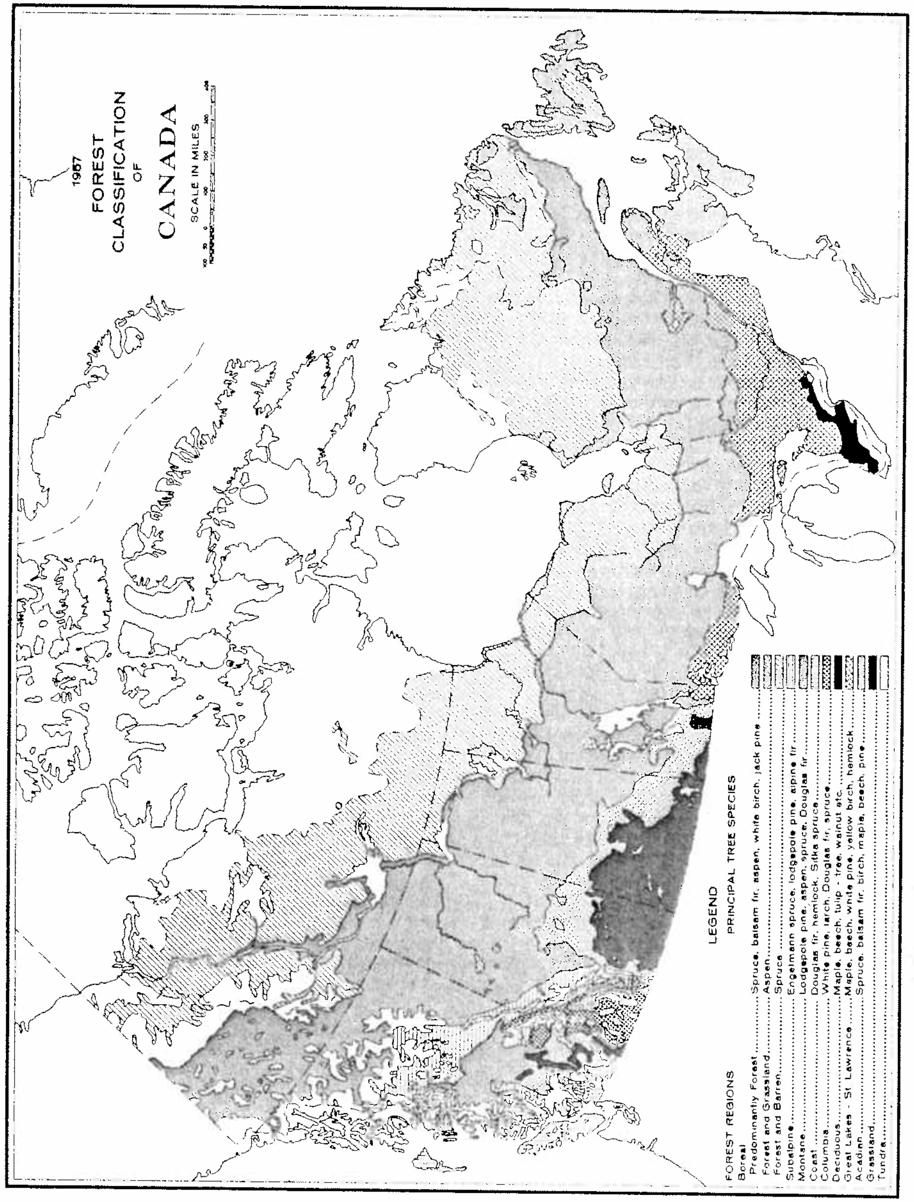
Considering all aspects of forestry - past, present and future - everything, life itself, appears to depend almost entirely on the tree.

The "Message of the Tree" given to us by Franklin de Assis, says:

"'Who are you?' you might ask if by chance you still do not know me well. I am the beam sustaining the roof of your house which protects you from the elements; I am the door of your house, the top of the table on which you eat, the handles of your tools and the bed where you lie down to rest after your day's work.

"I am, too, the warmth of your fireplace on cold winter nights and the friendly shade on hot sunny days; I am the bountiful donor of the fruits that fill your hunger and quench your thirst; I am the flower that adorns and enhances your moments of triumph or of sadness; and it is I who purify and perfume the air that you breathe.

"Without your realizing it, I am always there beside you, in a thousand ways, accomplishing humbly and with silent devotion the mission which is my role in Nature: when, in the mystery of love, you were born to the joys and realities of life, I was the cradle in which motherly love placed you so fondly, and when your eyes close on that last day, I shall still be there, the coffin that will enclose your lifeless body, and your silent companion in your final dwelling place. Oh you, who read these words symbolically placed on my lips! When you enter the enveloping, caressing shadow of the wood, where I have always had my favorite abode, when you are alone, stop and listen: amid the murmur of the stream and the chirping of the birds, deep down in your soul, you will hear my message of tenderness and fellowship, and the sweet song of love and gratitude which I raise to the supreme Creator of all beings and of all things. Who am I? I am the Tree; love me and protect me, and you will be loved."



ABSTRACT

LES FORETS DU CANADA: LA SITUATION PASSEE, PRESENTE ET FUTURE

Dr. Gustav A. Steneker

Le Canada est un pays forestier avec un potential de récolte de 19 milliards de mètres cubes soit 7% du total mondial. Le Canada possède aussi la plus grande réserve de résineux après l'Union soviétique.

Grande exportatrice de produits forestiers (la valeur des exportations canadiennes en 1980 atteignait 22 milliards de dollars), l'industrie forestière canadienne est responsable de l'emploi direct et indirect d'un travailleur canadien sur dix.

Les terres publiques constituent la majeure partie du domaine forestier de 326 millions d'acres et sont administrées par les gouvernements provinciaux et fédéral dans l'ordre de 77% et 17%; 5% des terres relèvent du secteur privé.

Depuis les premières utilisations par les indigènes, la demande pour la bois n'a cessé de croître. L'industrie de la pâte et du papier utilisant les résineux, a connu son apogée vers 1880.

Les exigences de conservation ont imposé ultérieurement celles des législations. Les politiques des provinces touchant le domaine forestier se sont traduites par plusieurs formules de tenure, de propriété et de gestion, privées mixtes ou publiques.

En 1907, l'Université de Toronto établissait la première faculté de foresterie au Canada.

En dépit de toutes les mesures législatives, l'exploitation intensive et souvent irrationnelle a amené une baisse des ressources forestières. La régénération n'a pas été équivalente à la récolte.

La tendance est maintenant à l'aménagement polyvalent de la ressource pour satisfaire les besoins souvent conflictuels des utilisateurs.

DR. GUSTAV A. STENEKER received his undergraduate training in Forestry at the University College of North Wales, Bangor. Following this, he went on to obtain both his M.Sc. and Ph.D. degrees in Forestry at the Universities of Toronto and Michigan, respectively. Dr. Steneker is an expert on both sugar maple and trembling aspen, and has written several papers, information reports and management manuals on these species. At present, Dr. Steneker is employed by Environment Canada, Canadian Forestry Service, as Director of International Forestry.

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LES PONTS COUVERTS DU QUEBEC

Henri-Paul Thibault

Recouvrir les ponts afin de protéger les structures de bois contre les intempéries n'est pas un phénomène typiquement québécois. On retrouve des ponts couverts tant en Europe qu'en Asie, dont certains remontent aux XIIe et XIIIe siècles. C'est au Québec cependant qu'on construisit les derniers ponts couverts dans les années 1960.

Le développement du réseau routier se fit tardivement en Amérique du Nord, celle-ci jouissant d'un excellent système de communications navales. Il faut attendre l'arrivée du chemin de fer pour qu'une nouvelle technologie donne un essor considérable à la construction de ponts de bois.

Aux Etats-Unis, le premier pont couvert fut construit par Timothy Palmer en 1805, sur la rivière Shuylkill à Philadelphie, et ce à la demande du comité formé pour la circonstance; celui-ci insista pour que les poutres soient couvertes d'un toit et de murs pour les protéger contre le climat, le seul but incidemment de cette protection. La durée de vie d'un pont de bois ordinaire est souvent de 10 à 15 ans, à cause du pourissement des poutres, tandis que les ponts couverts ont une durée de plus de 100 ans.

Des ingénieurs tel le colonel Stephen H. Long et des architectes comme Ithiel Town, brevetèrent plusieurs types de structure et établirent tout un réseau d'agents; cette technologie s'étendit rapidement sur toute l'Amérique du Nord-Est.

Au Québec, c'est à Cookshire dans les Cantons de l'Est que fut érigé le premier pont couvert en 1835; celui-ci fut remplacé en 1868.

Au XIXe siècle, ce sont des entreprises familiales ou des municipalités qui furent responsables de la construction des ponts dont la majorité étaient à péage. Sans être obligé de suivre des normes gouvernementales, chacun choisissait le type de structure qui lui convenait le mieux. C'est ce qui explique la très grande diversité de structures à cette époque.

Après la Première Guerre mondiale, le gouvernement du Québec prend en charge le réseau routier inter-centres. C'est le début de l'automobile. L'ouverture de nouvelles régions à la colonisation, accélérée par la crise économique de 1929, nécessite la construction de nouvelles routes pour faciliter les communications. C'est à cette époque que le ministère de la Colonisation élabore un type de structure qui sera utilisé de façon exclusive pour les ponts couverts jusqu'en 1962, d'où le nom de "ponts de la Colonisation".

Nous avons dénombré au total au-delà de 500 ponts couverts au Québec dont il ne reste plus que 118.

A la fois moyen de communication et lieu de rencontres, ces espaces sombres ont donné naissance à de nombreux contes et légendes: "ponts des amoureux" ou "ponts des baisers", trésors cachés, abris de fantômes ou de brigands, n'en sont que quelques-uns. Plus près de la réalité, le nom de "ponts baladeurs" vient du fait qu'on pouvait souvent les récupérer après qu'ils aient été emportés par la crue des eaux du printemps.

La très grande majorité des ponts couverts du Québec n'ont qu'une seule travée. Par contre, le pont de Notre-Dame-des-Pins, le plus long présentement avec ses 149 mètres, dépasse de quelques mètres celui de Fort-Coulonge construit en 1898, malgré ses six travées. La portée moyenne d'une travée est de 30 mètres.

La ferme élaborée par le ministère de la Colonisation l'a été à partir d'un brevet de Ithiel Town de 1820. Elle est constituée d'un treillis de madriers qui s'entrecroisent à un angle variant de 45 à 60°, et retenus à chaque intersection par des chevilles de bois. Le haut et le bas sont fixés par deux rangées doubles de madriers ou cordes. Le tablier repose sur la corde inférieure. Pour empêcher les mouvements latéraux entre les deux fermes, des croisillons sont fixés au sommet et à la base. Utilisée pour les chemins de fer, cette structure était renforcée de poteaux verticaux dont l'espacement variait. Cette pratique s'appliqua par la suite au réseau routier.

Les ingénieurs du ministère de la Colonisation du Québec allégèrent cette structure. On a réduit les dimensions des pièces des treillis, augmenté le nombre de poteaux verticaux et renforcé le tout par des tiges de tension qui soutiennent le tablier. Les chevilles de bois sont remplacées par des clous et les croisillons sont aussi renforcés par des contreventements droits avec jambes de force. Nous avons désigné ce type de ferme sous le nom de "Town élaboré".

D'autre types de fermes furent utilisés au XIXe siècle. On retrouve ainsi des fermes: à poinçons multiples à nombre impair ou pair, brevetée par William Howe; à Croix de Saint-André simple, brevetée par le colonel Stephen H. Long, ingénieur de l'armée américaine en 1830, ou double, brevetée par le même William Howe en 1840.

Un cas unique, c'est le pont de Power's Court construit en 1861, seul exemple au monde de la ferme à corde supérieure arquée, brevetée par D.J. McCallum en 1851, un des constructeurs de ponts de chemin de fer les plus réputés de l'époque.

Quelques ponts ont été construits à des fins domestiques uniquement. On en retrouve trois à Saint-Rémy de Tingwick dans le comté d'Arthabaska et un à Saint-Méthode au Lac Saint-Jean. La dernière vague de construction de ponts couverts a eu lieu en Abitibi, dans le Nord-Ouest du Québec et se termina en 1962 avec l'érection du pont de Saint-Maurice de Dalquier sur la rivière Harricana. Certains individus nostalgiques ont cependant voulu poursuivre la tradition, avec plus ou moins de succès, en ne conservant très souvent que l'apparence d'un pont couvert traditionnel.

En 1978, le ministère des Affaires culturelles et le ministère des Transports du Québec concluaient une entente pour protéger et mettre en valeur 44 des 118 ponts couverts. Cette entente est en voie de révision et nous espérons pouvoir porter ce nombre à plus de 80.

Cet héritage récent, transmis par nos pères et amené par nos voisins du Sud n'en mérite pas moins une attention particulière afin que nous puissions le transmettre aux générations futures.

Fig. 1. Le pont Gould à Lingwick dans l'Estrie, sur la rivière au Saumon, avec sa dentelle, une structure brevetée par Ithiel Town en 1820. Il aurait été érigé en 1883.

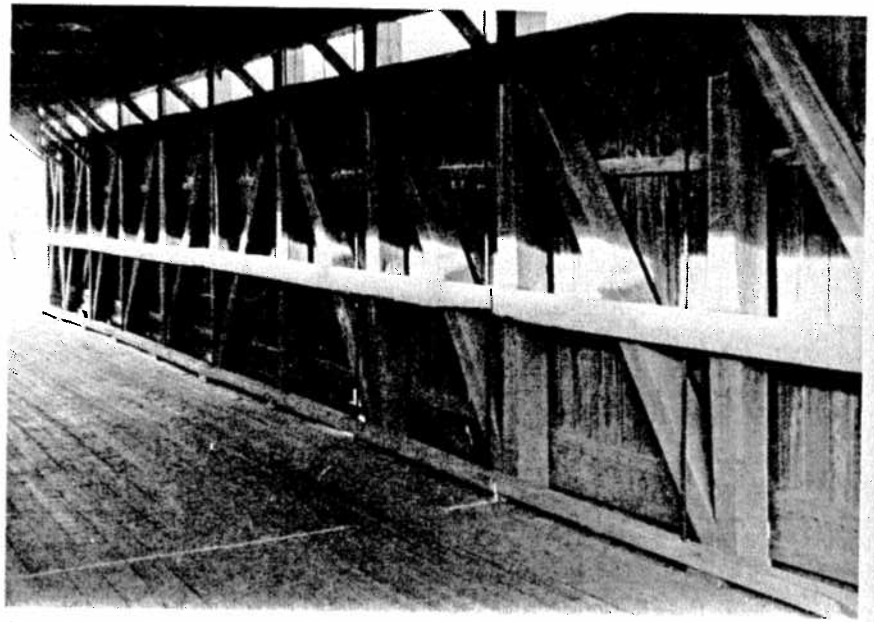

Fig. 2. Cette ferme à poinçons multiples, assez simple en soi, a été brevetée par le colonel William Howe (pont Drouin à Compton Station).

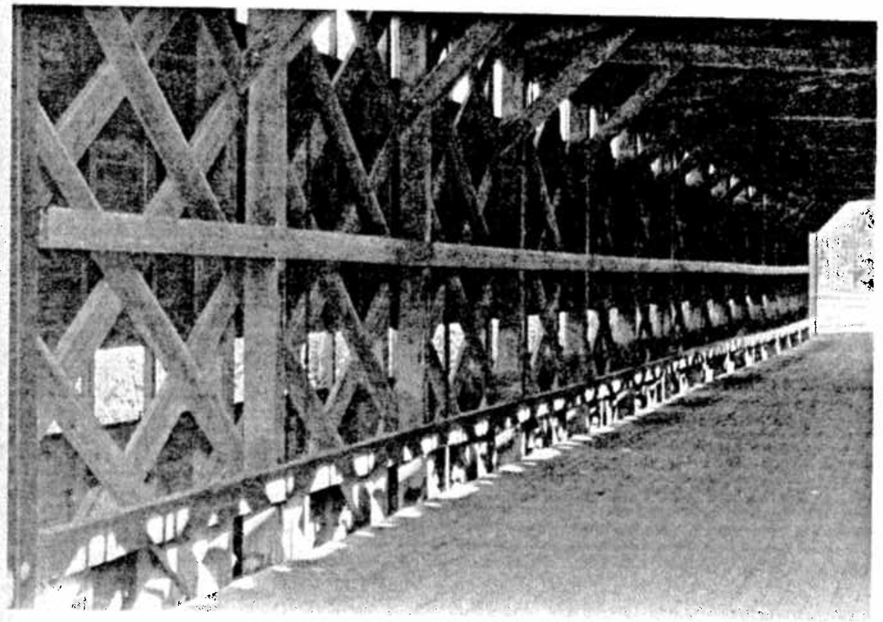

Fig. 3. Une ferme du type Town développée par le ministère de la Colonisation du Québec au début du XXe siècle (Pont de Sainte-Agathe à Nelson, comté de Mégantic).

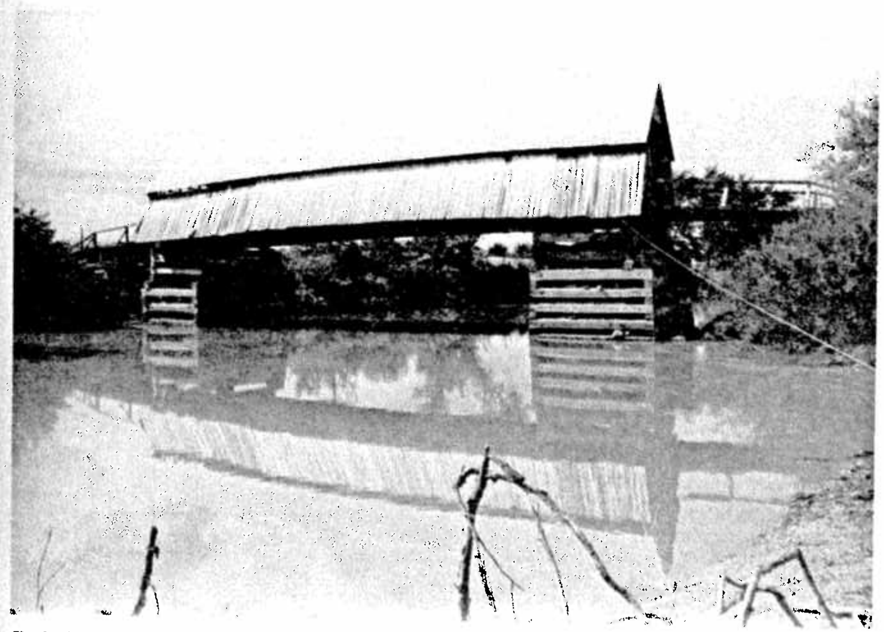

Fig. 4. Un pont couvert domestique, à Saint-Méthode au Lac Saint-Jean. Il enjambe la rivière Ticapoué.

ABSTRACT

COVERED BRIDGES IN QUEBEC

Henri-Paul Thibault

The tradition of covered bridges is not limited to the province of Québec; on the contrary, examples which date from the 12th and 13th centuries have been found in parts of Europe and Asia. Since the development of transportation routes in North America was relatively late, it was not until the arrival of the railway that construction of wooden bridges became widespread. Québec's first covered bridge was built in Cookshire in 1835; however, it was replaced in 1868.

During the 19th century, family enterprises or municipalities constructed many of the bridges. Government standards were non-existant and, as a result, the bridges varied stylistically. With the arrival of the automobile and the centralization of the government, there was a need to construct new transportation routes. It was at this time that the Ministry of Colonization devised a structure used exclusively for covered bridges until 1962; hence, the name "colonization bridges" became popular. Of the 500 such bridges which were identified, only 118 remain today.

Most covered bridges are only one lane wide, with a medium span of 30 meters. The last group of these bridges was built in the northwest part of the province in 1962. Certain individuals with a nostalgia for the past have tried, with more or less success, to follow this tradition; however, it is merely the exterior appearance that recalls the 19th century prototype.

In 1978, the Québec Ministries of Cultural Affairs and Transport formulated an agreement to preserve 44 of the 118 bridges. This agreement is currently under discussion and it is hoped that more than 80 bridges will be included, so that they may be preserved for future generations.

HENRI-PAUL THIBAULT est né à Montréal en 1944, et il est diplômé de l'Université de Montréal (M.A. en histoire, 1973). De 1968 à 1973, il participe à la reconstruction de la forteresse de Louisbourg (Nouvelle-Ecosse) en tant qu'historien d'architecture. Depuis 1973, il oeuvre à la sauvegarde et à l'étude des biens culturels du Québec au sein de la Direction générale du patrimoine du ministère des Affaires culturelles. Il est co-fondateur de la Bibliographie d'histoire d'Amérique française et de la Louisbourg Underwater Archaeological Society. Il a collaboré à diverses publications et revues, ainsi qu'au Dictionnaire biographique du Canada. Il prépare présentement un ouvrage sur les ponts couverts.

22412

THE DEVELOPMENT OF HISTORIC WOODEN ARCHITECTURE IN CANADA

Martin E. Weaver

What I would like to do is to make you aware of the growth of the use of timber in Canada by North American Indians and European settlers, and then to acquaint you with the influence of industrialization on current building patterns.

When the first European settlers came to Canada, they tended to use the timbers that were right on their doorsteps. In Figure 1, one can see a cedar swamp; the cedars that grew in these swampy areas were used by the first settlers in Ontario, for example, for the construction of their log buildings. In the first settlements in Québec, the tamaracks which grew along the riverbanks were also often used.

We no longer have in Canada, except in some very isolated instances, the enormous stands of virgin timber that we used to have. What we still see very frequently is second-growth timber, such as lodgepole pine. Whole areas were logged-out in the 1800's by the great companies, such as the Canadian Pacific Railroad.

The Europeans that first came to North America were more accustomed to parks, such as one can see in Figure 2, because the great European forest reserves had been very largely depleted. They arrived in North America and found Indians in the eastern woodlands building wigwams and very large longhouses with thin small timbers. On the plains, Indians built tepees - buffalo-skin tents with thin wooden poles to hold up the skins.

Probably the first substantial European timber building to be erected in Canada was the Habitation at Fort Royal, constructed in 1605 by Champlain for his first base. Figure 3 is a 1930's rendering of Champlain's first Habitation, which was prepared for its first reconstruction. The original building was burned down by some 'friendly' invaders from the south. One of the things which becomes apparent when we look at this reconstruction is that one has to make a lot of assumptions as to exactly how the building was originally finished.

All of the planks in the reconstruction were sawn by a reciprocating mill. The evidence is not very clear; it does appear that Champlain had a mill, but whether it was used to this extent, we're not sure. The construction of the interior of the building is based upon historical parallels from Europe. The roof, illustrated in Figure 4, is based on a typical 16th or early 17th century French roof. I draw your attention to tool marks on it, which I think are a little 'folksy', a little too textured; I think they probably would have been less rough. The interpretation of the original construction is based more on subsequent Canadian architecture, the poteaux en coulisse - the grooved post construction with filler logs - which I find it very hard to find parallels for in the early 17th century or late 16th century French context.

A large number of different types of Europeans arrived in Canada and built according to their traditional styles, such as you can see in 16th century Lavenham, Suffolk in East Anglia in England; or in typical German half-timber buildings that can be seen in the Kiel Museum - what the English call half-timber building and the French call charpente à pan de bois.

For many years, it was believed that, in North America, everybody arrived and built a log cabin. This has now been established to be a myth; but there were some log cabins, or log houses, of very clear Swedish origin. The Roger Mowry house, from Providence, Rhode Island, which looks like a log building, is in fact a frame house covered in plank. We probably had a lot of frame houses covered in plank in Canada; unfortunately, we know of no survivors.

Not only the French and English came, but many other ethnic group, including the Swedes and Moravians. Some of our earliest surviving buildings were built by Moravian missionaries. Figure 5 illustrates a Moravian building and powder house (Fig. 6) from Hopedale in Labrador, dating from 1720. One will notice that there are virtually no trees in this landscape and there probably were only a few. Although a sawmill was built at Hopedale by the Moravians, some of the woodwork for these buildings was probably brought from the United States. These were probably Canada's earliest prefabricated buildings.

The French colonists, arriving in Louisbourg, for example, constructed buildings which very closely followed the traditions with which they were very familiar in France. In some cases, Parks Canada, in its reconstruction work at Louisbourg, has had the benefit of original specifications. Figure 7 shows an original specification from about 1750; the recent reconstruction of this charpente house is illustrated in Figure 8. One of the interesting things about the French settlement of Louisbourg was that they wanted to give a very good impression of a substantial masonry town or fortress, partially to deter other people from trying to attack the city, particularly the British. The impressive stone gateway of Porte Frederick, which you can see from the sea, in fact turns out to be made of wood (Figs. 9 and 10). It is interesting to see this tradition of using wood but disguising it as stone, continuing right through to the early 20th century.

We have in Louisbourg some very enigmatic buildings: the so-called piquet or poteaux en terre or pieux sur solle, which one can see is a very strange building with diagonal braces holding up the walls (Fig. 11). We know that this existed on the site at Louisbourg, because it shows up in a tiny drawing at the bottom of a large plan. Unfortunately, we don't have any good parallels, and we didn't know where this type of building came from until quite recently, when I was looking at a painting of Napoléon reviewing his troops before the planned attack on England, and there in the centre of the painting was a piquet house with this strange diagonal bracing. It would appear, therefore, that this is in fact a temporary military building, or a building for military purposes. Examples of similar buildings, dating from the Civil War, can be found in the United States.

Wood was used to an incredible degree, particularly in remote trading posts like Old Fort William, Ontario. Figure 12 is a reconstruction; the original Old Fort William, which is now long since gone, was built by the Northwest Company.

Figure 13 shows the continuance of medieval tradition surviving to the late 19th century. This is essentially an English, or maybe even a Scandinavian, frame building erected somewhere near Ottawa in about the 1880's. You see the plaster on the inside of the house and vertical board and batten on the outside, keeping the weather out.

We imported our styles from everywhere. In Figure 14, one can see a frame building covered in clapboard; this is in St. Andrews, New Brunswick - the style here is very much derived from Maine. In fact, in some cases, when the Loyalists left the United States with the collapse of British rule, they even brought their houses with them; they were put onto barges and floated north and re-erected in Canada.

In Figure 15, we have a rather strange type of structure: the poteaux en coulisse or Red River frame or Hudson's Bay Company frame, as it is variously known - a style of construction which can, in fact, be traced back, if you care to do the detective work, to prehistoric Poland. What the linkages are in between, I don't think any of us are really quite sure; indeed, there may not be any. This was a company style of architecture for more than 100 years. These were very substantial buildings, which could be taken apart, transported to another site and put together again. These buildings moved around a lot.

There are Ukrainian settlements in Alberta, near Edmonton; you would think that you were in the middle of the Ukraine. The Dickebush Church in Figure 16 was constructed about 1900.

Fron Dr. Steneker's paper, you learned about the enormous quantity of timber resources that we used to have. Late in the 19th century, we used timber for everything, even for the surface of the street as one can see in Figure 17, in Old Québec City.

The massive use of timber extended to this almost wasteful construction of timber, which is actually stacked planks. Figure 18 shows a grain elevator at Gretna, Manitoba, being constructed in 1881. Figure 19 illustrates a private house in southern Ontario from about 1830, where the planks which were about 6" or 7" wide were staggered backward and forward to provide a key for the attachment of stucco or plaster. We made buildings by

piling logs, not lengthwise, but across the widths of the walls, in so-called cordwood construction. These buildings were, in fact, erected around the period of the Second World War, although this is a tradition of construction which goes well back into the 19th century. The walls were approximately 2' (maybe 75 cm) thick.

Dr. Steneker mentioned the use of white pine by the British Navy, particularly to replace the supplies of pine from the Baltic which was inaccessible during the Napoléonic Wars. The British and French were constructing ships in exactly the same way, using exactly the same tools - a very conservative industry. The only thing which changed very rapidly at the beginning of the 19th century was the use of block-making machinery. This was the first introduction of mass production, particularly pioneered in England at the Portsmouth Royal Dockyard. This was wood-working using machine tools.

Figure 20 is a British naval supply cache, an explorers' cache, dated from 1853, still surviving in Canada's high Arctic near Melville Island. This is one of the most incredible assemblies of artifacts which still survive in Canada, and is perhaps very rare in the world. The woodwork in Figure 21 - the boards along the tops of the walls and the posts in the middle of the building - are all made from ships' masts and spars of Canadian white pine, which may have been felled in the Ottawa Valley, rafted to Québec, shipped to England, built into a ship, and then sailed back again and deposited in this cache. The barrels are made from Canadian white oak, also shipped the same way. The ship's carpenter from **HMS Resolute**, who erected this building, used scarf joints, which are very typical of ship construction. We have been conserving this cache (Fig. 22); the woodwork which survives in this Arctic environment is still so fresh that, if you cut it, the wood is still bright and yellow inside, with a strong resinous smell. Some of the dated lignum vitae pulley sheaves from this building are early enough to have been made on Brunel's first Portsmouth block-making machinery.

The tools which were used in the construction of these historic Canadian buildings also had a long res- axes or the larger axe such as you see in Figure 23, which is a 17th or early 18th century French axe currently at Louisbourg. The axe was one of the most common tools in use. From the Atlas de Masse, a French text of the early 18th century, we can see the use of a unique tool which continues in the French Canadian tradition, but does not survive in the English tradition. This tool is known as a cross-axe or twybill, and in French as a besaigue. It is a very strange shaping tool, a variation of the slick - a very broad-bladed chisel with a couple of handles sticking out. This survived in use in Québec and produces quite distinctive tool marks, which cannot be mistaken for axe marks.

We had, of course, a few "crazy" people around, who came up with inventions which were supposed to make things easier for the men who were felling the trees and cutting them up. Whether one invention, which dates to the 1880's and which stood up on legs and had the operator sitting on a saddle, was ever actually used or not, we don't know; but the enormous labour of felling these trees by hand with cross-cut saws and axes, obviously was something everyone was trying to get around.

In West Coast Indian architecture, in many cases, the timbers were split from the live trees. Great planks - huge timbers - were cut out of their parent trees with wedges. You can see the planks of split timbers on the early 19th century model in Figure 24. The finishes of these split timbers were frequently obtained by working with a small adze, traditionally made with shells or from stone and, subsequently, from copper and other metals after the period of European contact.

The use of split timber was not limited to the West Coast Indian; it was quite common in both the English and the French Canadian settlement. In an inn near Lauzon in Québec, built in the middle of the 18th century (Fig. 25), all of the boards were split. Splitting was, of course, used for the making of shakes to go onto roofs. A large splitting axe, with a very heavy mallet, was used for this task (Fig. 26).

The patterns of the axes also follow very long traditions. The work of blocking, hacking and hewing - which pectable European tradition behind them, whether they were small hand are the technical terms for getting the square timbers out of the round tree trunk - is a long and tedious business (Fig. 27). What is frequently done today, if we're trying to make reconstructions of these early timber buildings, can be seen in Figure 28. The hard work of reducing the timber to an approximately square section is done with a chainsaw, cutting at right angles to the grain, and then the final slabbing or removal of the waste wood is done with a broad axe. Then we frequently have to go back and put in some extra axe cuts, to simulate the original texture produced by the felling axes.

The use of broad axes and pit saws, to produce authentic tool marks in our reconstructions, has become more and more common in recent years (Fig. 29). Unfortunately, in the first reconstructions which were made in the 1930's and in the 1950's and '60's, very frequently inaccurate finishes were provided by not using the original tools, and we ended up with some very poor results. There were variations in these tools between the English and the French traditions, but the resulting tool marks are very much the same.

Writing in England in the 17th century, John Evelyn, in his book de Sylva ("On Forests"), illustrated a watermill with a reciprocating saw using three blades, called a gangsaw (Fig. 30). John Evelyn recommended that this type of mill should be constructed in North America to aid in the exploitation of the forests. In Figure 31, you see a water-powered gangsaw at King's Landing in New Brunswick. Figure 32 shows the saw within the mill at King's Landing - a single, very heavy blade moving up and down in what was known as a sash frame. In Figure 33, one can see what may be a Canadian invention; it's called the muley saw. It has a very thick blade braced by two pieces of wood - one on either side - acting as two cheekpieces to stiffen the blade. The advantage of this was that you could put very much larger tree trunks through the saw. With the sash-framed blade, the size of the frame which held the saw blade restricted the size of the log. Thus, the muley saw was an improvement; but it wasn't an improvement for very long, because, as we know from various references in England and elsewhere, the circular saw was invented somewhere towards the end of the 18th century, possibly in the 1780's.

Figure 34, which comes from the Encyclopedia Brittanica of 1810, shows a small circular saw, at the top. In terms of actual use on buildings in North America, the earliest evidence that I know of is in Massachusetts in 1813. We actually have circular saw marks on lathing in a well-dated building there. However, it should be pointed out that we had a saw mill in Ottawa in the 1880's, where the old reciprocating gangsaws were in use for the production of thousands of planks per day (Fig. 35).

The introduction of the circular saw and the introduction of steam power were of great importance. Steam power was used not just in fixed mills, but in portable sawmills, which could be taken out into the forest or around the country. From the middle of the 19th century, portable steam engines - mobile steam sawmills - became quite common. Another very important invention of the 19th century actually dates back to about the 1840's. It is the replaceable saw tooth. The circular saw, shown in Figure 36, actually has teeth that can be removed, so that rather than the saw getting smaller in diameter every time you sharpened it, you could take the tooth out and replace it when it became blunt - an extremely important development.

By the end of the 19th century, architectural uniformity had begun in Canada: the ethnic and regional differences were disappearing and were being replaced by structures like Vancouver House (Fig. 37) and this house in Ottawa (Fig. 39), both of which are from the 1880's and both of which are almost entirely machine-made. All of the timbers in Vancouver House have been through sawmills and planing mills. A sample taken from the boarding of Vancouver House (Fig. 38) appears to be redwood, showing signs of having been attacked by drywood termites - an insect which does not exist in Canada. The timber has been imported from California. This is such a strange thing that they should be importing timber to Canada; presumably, it was because the mills further to the south were operating at full production, and maybe it was cheaper to bring the material from there.

However, the last two illustrations (Figs. 39 and 40) demonstrate the diversity of building processes that still existed in Canada by 1880. The house in Figure 39 was constructed in Ottawa using machines. At the same time, Indians were still constructing tepees in the ancient way. The evolutionary process continues. The photo of the Blackfoot and his home (Fig. 40) was taken on the site of what is now Calgary.


Fig. 1. Cedar swamp near Ottawa. The first European settlers used the timbers they found nearest to them.


Fig. 2. Formal forest/park, old royal hunting park, Greenwich, London: chestnuts planted by Queen Victoria.

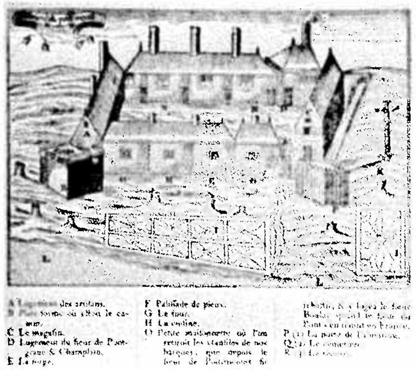
Fig. 3. Champlain's habitation 1605.


Fig. 4. Roof based on good French source material. Finish possibly too folksy.

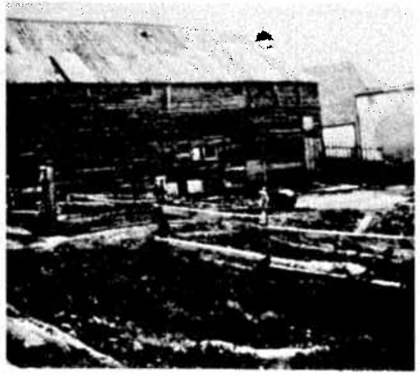
Fig. 5. Hopedale Moravian barn/living block.


Fig. 6. Moravian Mission, Hopedale, Labrador, 1720. Powder House.

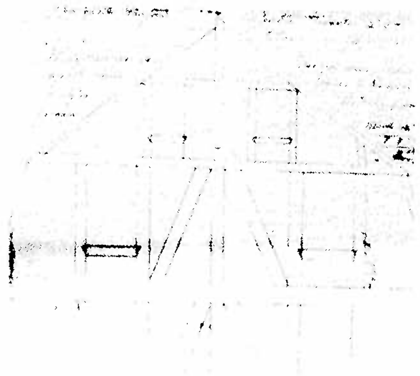

Fig. 7. Specification and drawing for Louisbourg House 1752. Brisson house *charpente pierrottée.*

Fig. 8. Specified house built at Louisbourg.

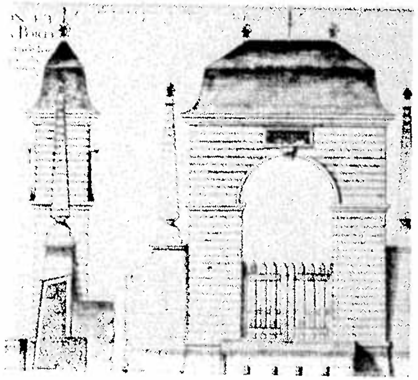

Fig. 9. Porte Frederic, 1742, Louisbourg. Wood constructed to resemble masonry.

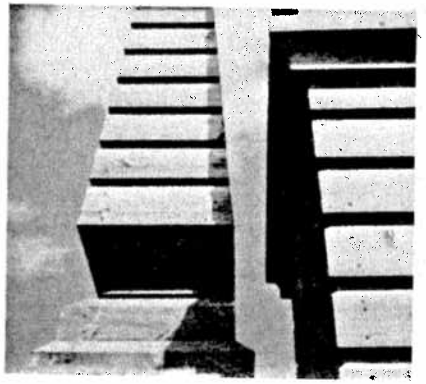

Fig. 10. Detail of Porte Frederic, reconstructed.

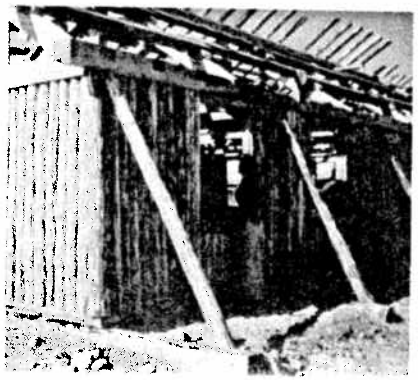

Fig. 11. Piquet house reconstruction as *pieux en terre* or *poteaux sur sol.*

Fig. 12. Maximum use of timber Old Fort William, Ontario. (Northwest Company trading fort). Early 19th century reconstructed oven.

Fig. 13. English-style 18th Century century framed house developed in Maine and transferred to St. Andrews, N.B. by loyalists.

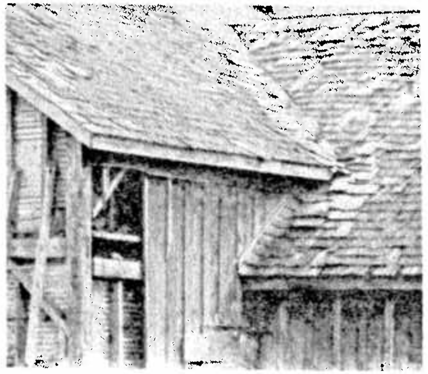

Fig. 14. Vertical board and batten mid 19th century. Ontario *en charpente* or half-timber frame. Scandinavian origin.

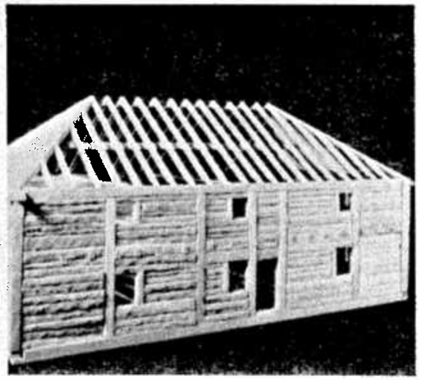

Fig. 15. Model of warehouse built of *poteaux en coulisse* also known as Red River Frame or Hudson's Bay Company Frame. Fort St. James, British Columbia.

Fig. 16. Dickebush, Alberta. Ulkrainian Church c. 1900.

Fig. 17. Breakneck Steps. Quebec 1890. Champlain Street.

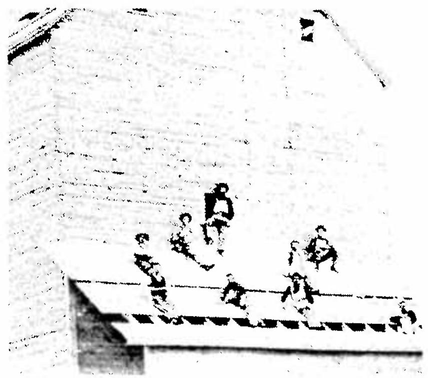

Fig. 18. Gretna, Manitoba 1881, horizontal plank or stacked plank construction.

Fig. 19. Ca. 1830 southern Ontario staggered horizontal plank.

Fig. 20. Dealey Island supply cache 1853, Northwest Territories.

Fig. 21. Dealey Island supply cache 1853. Canadian white pine spars, masts, and white oak barrel staves.

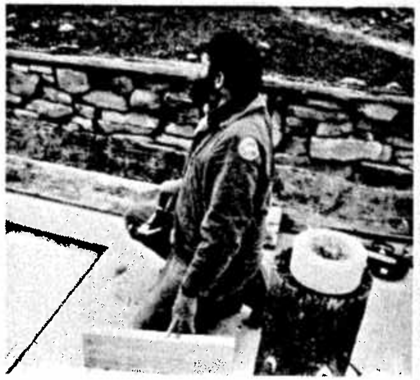

Fig. 22. Dealey Island, sealing off artifacts.

Fig. 23. French 17-18th century axe, Louisbourg.

Fig. 24. Sea Shell adze.

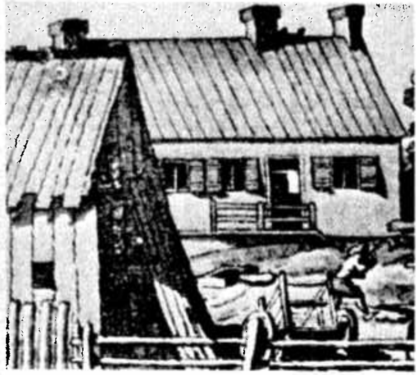

Fig. 25. Lauzon Inn, Quebec, c. 1783 split or riven boards. .

Fig. 26. Using a slitting axe or froe to split riven boards.

Fig. 27. Blocking, hacking and hewing, Muskoka, Ontario 1873.

Fig. 28. Modern axe work often speeded up by a chainsaw and then finished with a broad axe.

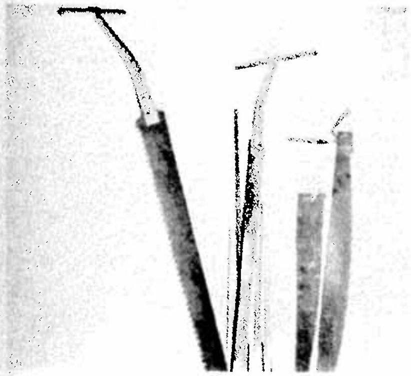

Fig. 29. Pit saws, Lower Fort Garry, Manitoba.

Fig. 30. John Evelyn "de Sylva" 1670 reciprocating saw mill.

Fig. 31. King's Landing N.B. restored saw mill.

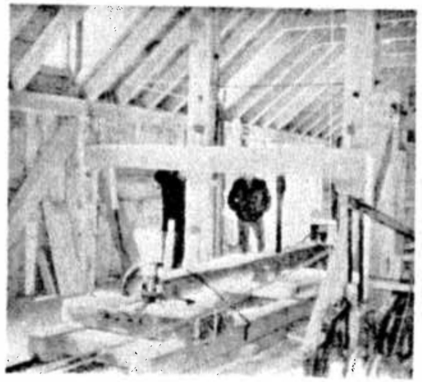

Fig. 32. Muley Saw, Upper Canada Village.

Fig. 33. King's Landing sash saw mid 19th century.

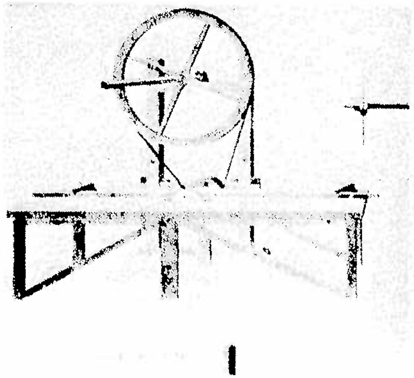

Fig. 34. Smart's saw mill London 1810 circular saw. Earliest known work in North America dated 1813 Massachusetts.

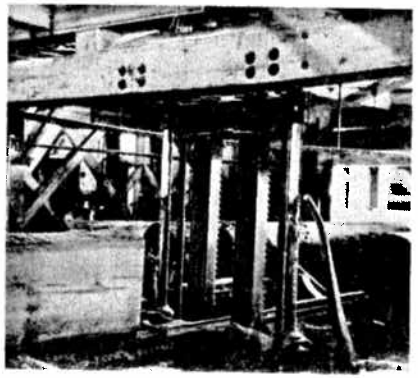

Fig. 35. Reciprocating gang saw 1870-80. Ottawa.

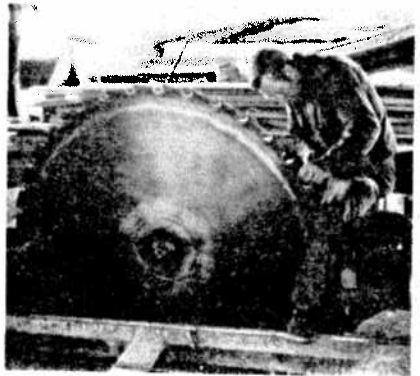

Fig. 36. Removable teeth patent circular saw. First introduction ca. 1840.

Fig. 37. Roedde House 1893, Vancouver, all elements are machine-made.

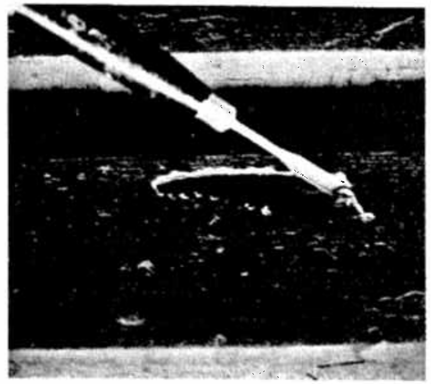

Fig. 38. Roedde House 1893, Vancouver. Imported redwood from California.

Fig. 39. Machine-made woodwork, Ottawa House late 19th century.

Fig. 40. Blackfoot teepee 1889 near Calgary, Alberta.

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ABSTRACT

L'EVOLUTION DE L'ARCHITECTURE EN BOIS AU CANADA

Martin E. Weaver

Les Européens s'établirent au Canada au XVIIe siècle dans un environnement de forêts vierges. Utilisant les ressources à portée de main, ils construisirent en bois rond leurs maisons, leur fermes, leurs églises et leur écoles. Le travail du bois était traditionnel: le charpente à pan de bois, le demi tronc d'arbre, des piquets, des poteaux en terre et des poteaux en coulisse. La plus imposante construction en bois, érigée en 1608, fut probablement l'Habitation de Champlain à Québec. Les guerres napoléoniennes ont accru énormément en Europe la demande de bois provenant des colonies.

Les technologies nouvelles se sont installées reduisant l'effort humain pour le sciage et le façonnage du bois. Les scies verticales, parallèles alternatives puis la scie circulaire mue à la vapeur installée ou non dans une scierie, a permis de produire à la fin de cette évolution des planches. De là, les constructions en bois, bien que s'inspirant de styles européens se sont particularisées. De la construction en rondins, on est passé à celle de charpente. L'auteur fait ressortir par des illustrations qu'au Canada, nous avons emprunté nos styles de partout et que l'architecture en bois a subi toutes les influences étrangères non seulement européennes, mais ultérieurement américaines. Jusqu'à la fin du XIXe siècle, nous avons utilisé le bois brut, dans toutes les constructions y compris celle des navires. L'évolution des techniques de sciage a amené celle des techniques de construction.

MARTIN WEAVER was born in 1938 in London, England and received his diploma in Architecture from the Architectural Association in London in 1961. He has been an architect and conservator on excavations in Greece, Iran, Turkey, Spain, Canada's Arctic, England and Scotland. From 1962 to 1967, he was a restoration architect for the Greater London Council in England; and was a Ford Foundation lecturer on architectural conservation for the Middle East Technical University in Ankara, Turkey from 1967 to 1970. Mr. Weaver was a UNESCO consultant on the conservation of Iranian Islamic monuments from 1969 to 1971 and a research associate for the Department of Anthropology at London University from 1970 to 1972. He directed training programmes on the conservation of heritage structures and sites for the Canadian federal government from 1972 through 1980. Mr. Weaver served as the President of the Association for Preservation Technology from 1976 to 1980; and as the President of the International Institute for Conservation, Canadian Group, from 1979 to 1981, as well as being its Vice-President from 1981 onwards. He is now the Director of Education and Technical Services at Heritage Canada Foundation, having acceded to that position in 1979.

THE YEARS OF CONSTRUCTION AND ALTERATION OF TWO BUILDINGS, AS DERIVED BY THE KEY-YEAR DENDROCHRONOLOGY TECHNIQUE©

22413

Herman J. Heikkenen and Mark R. Edwards*

The interest expressed by the Roman Catholic Archdiocese of Washington and the Maryland Historical Trust (1) in establishing precise dates for the St. Francis Xavier Roman Catholic Church and for Newtown Manor House in St. Mary's County, Maryland, using the American Institute of Dendrochronology's key-year dendrochronology technique (2), led to this study. The key-year technique relates to a new dendrochronological method for the study of the annual growing seasons and tree species over an extended period of time. The key-year technique relates particularly well to a method for accurately determining the year of construction and authenticity of timbered structures (Heikkenen, 1978).

I. HISTORIC STRUCTURES

St. Francis Xavier Roman Catholic Church and Newtown Manor House, both listed on the National Register of Historic Places and on the Maryland Inventory of Historic Sites, are located in southwest St. Mary's County, Maryland, well within the key-year pattern area of the counties of Prince George's, Anne Arundel, Charles, Calvert and St. Mary's on Maryland's western shore of Chesapeake Bay (3).

These 18th-century landmarks are located on a site important in the 17th-century ecclesiastical and social history of Maryland. Newtown, the first Maryland settlement after the state's first capital of St. Mary's City, was established as a mission in 1640. From this area of Newtown Neck and from other locations in southern Maryland, English Jesuit priests conducted missionary activities among the Indians and ministered to the needs of the settlers from the second quarter of the 17th century. In 1668, the Society of Jesus purchased the Manor of Little Breton, an 850-acre tract in Newtown. It was on this tract that these two structures were erected.

St. Francis Xavier Roman Catholic Church is a long, narrow, one-story frame structure (Fig. 1, a) with two octagonal additions built of brick: one on the northwest, which marks the entrance, and the other on the southwest, sheltering the sacristy and confessional. The interior of the church is highly important architecturally, distinguished by a barrel-vaulted ceiling supported by two sets of piers which create a nave and side-aisle. There is a dome over the chancel and altar, located near the southeast octagonal end. The altar area also features a fine mid-18th century reredos (4). The church is nationally significant as the oldest Catholic church in continuous use in English-speaking America (5).

One hundred yards southwest of the church stands **Newtown Manor House** (Fig. 1, b), a massive, two-story, five-bay by two-bay structure, constructed of brick laid in Flemish bond, resting on a high brick basement. The structure features a virtually unchanged basement, which houses an interior kitchen and storage areas, including two with original wine storage racks. The first- and second-story living space is characterized by fine, unaltered woodwork and trim (6).

II. THE PROBLEM: PRECISE DATING

When the Archdiocese of Washington recently began planning for the restoration of these buildings, one of the first problems which emerged was the plethora of possible construction dates for these structures as indicated in at least six secondary research sources, written at various times during this century. Using, as a focal point, a thorough analysis of what historical research did exist, the goal of this study was to definitively pinpoint original construction dates and dates of major alterations, through scientific analysis of historic building fabric.

Many sources have provided information which appears to have been deduced from major assumptions, involving relatively little primary source data. Most researchers and writers, who described the construction of the present church, based their claim that this was the third church on the site on a scanty historical record. Most researchers noted that the first church was built in 1662, near the ceetery grounds, some distance from the present church. This was replaced before 1719 by a second structure, mentioned in a contemporaneous will (7). The dean of Maryland architectural historians, Henry Chandlee Forman, in his work Early Manor and Plantation Houses of Maryland, described what he believed was the second church on the site, noting: "The ancient square chapel beside the house has gone, but traces of its foundations are evident." We now know, from a recently completed archaeological investigation, that he was mistaken and that these foundations were, in reality, those of the first manor house at Newtown (8).

Forman's 1934 analysis became the basis for later historians' research on the site. One of St. Mary's County's most important historians, Edwin Beitzell, did look carefully at other sources of data, including an 1884 letter by Father Treacy (who served at the church during 1882-1883), found in the Woodstock Letters, part of the Maryland Jesuit Archives housed at Georgetown University: "Between the present church and the Manor-house, the foundations of some ancient building may still be traced. Those who have examined them carefully say that they were, judging from their form, the foundations of a church which was built anteriorly to the present one." Even Father Treacy's 19th-century analysis was incorrect and helped perpetuate the theory that the present structure was the third church to be built on the site. Mr. Beitzell's discussion of the historical event which closed the first church - the Protestant Revolution of 1689, which officially proscribed Catholic activities in the state - is, no doubt, correct; but the primary evidence, which leads to his and other historians' claims that a second church was erected circa 1704-1705 and then forced to close almost immediately because of the Intolerance Act, cannot be located and is not corroborated through archaeological analysis.

The date of 1766, which most historians give for the construction of the present church on the site, is based on solid primary evidence, specifically a number of 18th-century bills, housed as part of the Woodstock Letters at Georgetown University. But rather than indicating the construction of a third church, as Mr. Beitzell states in The Jesuit Missions of St. Mary's County, Maryland, these point toward the alteration of an already extant building, noting such construction activities as plastering, lathing, insertion of a dome over the altar, and initial construction for the choir (9). A second undated bill makes additional references to the construction of a choir (plastering side walls, lowering ceiling, dome, etc.) (10). Lastly, based on these and later ledger accounts, many researchers gave the date for the construction of the entrance at the front of the church, which housed a vestibule and choir loft, as 1767, with a sacristy and confessional added to the rear of the church in 1816 (11).

No exact date has been offered by historians for the construction of Newtown Manor House, although architectural evidence indicates a possible date range from circa 1750 to 1790. Alterations and expansions of the house, as indicated in 19th-century primary sources, were noted by a wide array of historians as occurring in 1816 (12).

With such a wide range of dates produced through historical research, the Archdiocese of Washington turned to the Maryland Historical Trust and the American Institute of Dendrochronology for assistance. The previously-mentioned pilot study, produced in 1981, showed the viability of using dendrochronology as a tool to exactly date historic buildings built partially or entirely of wood. The project was then organized to provide exact dates of construction for the church and manor house, as well as to produce an undisputed chronology of building construction at the site. The testing also aimed at determining the precise sequence of major alterations to the two buildings (for example, the change in roof configuration of the Manor House, from gambrel to the present jerkinhead gable).

III. THE KEY-YEAR TECHNIQUE

The key-year technique is based on samples of the growth rings of trees taken either from living or dead trees, stumps, logs or structural timbers on a given site.

The annual ring widths of a given tree are expressed in a relative manner: for example, the width of the 1980 ring, relative to the 1979 ring, is either greater (+), less (-) or equal (0). The 1979 ring is, in turn, compared to its preceding year (1978), and so on. The relative ring widths (RRW) of all the trees sampled from a given site are then expressed as the percentage of the RRW which coincide in a given year, being +RRW, -RRW, or ORRW.

A year in which a significant percentage of the RRW is in agreement is termed a key year (KY). The significant percentage of agreement for RRW for a given year and for a given sample is determined by use of a cumulative binomial distribution table. The cross-dating test is made by aligning the two KY patterns (year by year) until the best fit is found, using a $\pm$ contingency table and applying: 1) the chi-square (X^2) test without transformation, and 2) the kappa (K) statistical test. The chi-square value for each year of alignment is classified as being either in agreement or disagreement. The chi-square and kappa values of highest association and agreement for the year of best fit greatly exceed the other derived annual values.

IV. THE KEY-YEAR PATTERN: LIVING TREES

The key-year pattern for the oaks of Maryland's western shore was initiated by sampling recently-living oaks from four old-growth stands, with known dates regarding the last year of growth.

Prince George's County: 1) Belt Woods, near Kobes Corner, logged during the fall of 1980.

St. Mary's County: 2) Tudor Hall Woods, near Leonardtown, logged during the fall and winter of 1979; and 3) Fox Woods, near Hollywood, logged during the fall of 1979.

Charles County: 4) Gunston Woods, near Welcome, logged during the late winter and early spring of 1979.

Within each of these stands, disks were sawn from the stumps of the oldest oaks. The longest radius per disk (pith to cambium) was then selected and the width of each annual ring measured.

Belt Woods

The development of the key-year pattern was initiated with Belt Woods, which was the old-growth stand having the oldest oaks. The width of each annual ring of the 16 oaks was measured; and the relative ring widths (RRW) for each oak were calculated. The years when a significant percentage ($P = 0.05$, $n = 16$) of the RRW were in agreement established the key years (KY).

Tudor Hall, Fox and Gunston Woods

The cross-dating of the Belt and Tudor Hall Woods KY patterns was achieved by aligning the Tudor Hall KY pattern with the Belt KY pattern, until the year of best fit was found. The chi-square and kappa values were calculated from 1980, then 1979, and back each year in time to 1960. The chi-square value of highest agreement was 22.8 and the kappa value was 0.78 for the year 1979 (Table I). The KY patterns for the oaks of Belt and Tudor Hall Woods were then combined.

Then, the Fox Woods KY pattern was aligned and combined, followed by the Gunston Woods KY pattern.

The four KY patterns thus form the recently-living oak KY pattern for Maryland's western shore. This KY pattern extends from 1980 back to 1730, a total of 251 years; there are 72 +KY and 65 -KY ($P = 0.05$, $n = 64$) (Table I and Fig. 2).

V. THE KEY-YEAR PATTERN: HISTORICAL STRUCTURES

The extension of the oak KY pattern backward in time beyond that of the recently living trees was achieved by obtaining KY patterns from historical structures within the study area. The KY pattern for a given historical structure was developed in the same manner as for the recently living trees.

Within a given historical structure, wood samples having bark or wane were removed from structural members by sawing or drilling; the location was described and coded (13).

The cross-dating of historical structures was achieved by alignment of the KY pattern of a given historical structure with the living tree KY pattern. The year of alignment having the highest chi-square and kappa values was selected as the year to combine the KY pattern of the historical structure with the living KY pattern.

A total of 28 historical structures was combined into the KY pattern for the oaks of Maryland's western shore. The length of this KY pattern is 410 years, from 1980 back to 1570 (Heikkenen, 1982).

VI. CROSS-DATING: NEWTOWN NECK OAKS

During 1981, seven oaks were felled on Newtown Neck for purposes of historical reconstruction. Disks were removed from the stumps to establish the association of the living oaks from

Newtown Neck with the recently-living oak key-year pattern.

The seven oak samples provided a KY pattern of 91 years in length, with 12 +KY and 14 -KY ($P = 0.14$, $n = 7$). The year of alignment was 1981 ($X^2 = 10$, $K = 1$) - the last year of tree growth (Table II, a & b; and Fig. 3).

VII. CROSS-DATING: NEWTOWN MANOR HOUSE

The cross-dating of the Newtown Manor House, both the original house and the later additions, is based on:
1) 18 samples cored or sawn from the joists and beams of the first floor;
2) four samples cored from upright posts on the third floor; and
3) ten samples cored from the rafters in the attic.

Basement

A total of 16 oak samples were measured to develop a KY pattern of 36 years in length, having 9 +KY and 11 -KY ($P = 0.05$, $n = 16$). This basement KY pattern was aligned with the area KY pattern from 1889 back to 1700. The year of best fit was 1789, when 8 +KY and 7 -KY matched (no mismatches) with a chi-square value of 15 and a kappa value of 1 (Table II, a & b; and Fig. 4).

Addition

The addition to the original Newtown Manor House was studied by developing a KY pattern from the upright timbers of the third floor and the exposed rafters in the attic.

A total of nine of 14 samples was measured - five oak and four tulip poplar. The combined oak and tulip poplar KY pattern was 75 years in length, had 16 +KY and 26 -KY ($P = 0.14$, $n = 9$). This key-year pattern aligned with the area KY pattern at 1816 ($X^2 = 13.74$, $K = 0.70$), with 9 +KY and 15 -KY matching (four mismatches) (Table II, b; and Fig. 5).

VIII. CROSS-DATING: ST. FRANCIS XAVIER CHURCH

The cross-dating of St. Francis Xavier Roman Catholic Church is based on wood samples, having bark or wane, removed from the roof rafters and tie beams in the attic, and from the sills in the crawl space below the floor.

Rafters and Sills

A total of 14 tulip poplar samples, plus one oak sample, having bark or wane, were cored from the roof rafters and tie beams in the attic of the church. However, due to insect damage, only eight samples from the original church were suitable for measurement. The KY pattern based on eight tulip poplar samples was 90 years in length, with 20 +KY and 18 -KY ($P = 0.05$, $n = 8$). The year of best fit was 1731, when 8 +KY and 5 -KY matched, with a chi-square value of 10.37 and a kappa value of 0.85 ($P = 0.05$)(Table II, a & b; and Fig. 6, a & b).

A total of five samples from the sills were removed - all oak. All samples proved suitable for measurement and provided a KY pattern of 58 years in length, having 4 +KY and 6 -KY ($P = 0.14$, $n = 5$). The year of best fit was 1730, with 1 +KY and 3 -KY matching ($X^2 = 4$, $K = 1$) (Table II, a & b; and Fig. 6, a & b).

Original Church

The oak and tulip poplar KY patterns of the original church were then combined, providing a 90-year KY pattern having 14 +KY and 12 -KY ($P = 0.05$, $n = 13$). The combined oak-tulip poplar KY pattern was aligned with the area pattern from 1769 back to 1669. The year of best fit was 1731, having 5 +KY and 5 -KY matching, with a chi-square value of 10 and a kappa value of 1 (Table II, b; and Fig. 6, b).

IX. CONCLUSIONS

Newtown Oaks

The recently-living oaks from Newtown Neck are from the same population as the recently-living oaks of Maryland's western shore, based on the statistically significant matching of the key-year dendrochronological patterns. Thus, the assumption is valid that key-year patterns derived from historical structures on Newtown Neck could be matched by testing against the entire oak key-year pattern of Maryland's western shore, extending from the present back 410 years to 1570.

Newtown Manor House: Original

The present Newtown Manor House was originally constructed as a 1½-story, gambrel-roofed brick structure (Maryland Historical Trust, 1980). Although the house's construction date has not been firmly established, estimates have been made as follows: soon after 1661, by Forman (1934); ranging from 1649 to 1680, by Pogue (1972); and in the mid to late 18th century, by the Maryland Historical Trust (1980).

This study has established that, of the timbers used in the ceiling of the first floor (i.e. taken from the basement), some had come from oaks which had completed the growing season of 1788 and some from oaks which were just beginning the growing season of 1789 when they were felled.

Because the foundation of the present Newtown Manor House is of brick which supports the timbers, the probability is high that construction began before the spring of 1789. Supporting evidence for this date of construction are 18th-century bills for construction materials (planks, nails, brick and carpentry work), dated during 1786, 1787 and 1788. Documentation also exists from 1790 for the purchases of glass and linseed oil (14).

Thus, the present Newtown Manor House was constructed shortly after the American Revolution ended, specifically during the years from 1786 to 1790. The trees were probably felled during the fall and winter of 1788-1789, with some being felled in the early spring of 1789. The timbers were then hewn and placed during 1789.

Newtown Manor House: Alteration

The present Newtown Manor House was altered shortly after the end of the War of 1812. The alteration was the extension upward of the 1½-story gambrel-roofed house to its present 2½ stories with gable roof (Fig. 1, b).

The date for this major rebuilding is 1816, according to Pogue (1982) and Burch (1978). This date is based on existing documents for bricks and carpentry work. The last year of tree growth for the oak and tulip poplar timbers used to construct the third floor and rafters was during the growing season of 1816. Thus, the construction date of 1816 is also supported by this key-year dendrochronology study.

St. Francis Xavier Roman Catholic Church

The year of construction for the main block of the present church (Fig. 1, a) is given as 1766 by Pogue (1982, 1972), Burch (1978), Beitzell (1976) and the Maryland Historical Trust (1980). As described previously, the date is based on existing documents from 1766 for construction materials and labor.

The last year of tree growth for the oak sills in the main block of the church is 1730. The rafters were made from tulip poplar trees which had completed the growing season of 1731. Thus, the years of construction for the first part of the present church should include the wood-framing during 1730-1731. These years are based on the matching of the key-year patterns of the oak, tulip poplar and combined oak-tulip poplar, with the oak key-year pattern of Maryland's western shore.

Possible explanations for the differences in previous estimates of the years of construction for the church should include:
1) lessening religious intolerance during the decade of 1730. Even though religious fervor had diminished from the levels of the late 17th and early 18th centuries, the church may have been built to resemble an outbuilding (perhaps a barn), to camouflage its true use, and recorded as such in historical records for the properties of Newtown Manor House during the first half of the 18th century;
2) historical documents for the period 1766-1767. These indicate that repairs, interior modifications and brick additions were made to the ends of an **existing** wooden building. There is **weathered** wooden siding at the front end of the church, inside the brick addition of 1767, indicating that the building was a self-contained structure prior to that time.

X. ACKNOWLEDGEMENTS

The American Institute of Dendrochronology and the Maryland Historical Trust acknowledge the interest in and cooperation with this study of Father John T. O'Neill, Director of Restoration, St. Francis Xavier Roman Catholic Church.

Also appreciated are the efforts of Mike Smolek, Regional Archaeologist for the Southern Maryland Regional Preservation Center, for obtaining the oak samples from Newtown Neck; and of Hugh A. Beard, scientist for the American Institute of Dendrochronology, for obtaining the samples from the oak sills of St. Francis Xavier Roman Catholic Church, and for his assistance with this study.

The wood samples obtained in this study, as well as the original measurements, computer printouts and the years of best fit of the key-year pattern, are on file with the American Institute of Dendrochronology, Blacksburg, Virginia.

The original field notations and comments are on file with the Maryland Historical Trust.

TABLE I
The Association and Agreement of the KY patterns
of the recently living Oaks from four old-growth stands:
The Initiation of the Oak KY pattern for Maryland's Western Shore

Old-Growth Oak Stands	Sample Size	Year of Best Fit	X²	K¹	Key Years +	–	Σ
Belt	16	1980			46	51	97
Tudor	16	1979	22.8¹	.78¹	42	45	87
Combined BT	32				61	48	109
Fox	16	1979	25.3	.88	31	29	60
Combined BTF	48				62	62	124
Gunston	16	1979	19.9	.85	21	24	45
Combined BTFG	64				72	65	137

¹The chi-square and kappa values are highly significant (P = .01).

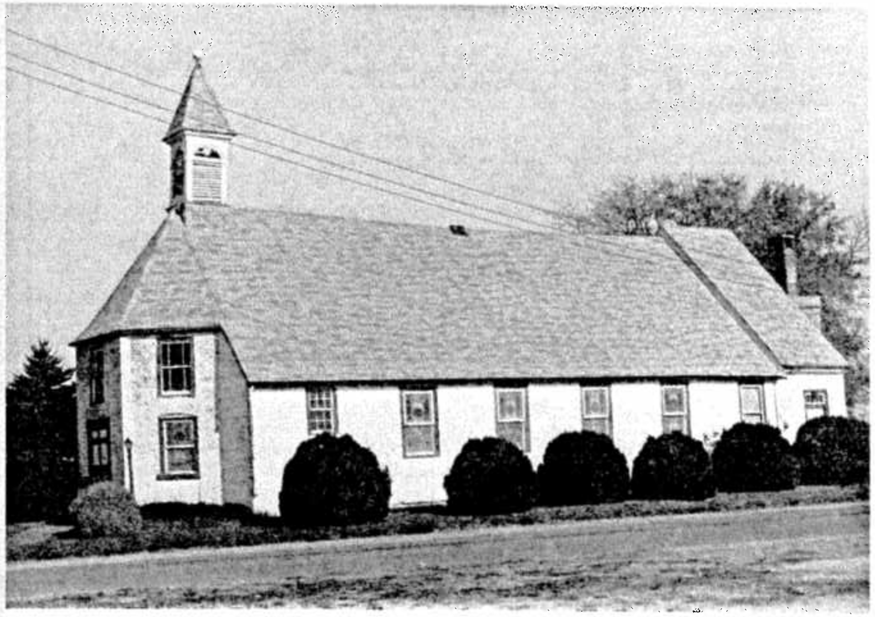
TABLE IIa
The Key-Year Patterns Derived from the Historical Structures:
St. Francis Xavier Roman Catholic Church and the Newtown Manor House

	Tree Species	Sample Size	Key-Year Pattern* +	–	Σ	P	LENGTH
Newtown Oaks	oak	7	12	14	26	.05	91
Newtown Manor							
Basement	oak	16	9	11	20	.05	36
Third Floor/Attic:	oak	5	4	4	8	.14	21
	tulip	4	18	23	41	.14	75
Combined		9	9	15	24	.14	75
St. Francis Church							
Sills	oak	5	4	6	10	.14	58
Rafters	tulip	8	20	18	38	.05	90
Combined		13	14	12	26	.05	90

TABLE IIb
The Key-Year Patterns for St. Francis Xavier Roman Catholic Church
and the Newtown Manor House
when Cross Dated with the Oak Key-Year Pattern for Maryland's Western Shore

	Year of Best Fit	n	X²	K	Matching Key Years +	–	Σ
Newtown Oaks	1981	7	10.0	1.0	6	4	10
Newtown Manor							
Basement	1789	16	15.0	1.0	8	7	15
Third Floor/Attic:	1816	9	13.7	.7	9	15	24
St. Francis Church	1731	13	10.0	1.0	5	5	10

*All values highly significant (P = .05).


a


b

Fig. 1. (a) The present St. Francis Xavier Roman Catholic Church (SM-59), and (b) Newtown Manor Hourse (SM-58), Newtown Neck, St. Mary's Country, Maryland. (M.R. Edwards, Maryland Historical Trust).

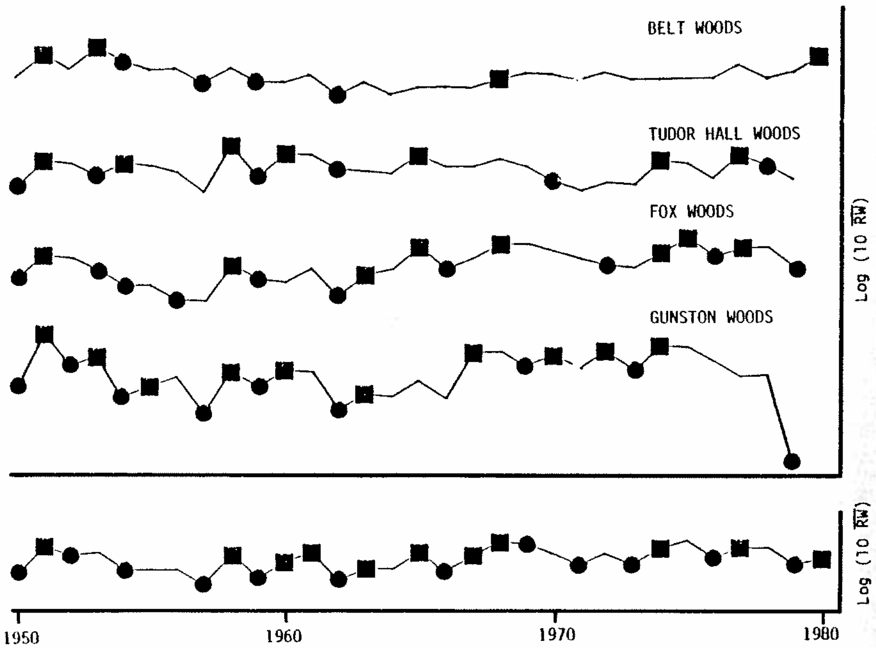


Fig. 2. The oak key-year pattern for each of the four old-growth sands (P = .05, n = 16) plotted as the log 10 mean ring-width (RW); and the mean ring-width (P = .05, n = 64) plotted as the log (10 RW). (■ = +KY, ● = –KY).

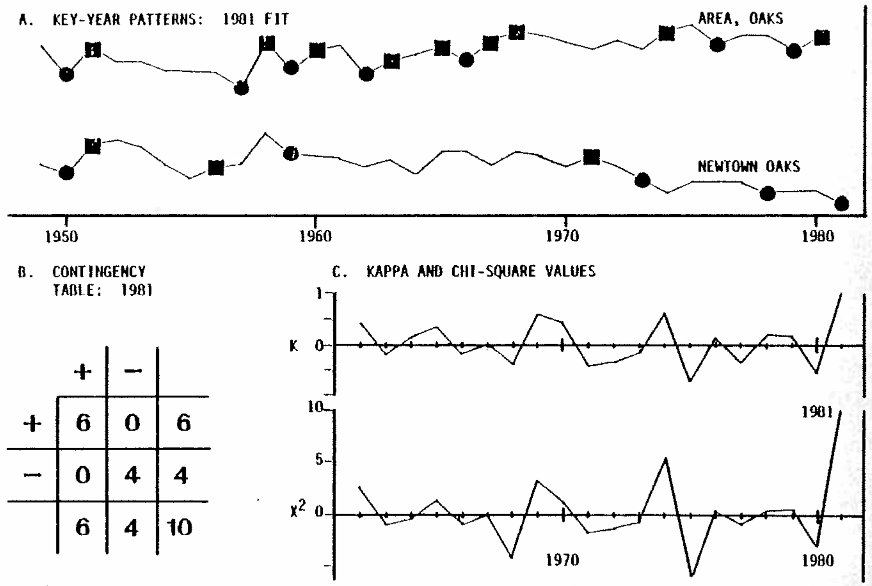


Fig. 3. The cross dating of the oak key-year pattern from Newtown Neck (P = .14, n = 7) with the area oaks key-year pattern. The year of best fit for the last year of tree growth was 1981 (X^2 = 10, K = 1.0).

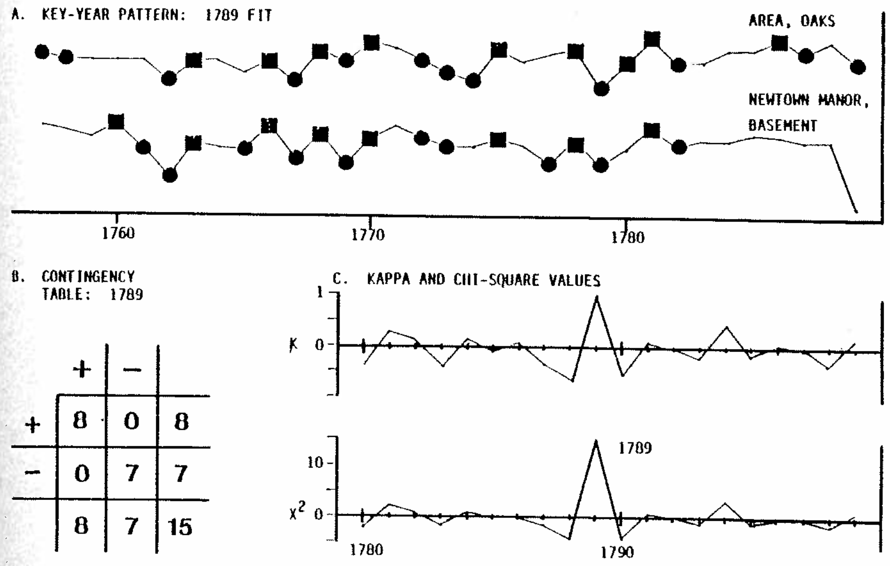


Fig. 4. The cross dating of the oak key-year pattern (P = .05, n = 16) for the basement ceiling timbers in the Newtown Manor Hourse with the oak key-year pattern. The year of best fit for the year of last tree growth was 1789 (X^2 = 15.0, K = 1.0).

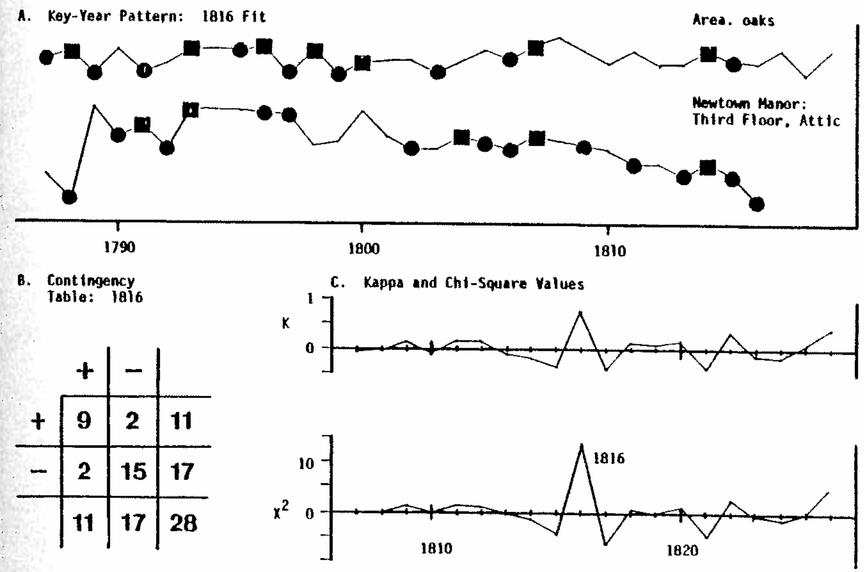


Fig. 5. The cross dating of the key-year pattern (P = .05, n = 9) for the third floor and attic timbers and rafters of the Newtown Manor House, with the oak key-year pattern. The year of best fit for the last year of tree growth was 1816 (X^2 = 13.7, K = .7).

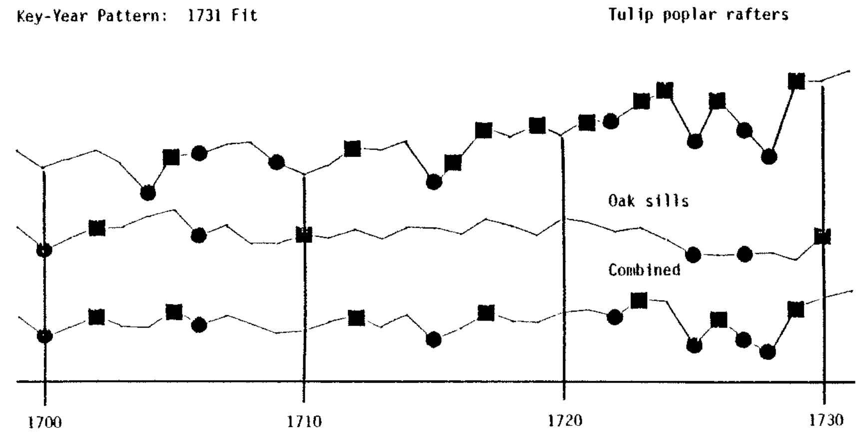


Fig. 6a. The cross dating of the key-year patterns of the oak sills and the tulip poplar rafters from St. Francis Xavier Roman Catholic Church. The years of best fit were 1731 for the rafters (X^2 = 4.00; K = 1.0). Thus the oak and tulip poplar key-year patterns were combined.

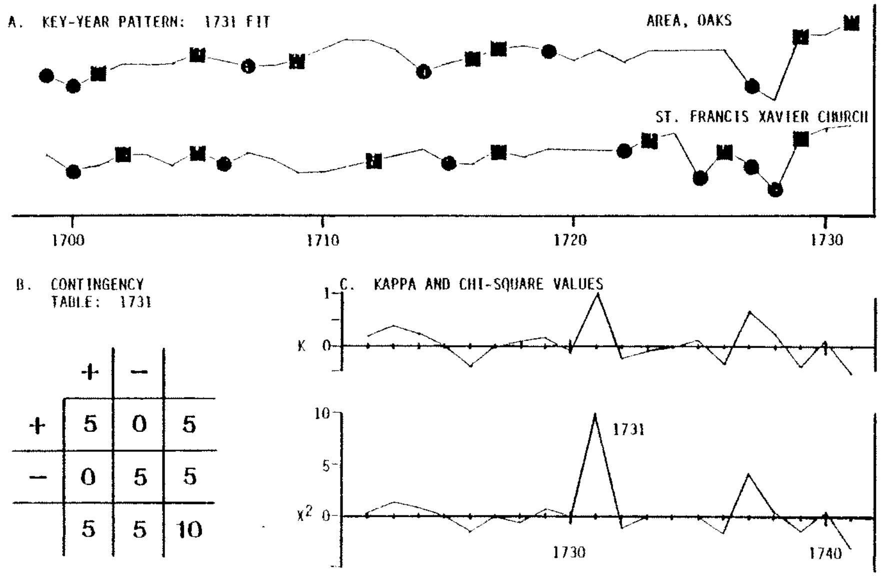


Fig. 6b. The cross dating of the combined oak sill and tulip poplar rafter key-year pattern (P = .05, n = 13) of St. Francis Xavier Church with the oak key-year pattern. The year of best fit was 1731 (X^2 = 10.0; K = 1.0).

FOOTNOTES

1. The Maryland Historical Trust serves as Maryland's State Historic Preservation Office, and is a division of the Department of Economic and Community Development. The Archdiocese of Washington contracted with the Trust in 1982, who in turn sub-contracted with AID, to produce this study.
2. United States Patent No. 4,373,393.
3. This pattern was established as part of a 1981 study prepared by AID for the Maryland Historical Trust and the St. Mary's City Commission. For more information, see: the April 8, 1981 report, The Key-year Dendrochronological Pattern for the Oaks (Quercus spp.) of Maryland's Western Shore: 1570-1980, A Demonstration Project on the Dating of Historical Structures; Dr. Herman J. Heikkenen, "Tree-Ring Patterns: A Key-Year Technique for Cross Dating" (in review); and Mark Edwards, "Dating Historic Buildings in Lower Southern Maryland Through Dendrochronology", Perspectives in Vernacular Architecture (Vernacular Architecture Forum, 1982).
4. Maryland Historical Trust, Inventory of Historic Sites in Calvert County, Charles County and St. Mary's County (Annapolis, Maryland Historical Trust, 1980), p. 127.
5. National Register Nomination for St. Francis Xavier Church and Newtown Manor House Historic District, Mrs. Preston Parish, 1972, files of the Maryland Historical Trust.
6. Ibid.
7. The will of Henry Spink, noted on page 59 of Edwin Beitzell's The Jesuit Missions of St. Mary's County, Maryland.
8. This study was also undertaken in 1982 by Dennis J. Pogue for the Archdiocese of Washington. See his report entitled "Archaeological Investigations at St. Francis Xavier Church in Newtown (18 ST 16), St. Mary's County, Maryland", on file at the Maryland Historical Trust.
9. These ledger accounts were carefully re-read and catalogued by Father John T. O'Neill, Director of Restorations for this project. The ledger, filled out on May 16, 1766 by Father James Ashby, notes:

"To plastering and lathing	4-11-5
To (2) (?) and mending ye (?)	0-10-0
To making 2000 toyle [tile] and burning ye lime	1- 5-0
To laying guier [choir] floor with toyle [tile]	0-15-0
To ye stone in ye foundation	1-10-0
To brickwork in ye guier [choir]	10- 0-0
To balance due	19-10-5"

10. The ledger lists the following:

"by building of guire [choir]	10- 0-0
by plastering side walls 65 at 3 (?)	0-46-3
by lower cieling 34 at 6 (?)	0-17-2
by Dome 15 (?) by 2 high 30 at 8	1- 0-1
by 500 Tiles, Chimneys and laying of Quire [choir]	1- 3-6"

11. Beitzell (1976), Pogue (1982), Maryland Historical Trust (1980).
12. Ibid.
13. Original field data is on file with the Maryland Historical Trust, Annapolis, Maryland, and with St. Mary's City Commission, St. Mary's City, Maryland.
14. Personal communication from Father John T. O'Neill, Director of Restoration, St. Francis Xavier Roman Catholic Church, Leonardtown, Maryland (1982).

AUTHORS' NOTE

*This paper was kindly presented on behalf of the authors by Maximilian L. Ferro, AIA, RIBA, New Bedford, Massachusetts, USA.

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ABSTRACT

DETERMINATION DE LA DATE DE CONSTRUCTION DE DEUX EDIFICES ET CELLE DES MODIFICATIONS APPORTEES A LEUR STRUCTURE, PAR L'APPLICATION DE TECHNIQUES DE DENDROCHRONOLOGIE BASEES SUR L'ANNEE DE REFERENCE

Herman J. Heikkenen et Mark R. Edwards

La lecture des couches de croissance qui se sont formées sur le bois utilisé pour construire la charpente de monuments historiques est un moyen efficace d'établir la datation de la construction. En faisant des recherches archéologiques et historiques, on obtient parfois des dates différentes; en ce cas on pourra en appliquant des techniques de dendrochronologie basées sur l'année de référence déterminer l'année de construction ainsi que l'authenticité des structures en bois de charpente.

La technique de l'année de référence est basée sur des échantillons de bois prélevés sur des arbres vivants ou morts ou sur le bois de construction.

La largeur relative des couches de croissance (LRC) de tous les arbres servant d'échantillons est exprimée en pourcentage de la LRC coïncidant pour une année donnée. Donc, chaque année de croissance est exprimée par le symbole +, -, ou 0, par rapport à l'année précédente. Au moyen de formules mathématiques, on peut analyser les données en se basant sur les espèces de bois comparables, les régions géographiques et les dates.

Pour chaque région, il est important de connaître les différences climatiques ainsi que les événements historiques qui ont pu influer sur les conditions. Par conséquent, il est nécessaire de mettre au point des "références" de la région par rapport auxquelles on peut comparer la croissance d'une forêt et les bois de charpente tirés de cette région.

On prélève alors des échantillons significatifs de l'édifice pour les comparer à l'année de référence de façon à déterminer la date de la construction.

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MARK R. EDWARDS is the Deputy State Historic Preservation Officer and Administrator of the Survey and Planning Services Branch of the Maryland Historical Trust. He received his B.A. in History from Lafayette College in 1974 and his M.S. in Historic Preservation from Columbia University in 1976. In addition to being a frequent contributor to historic preservation publications, Mr. Edwards has been involved with a number of organizations, including the Vernacular Architecture Forum, the Preservation Alumni of Columbia University and the Society for Industrial Archaeology.

CRITERES DE DATATION DES CHARPENTES "UNE EXPERIENCE DE DENDROCHRONOLOGIE REGIONALE"

Jean-Louis Taupin

FINALITE

La compréhension d'un bâtiment risque de rester très imparfaite si l'on ignore la date et les étapes de sa construction. Dans certains cas de bâtiments apparus dans le déroulement d'événements politiques par exemple, cette ignorance risque même d'entraîner une incompréhension totale.

Il n'est pas rare, même pour des bâtiments du XVIIIe siècle et davantage encore à mesure que le bâtiment est plus ancien, que des témoignages d'archives soient insaisissables ou inexistants.

Encore faut-il avoir présent à l'esprit que la lecture d'un texte peut ne pas conduire obligatoirement à un rattachement chronologique certain et détaillé. Or une datation progressive de groupes de bâtiments est nécessaire pour que nous puissions acquérir une vision claire de l'évolution architecturale, évolution repérable dans les modes techniques, dans les modes de conception de structures qui sont souvent la condition décisive d'une évolution dans la conception des formes et dans le sentiment esthétique.

Un exemple d'une incidence des modes de conceptions des structures sur la conception des formes, est donné en France, à l'articulation des XVe et XVIe siècles: c'est à cette époque que se dégagent, au delà des modèles du château médiéval, de grandes formes architecturales qui seront bientôt disciplinées et soumises à une réflexion que stimulera et fortifiera l'exemple des théoriciens novateurs de la Renaissance italienne.

Lors des mutations intervenues dans la composition des châteaux, c'est à un haut degré de cohérence et de nécessité que s'associent la constitution structurelle des charpentes d'une part, et d'autre part la volumétrie des toitures si déterminante sur la composition esthétique des édifices.

Une formule originale de composition du château français est ainsi sortie entre les XVe et XVIe siècles de cette inter-fécondation.

CRITERES DE DATATION

Quels sont les moyens, méthodes ou critères permettant d'établir des datations?

1) Il est évident qu'on ne peut déduire ici les datations en partant du critère des configurations de forme ou de structure comme c'est trop souvent, faute de mieux, l'habitude, puisque c'est précisément l'inverse que l'on attend.

2) On connait les limites des précisions des procédés de datation par le carbone-14: pour un événement survenu aux alentours de l'année 1500, la marge de cette incertitude est de l'ordre de plus ou moins 65 ans.

3) En revanche l'incidence sur la croissance des arbres, de l'irrégularité annuelle des facteurs climatiques fournit théoriquement un repérage chronologique précis par rapport à un bois déjà daté et qui fait l'objet des études de la dendrochronologie.

Cette précision n'est en principe limitée que par une éventuelle disparition des couches superficielles des bois de construction ou par la méconnaissance du temps de stockage de ces bois avant la mise en oeuvre.

Or, il n'est pas rare de trouver sur l'ensemble du volume des bois et sur les milliers de pièces qui constituent une charpente de dimension moyenne, des zones où le bois est encore habillé des derniers cernes d'aubier contigus à l'écorce.

D'autre part, il semble bien d'après l'examen de certaines déformations des pièces et d'après des recoupements de documents, que les bois étaient souvent mis en oeuvre verts, ce que peuvent justifier deux observations pratiques:

a) le souci de tirer un meilleur rendement de l'outillage en travaillant un bois non encore durci;

b) l'intérêt de ne pas immobiliser pendant trop longtemps un capital important représenté par 100 ou 200 tonnes de bois.

De plus en plus grande est la difficulté présentée par la mise en corrélation de manière certaine des diagrammes de deux échantillons à mesure qu'augmente la distance géographique de leur point de provenance.

Selon une démonstration faite par M. Hollstein pour le chêne d'Europe Centrale,[1] la valeur moyenne du coefficient de coïncidence passe de 0,7 pour une distance de 100 km séparant deux échantillons de chêne, à 0,55 environ pour une distance de 600 km, valeur donc déjà très proche du coefficient de 0,5 correspondant à une corrélation nulle. Cet avertissement est à prendre d'autant plus au sérieux que le configuration géographique de l'Europe, domaine de notre activité, divise celle-ci en une grande variété de climats locaux.

PREPARATION D'UNE COURBE DE REFERENCE

Les problèmes de la dendrochronologie relative, les problèmes de la dendrochronologie absolue sont très différents. On peut comparer l'une à l'autre avec sécurité à très peu d'années près, des pièces de bois d'une construction néolithique immergées depuis trois millénaires, sans avoir la possibilité de leur donner un calage précis dans le temps.

La dendrochronologie absolue, elle, exige l'existence préalable d'une courbe de référence continue, précise et indiscutable. On ne peut pas espérer obtenir la constitution même d'une courbe de référence seulement par la juxtaposition de diagrammes élémentaires issus de pièces de bois strictement datées par une documentation historique certaine.

Il faut mettre en série des échantillons différents, raccordés les uns aux autres par chevauchement, suffisamment nombreux pour reconstituer la séquence chronologique, chacun apportant un témoignage sur 20 à 200 ans, 300 ans environ. (40 ans peuvent donner environ 10 cm d'accroissement de bois de chêne.) Chaque nouvel échantillon nécessite pour sa mise en corrélation une discussion de probabilité particulière.

Cette entreprise nécessite donc l'enregistrement de nombreuses et délicates mesures qui doivent répondre aux trois impératifs suivants:

1) concerner des échantillons d'une même essence et répartis d'une manière continue sur une période de temps étendue (du XXe au XIIIe siècles au moins, par exemple);

2) être constituées d'échantillons recouvrant ensemble plusieurs fois les décennies réunies dans ce laps de temps:

3) être composées d'échantillons issus du même bassin climatique.

L'incidence de ce dernier facteur (l'homogénéité de provenance géographique), encore qu'elle soit difficilement estimable avec précision, étant, on l'a vu, d'une importance essentielle.

Les chercheurs allemands ont établi, pour le chêne, des éléments de référence propres à trois bassins climatiques: la Bavière, l'Allemagne du Nord, et la Rhénanie (application à l'expertise de la tour Nord-Ouest de la cathédrale de Trèves notamment).

Plusieurs courbes ont été établies en Grande Bretagne pour des contextes géographiques particuliers. Des recherches ont été conduites en Irlande, au Danemark, en Suisse.....

Pour les raisons signalées plus haut, on ne peut considérer que ces courbes soient directement utilisables pour des édifices situés dans le centre, l'ouest ou le sud de la France.

Comme il ne semblait pas qu'en 1978 des documents de références réellement fiables aient été collationnés pour des régions climatiques françaises déterminées, nous avons mis à profit une succession de chantiers de restauration de charpentes de "Monuments historiques localisés dans le centre est de la France" pour récolter des échantillons assortis des observations d'identification indispensables, de manière à rendre possible la préparation progressive des tronçons de courbe de référence propres à cette région, et aussi pour augmenter les chances d'établir de manière fiable une éventuelle corrélation avec les courbes allemandes déjà existantes.

Depuis 1978, les prélévements faits ont été régulièrement communiqués au Centre technique du Bois à Paris où Madame Yvonne Trenard a entrepris une campagne d'étude sur ce sujet. La plupart concernent des pièces de chêne. Les mesures ont été faites par ce laboratoire et enregistrées automatiquement sur cassette, puis le traitement statistique des mesures exécuté par ordinateur. Des essais de calage chronologiques ont été commencés par Mme Trenard avec toute la prudence qui s'impose, par une mise en corrélation avec la courbe bavaroise. Plus récemment, une collaboration s'est nouée entre le Centre technique du Bois et le nouveau Laboratoire de dendrochronologie animé par Monsieur Lambert à la faculté des Sciences de Besançon, et une collaboration pourra s'étendre à des échanges avec le nouveau Laboratoire des Frères Orsel de Moudon en Suisse.

LOCALISATION

Les édifices d'où proviennent nos échantillons sont localisés dans les départements de la Loire, Saône et de l'Allier (illustration 1). Quoique leur contexte territorial (situation des bâtiments, massifs forestiers proches) s'étende dans une ellipse dont le plus grand diamètre est de 180 km, entre quatre vallées: l'Allier, la Loire, la Saône et le Rhône, et s'étage entre des altitudes de 250 à 600 m environ, il semble que la zone où se situent ces bâtiments puisse être raisonnablement considérée en première approximation comme homogène sur le plan climatique. Il est bien évident que même une grande proximité géographique ne peut écarter tout risque de singularités locales dues à une incidence pédologique, géologique ou hydrologique, par exemple.

ECHANTILLONS

Les échantillons de chêne rassemblés (140 environ) sont tous des tranches perpendiculaires au fil du bois: il a paru en effet préférable dans un premier temps d'investigations, d'effectuer des prélévements sur des pièces de rebut et sur toute la largeur de celles-ci, plutôt que de pratiquer des carottages. La nécessité bien évidente de limiter les prélévements à des pièces de rebut apporte un frein considérable à la constitution des collections. Il est évident en outre qu'une critique est à faire dans tous les cas pour situer chaque échantillon dans la vie du bâtiment en fonction des phases de construction et des réparations qui peuvent être relevées sur ceux-ci.

Quelques échantillons proviennent de chênes modernes. Les bâtiments, origines des échantillons anciens, sont à peu près tous des charpentes à chevrons porteurs couvrant des bâtiments rectangulaires. Il s'agit en particulier:

- de la charpente du Logis abbatial du Charlieu (Loire), supposée avoir été construite par les abbés de la Madeleine dans les années 1514 à 1527 (illustrations 2a et 2b);
- de la charpente de la croisée du transept de l'église prieurale d'Ambierle (Loire), construite entre 1450 et 1474 (la charpente du transept ayant pu faire l'objet d'une reconstruction au XVIIe siècle);
- une pièce issue de la chapelle située à l'est du transept nord de l'église prieurale d'Ambierle;
- des charpentes du Farinier et de la Tour de l'eau bénite et l'abbaye de Cluny (Saône-et-Loire);
- de la charpente de la Maison dite de Louis XI à Cusset près de Vichy (Allier);
- de la charpente du sanctuaire de l'église de Brou, qui est censée avoir été édifiée vers 1515 à 1522;
- une pièce issue du clocher de l'église de Sassenage (Isère);
- des planchers de la Manécanterie de Belley (Ain), supposément édifiée au XVIIIe siècle;
- et surtout d'un bâtiment situé dans la commune de La Pacaudière (Loire) et supposé daté de la fin du XVe siècle ou début du XVIe siècle (illustrations 3 et 4).

LE PETIT LOUVRE DE LA PACAUDIERE

Ce bâtiment est l'élément principal d'une petite bourgade créée pour assurer la fonction de relais sur la Route Royale du Bourbonnais à Lyon, devenue tronçon principal de ce qui a été jusqu'au XVIIe siècle le "Grand chemin de Paris à Lyon". L'usage de ce bâtiment, connu sous le nom de Petit Louvre, n'est pas identifié avec certitude, mais à en juger par sa décomposition en plusieurs grandes pièces identiques on pourrait lui attribuer une fonction d'hébergement. Certains détails d'ornementation font penser qu'il pourrait avoir été plus ou moins directement au service du Roi, relais de poste par exemple.

Des graffiti nombreux y ont été découverts, comportant des dates dont les plus anciennes jusqu'ici sont 1546, 1543, 1534, 150?, ...

Les travaux entrepris sur ce bâtiment ont consisté (1977-78) dans la consolidation de la charpente de très vaste dimension qui l'abrite: cette charpente très déformée est constituée de chevrons porteurs en chêne, longs de près de 15 m (illustration 5). Des échantillons ont été recueillis sur cette partie de la construction:

- échantillon (A), tronçon de sablière - 85 cernes, aubier complet de 17 ans;
- échantillons (B) - 96 cernes, 4 ans d'aubier;
- échantillon (C), tronçon de poinçon correspondant aux nombres les plus élevés de la numérotation de marquage de charpente - 41 cernes mais privé d'aubier.

Des prélèvements, extraits en des points déterminés de chacun d'eux, ont été soumis à une expertise de datation au carbone-14: Madame Delibrias, au Centre des faibles radioactivités de Gif-sur-Yvette, a déterminé trois fourchettes de datation - 1410 ± 65 ans, 1415 ± 65 ans et 1520 ± 65 ans - qui respectivement replacées dans l'étendue de chacun des échantillons, pouvaient donner à ceux-ci comme date d'abattage:
(A) de 1487 à 1631;
(B) de 1417 à 1558;
(C) de 1352 à 1491 + X + Y (illustration 6).

La mise en corrélation des observations de chronologie relative et des observations de chronologie absolue par datation carbone-14, faites sur ces échantillons (A), (B) et (C), donnent une fourchette de 1487 à 1591 plus (X) années d'aubier si on voulait définir la fourchette de datation pouvant également s'appliquer à ces trois pièces issues de la charpente.

Une autre tranche de travaux en 1981 a concerné les planchers hauts du premier étage dont il fallait renforcer la résistance. Durant cette seconde campagne, la nécessité d'élargir l'espace compris entre les nappes consécutives de solives, audessus des poutres afin de procéder au renforcement de ces dernières, a permis de collecter une centaine de rondelles d'un diamètre moyen de 15 cm. Parmi ces tranches une sur dix environ comporte un aubier complet, permettant d'espérer une datation absolue. Les aubiers des solives: un de 13 ans, deux de 19 ans, quatre de 20 ans, un de 22 ans, un de 24 ans, et un de 25 ans (soit de 13 à 25 ans).

La comparaison de ces échantillons de solives munies d'aubier avec la courbe allemande de Munich a été complétée par une comparaison avec la courbe allemande de Trèves. La procédure de comparaison consiste:

- à relever, à partir du diagramme des variations absolues des cernes de l'échantillon à étudier mesurées sur un rayon, la séquence des variations en croissance ou en stabilité ou en décroissance d'une année sur l'autre (on ne tient pas compte des dix premiers cernes de croissance correspondant à dix ans durant lesquels la sensibilité de l'arbre n'est pas significative);
- à effectuer toutes les mises en position possibles de chaque échantillon par rapport à un autre pris en référence, à évaluer un coefficient de validité propre à chacun de ces mises en coïncidence et à les classer par rapport à des valeurs seuils: 99,9%, 99%, 95%; ainsi par exemple la comparaison d'un échantillon Pacaudière de 128 cernes avec un tronçon de 399 ans de la courbe de Trèves, fait apparaître 17 possibilités au niveau 95%;
- à l'épreuve est complétée par une mise en corrélation visuelle des diagrammes.

On ne pouvait pas attendre évidemment que la mise en concordance se fasse régulièrement d'une manière bi-univoque et absolue. Souvent on ne peut que reconnaitre un certain degré de probabilité de cette concordance: il faut s'attendre à ce qu'à partir d'un certain niveau d'incertitude, plusieurs solutions de concordance concurrentes se présentent simultanément dont certaines ne pourront être éliminées que par recoupement avec des arguments chronologiques fournis par d'autres techniques.

Une première probabilité de mise en coïncidence correspondait à la date de 1633, à rejeter pour des raisons d'analyse historique et architecturale immédiates. A un second niveau de probabilité apparait d'une façon cohérente la date de 1484 sur sept solives; de 1485 sur une autre; de 1483 sur une autre; et enfin la date de 1478 sur la dernière.

On remarque que l'ensemble de ces dix solives peut être calé sans ambiguité en chronologie relative avec deux des trois prélévements antérieurs faits sur la charpente:

- la pièce (A) de charpente, antérieure de trois ans au sous-groupe de sept solives de 1484;
- le dernier cerne existant (quatrième année d'aubier) de la pièce (B) de charpente, se situant sept ans avant le sous-groupe de sept solives, c'est-à-dire en supposant la restitution d'un aubier de 13 à 25 ans, entre 1487 et 1499, avec probabilité 1494 (illustration 7).

Jusqu'à ce qu'une nouvelle vérification soit faite, il faut constater:
1) un accord entre l'expertise du carbone-14 de la pièce (B) de charpente et la datation par la courbe bavaroise: carbone-14 = 1487 à 1511, courbe bavaroise = 1489 à 1499 période 1494;

2) mais un léger désaccord entre l'expertise au carbone-14 de la pièce (A) de charpente et la datation par la courbe bavaroise: carbone-14 = 1487 à 1511, courbe bavaroise = 1481.

Une épreuve de confirmation de coïncidence est en cours sur la base de comparaison avec les 94 autres échantillons de solives ne comportant pas d'aubier. Le nombre important des échantillons de solives (avec ou sans aubier) permet un grand nombre d'expériences de mise en concordance et donne à espérer une vérification statistique intéressante.

La légère divergence relevée plus haut avec la datation carbone-14 de l'un des échantillons appellera une discussion qui devra peut-être porter sur la méthode carbone-14 elle-même: on pourrait par exemple se demander s'il n'y a pas migration de carbone entre les cernes durant les années de vie de l'arbre postérieures à la formation des cernes sur lesquels a été pratiquée l'expertise carbone-14

On doit aussi se rappeler que la concentration de carbone-14 dans l'atmosphère est sujette à fluctuations et que pour cette raison cette méthode expérimentale est elle-même à l'état de recherche et qu'on ressent actuellement le besoin de la recaler sur des observations dendrochronologiques. On peut aussi invoquer l'insertion tardive d'une pièce dans la charpente.

En supposant ainsi expliquée cette légère divergence avec la datation carbone-14, on serait tenté de conclure que le plancher du comble n'a pas pu être construit avant 1485 et que la charpente n'a pas pu être construite avant 1494 environ.

La charpente aurait-elle été construite après le plancher? Cela est d'autant moins improbable que les deux structures, quoique contiguës, sont totalement indépendantes, les tirants de sablières n'ayant par exemple aucun rapport avec les poutres maîtresses du plancher. On arrive là sur un problème d'organisation de chantier. Les bois de charpente, volumineux, ont pu fait l'objet d'un abattage spécial avec emploi presque immédiat. Les solives, échantillons plus courants, auraient été puisées dans des stocks ayant subi un séchage de près de huit ans.

CONTEXTE HISTORIQUE

Si une telle interprétation devait être retenue, elle se présenterait sous un éclairage historique intéressant que nous résumons en quelques mots.[2]

Les routes postales en France (illustration 8), et spécialement l'itinéraire concerné ici, ont été organisées dans la première moitié du XVe siècle à des fins d'exploitation commerciale privée par Jacques Coeur, ensuite par Louis XI organisateur du Corps des Chevaucheurs des Postes Royales. Louis XI s'était déjà fortement intéressé à l'itinéraire du sud-est qui mettait en relation la vallée de la Loire avec le Lyonnais, le Dauphiné et l'Italie (illustration 9).

A la mort de Louis XI, la Régence a été confiée, de 1483 à 1492 pendant la minorité de Charles VIII, à Pierre et Anne de Beaujeu (fille aînée de Louis XI née en 1462, morte en 1522). Les résidences et les possessions de ces princes dans le Bourbonnais et le Beaujolais, pouvaient désigner à leur intérêt la poursuite de l'équipement du Grand Chemin Royal, et la construction par exemple d'un établissement aux abords même de la traversée un peu difficile des monts de la Madeleine à La Pacaudière, aux portes du Forez.

A partir de 1494, l'existence des relais de cette route s'avérait d'autant plus utile que se développaient alors les expéditions françaises en Italie. Plus au sud, à St-Symphorien-de-Lay, on peut remarquer les armoiries du couple royal, Charles VIII et Anne de Bretagne, à la façade d'un bâtiment de relais connu sous le nom d'Auberge de la Tête Noire. Cela concerne donc la période 1483 à 1498.

C'est bien dans ces années et par cette route que les idées, les séductions et les artistes de la Renaissance italienne s'introduisirent en France: on a pu avancer que la galerie appelée Pavillon d'Anne de Beaujeu, construite en 1498 par les de Beaujeu dans leur palais de Moulins, était la première expression en France de l'architecture de la Renaissance.

CONCLUSIONS

Lorsque des vérifications correspondant aux exigences de rigueur que s'impose Mme Trenard dans le développement de son travail, seront acquises, l'enchaînement de la courbe de référence pourra être poursuivi par des corrélations avec les autres échantillons recueillis dans la région.

Il sera dès lors possible, ayant fait un "lissage" des données recueillies par une simple moyenne arithmétique, de présenter un tronçon de courbe de référence acceptable pour une zone recoupant l'extrême sud de la Bourgogne, l'extrême nord de la région Rhône-Alpes et la partie orientale de la moyenne vallée de la Loire.

Il n'est évidemment pas possible encore de mesurer si une plus grande ressemblance relie cette courbe à la courbe de référence de Bavière ou à la courbe de référence de Rhénanie: un travail de comparaison s'étendant à des époques plus proches de nous serait nécessaire pour cela.

REFERENCES

1. cf. fascicule de la Société Linnéenne de Lyon, No. 6, juin 1976, Note de dendrochronologie sur le chêne antique de d'Eyzin-Pinet (Isère) par E. Hollstein et G. Chapotat.
2. Le connétable de Bourbon, né en 1490 et mort en 1527, dont on a prétendu que le Petit Louvre était un rendez-vous de chasse, n'a guère pu intervenir dans sa construction!

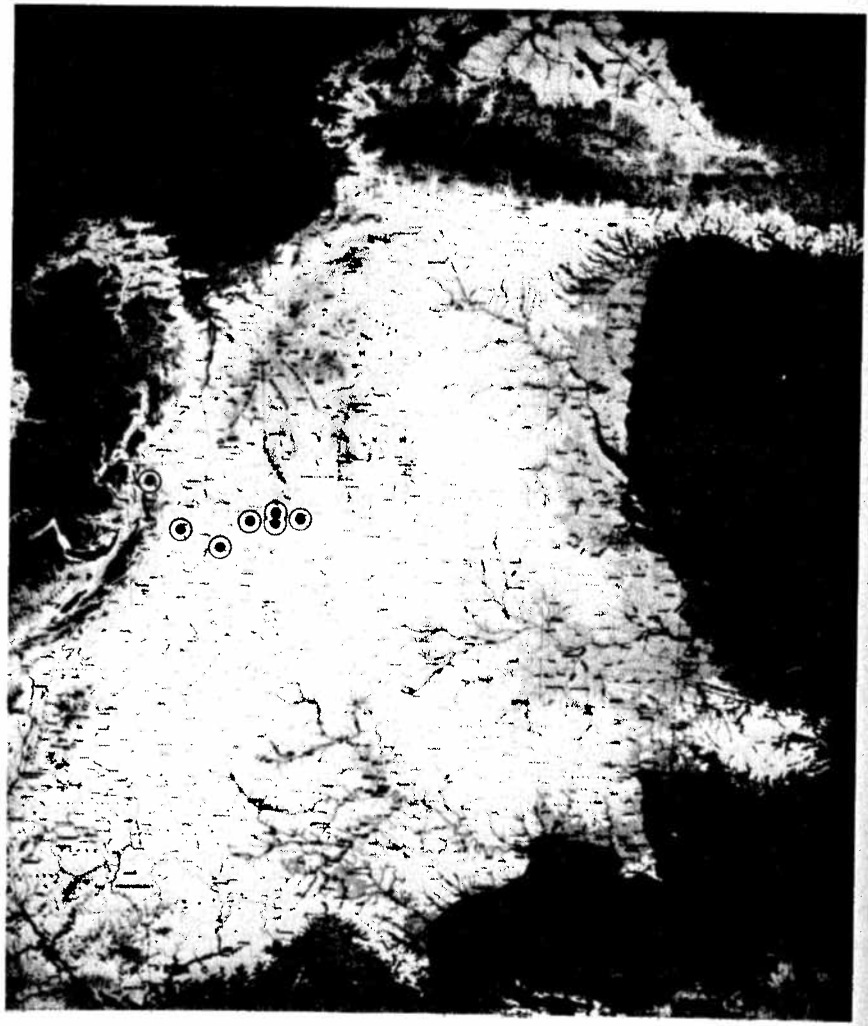

Fig. 1. Les édifices d'où proviement nos échantillons sont localisés dans les départements de la Loire, Saône et Loire, de l'Allier.

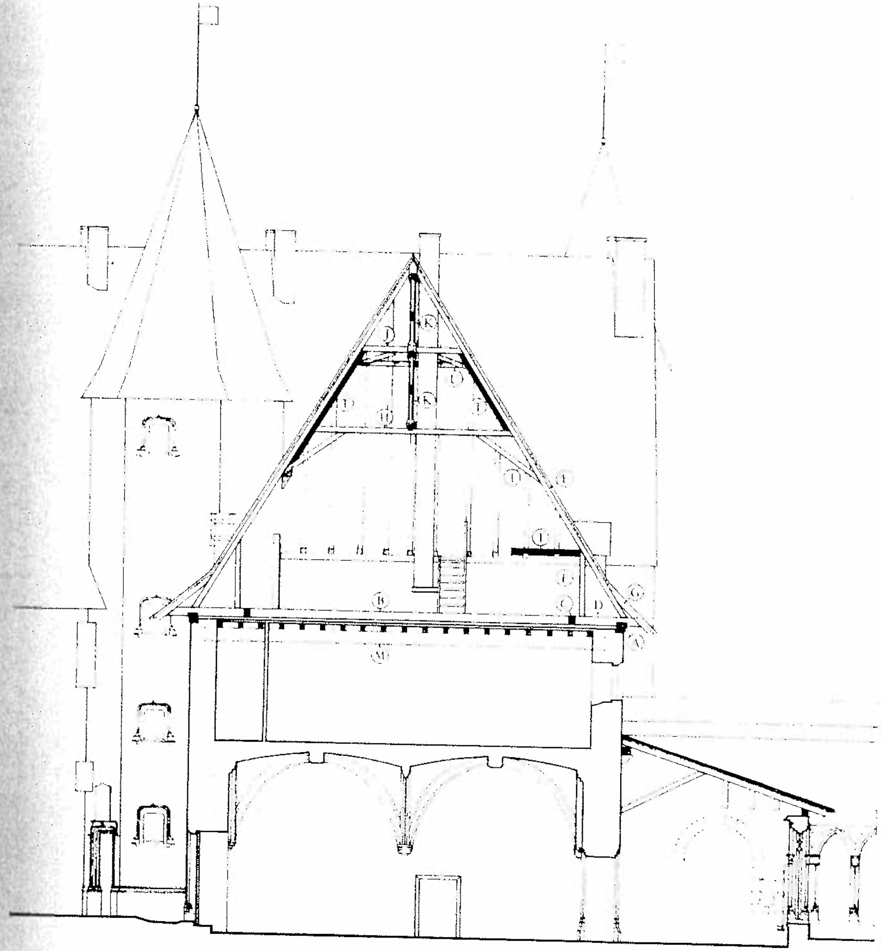

Fig. 2a. Coupe transversalle, relevé Jean-Louis Logis Abbatial, Charlieu (Loire) Taupin, Architecte en chef des Monuments Historiques.

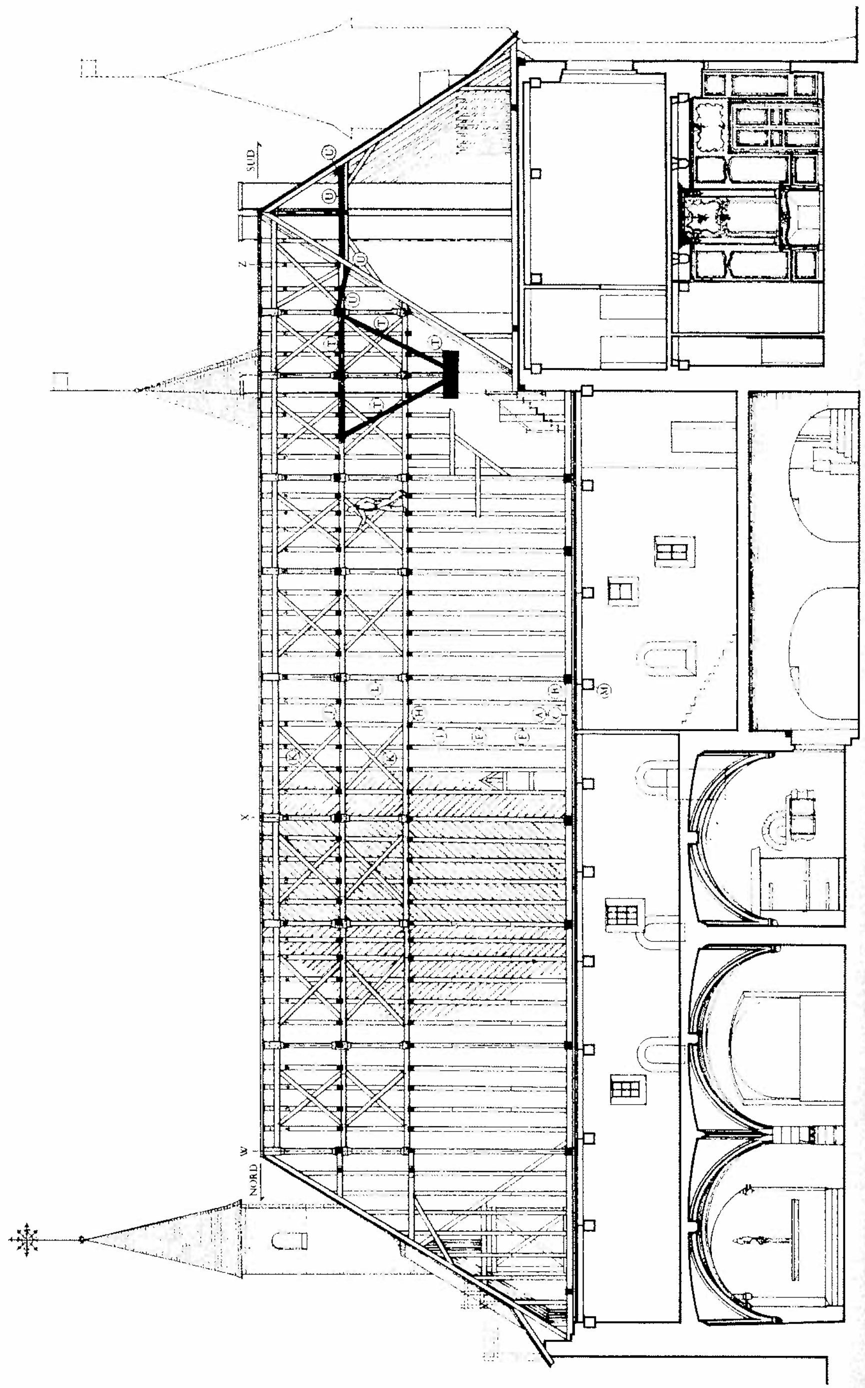

Fig. 2b. Coupe longitudinale relevé. Jean-Louis Taupin, Architecte en chef des Monuments Historiques.

Fig. 3.

Fig. 4. La Pacaudière — le Petit Louvre, marques originelles de montage.

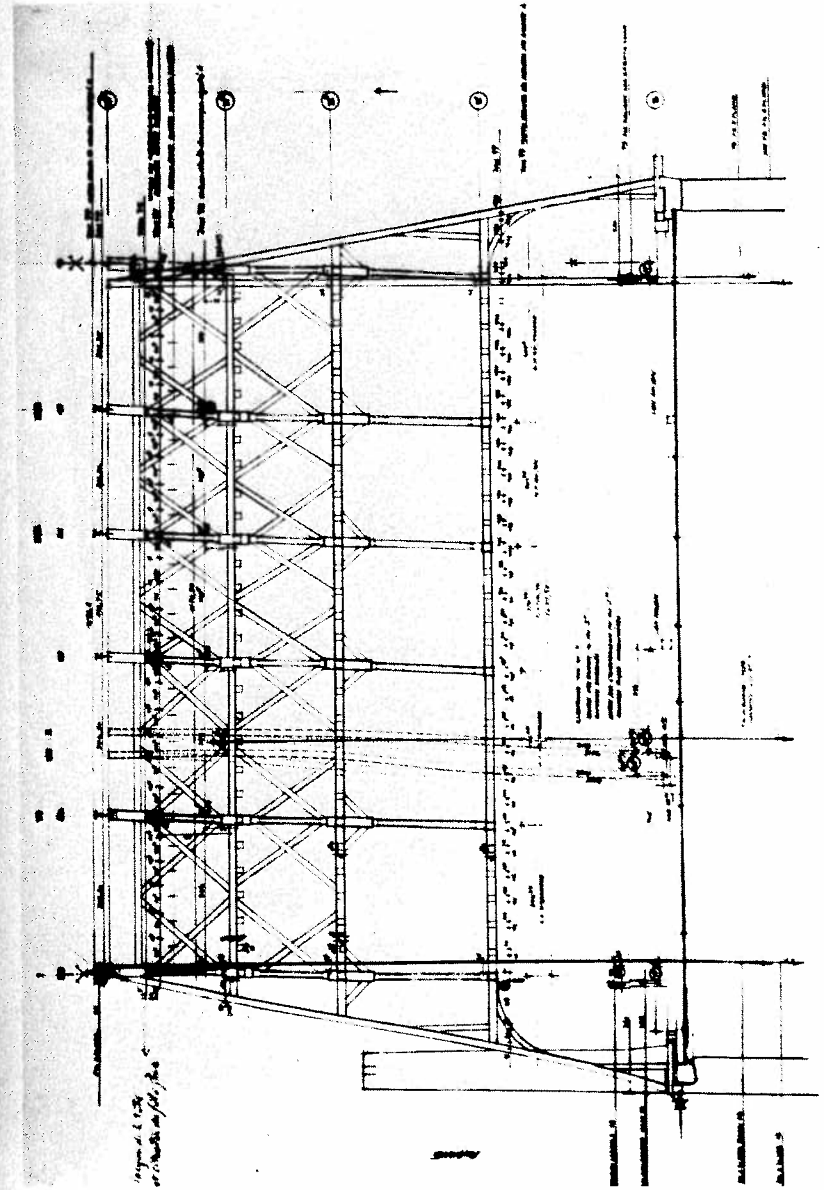

Fig. 5. La Pacaudière — Maison du Petit Louvre, coupe longitudinale sur la charpente. Relevé J.L. Taupin, Architecte en Chef, Monuments Historiques.

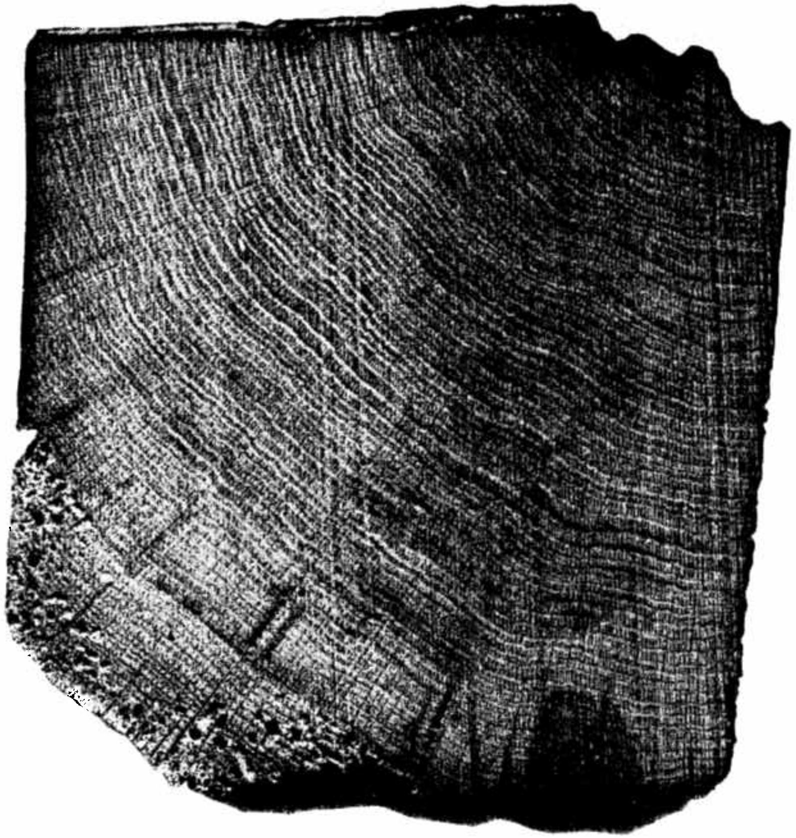

Fig. 6.

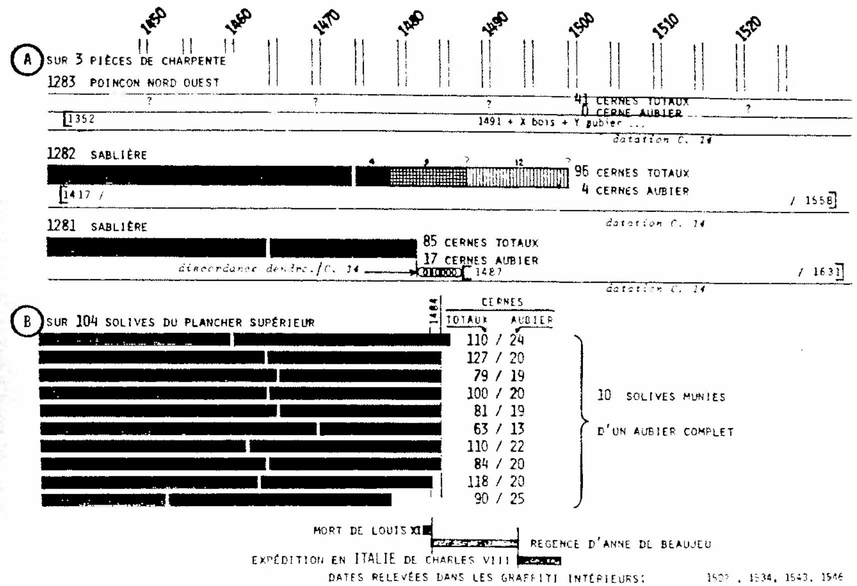

Fig. 7.

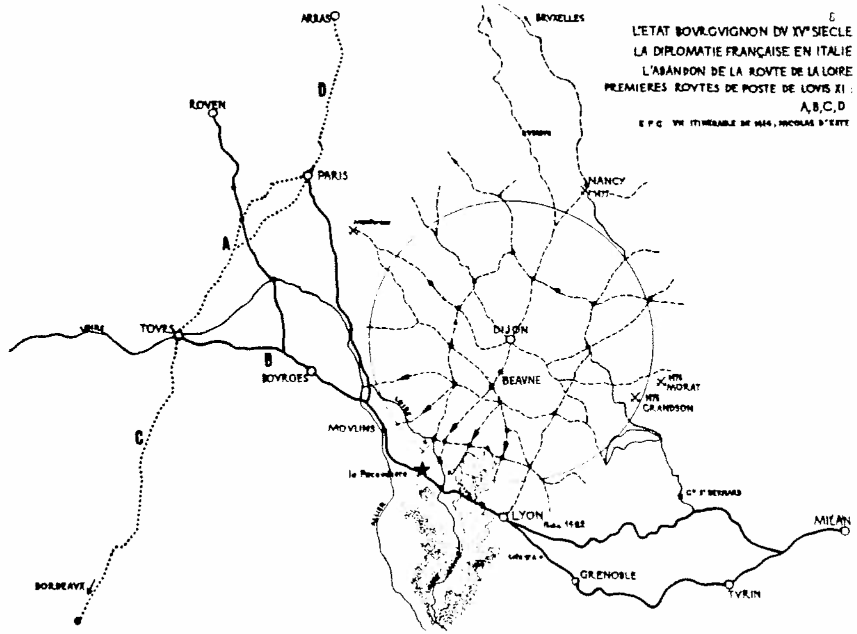

Fig. 8.

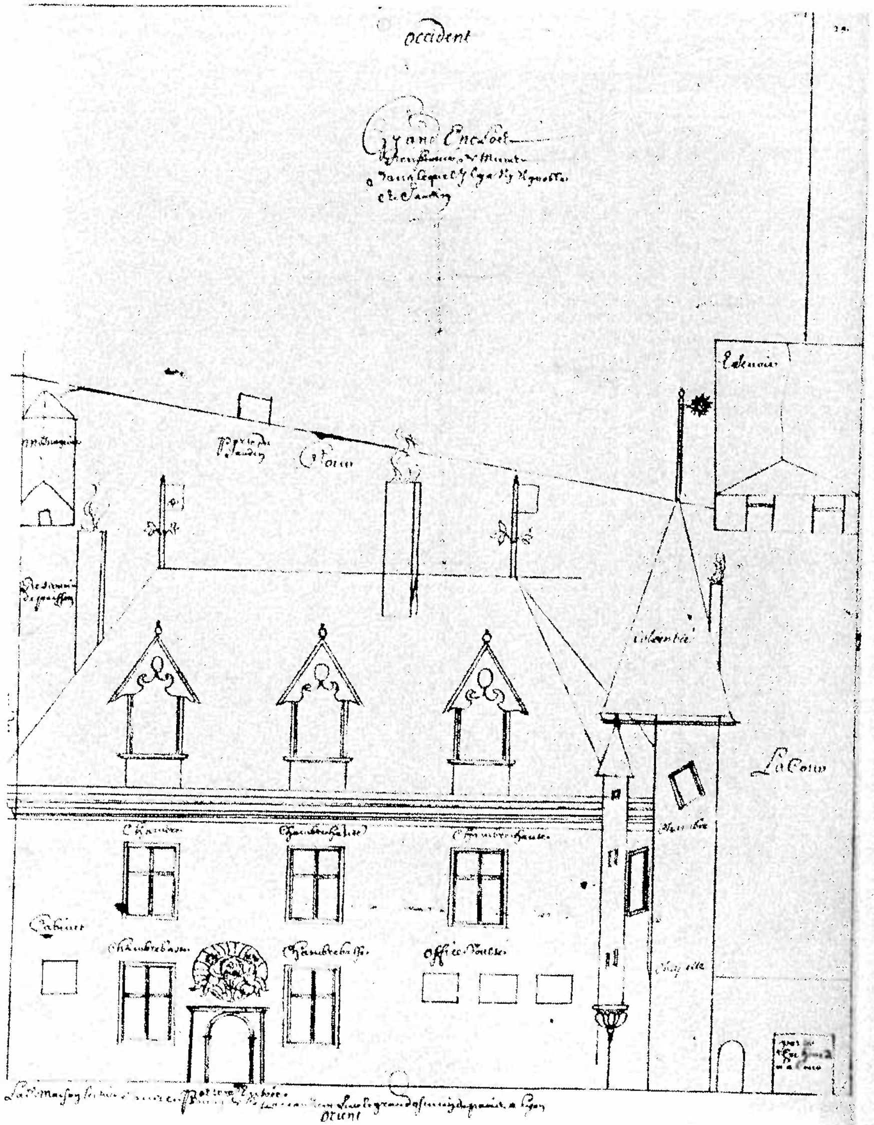

Fig. 9. "Maison située dans le bourg de la Pacaudière sur le grand chemin de Paris à Lyon". Collection de la Bibliothèque Nationale, Detailleurs fonds Gaignière.

ABSTRACT

AN EXPERIENCE WITH REGIONAL DENDROCHRONOLOGY

Jean-Louis Taupin

Construction dates are an indispensable requirement for a good understanding of our architectural heritage. One can only understand the evolution of technology and aesthetics within a chronological framework. Written documents, if they exist and if they are found, are not always sufficient. On the other hand, one can read within carpentry framing timber (oak, in this case), the irregularities caused by climate on the growth of a tree and compare these irregularities with wood of a known date. With this comparison, a precise age-guide is obtained. A dendrochronological date to within a few years is theoretically possible, if:
1) one finds, in the frame of the original structure, a piece of wood with its bark intact, which would indicate the year it was felled;
2) one knows the reference graphs for the climatic region in question.

In Europe, reference graphs have been established for different regions in Germany, Great Britain and Switzerland; but one cannot use them very well in certain regions of France. We have therefore undertaken to assemble the necessary elements to constitute a specific graph, useful for restoration projects in the eastern-central region of France (a 180 km diameter zone that covers part of the valleys of Allier, the Loire, the Saône and the Rhône). Since 1978, we have systematically taken wood slices for study, in collaboration with the Technical Centre for Wood. Our best developed observations have been applied to a building supposedly from the 16th century: the Petit Louvre at La Pacaudière, found on the Grand Chemin Royal between Paris and Lyon.

These samples were analyzed and compared among themselves, and also evaluated for the level of corresponding correlation by superimposing them on German growth graphs of Munich and Trèves. The results were cross-checked with chronological information supplied by other techniques.

It is interesting to consider these evaluations in relation to certain historic events of particular interest to this region:
- the date the trees used in the floors were cut - 1485 - gives the base of a date range, while graffiti in the building gives an upper date of 1534;
- the other part of the main highway going toward Lyon was started in the middle of the 15th century and was equipped for the needs of the royal court of Louis XI and his successors. Starting in 1494, this highway served to move troops to Italy and acted as a conduit for Italian culture into France.

JEAN-LOUS TAUPIN est architecte en chef des Monuments Historiques en France. Il est architecte diplômé d'Etat et membre de la Société (section française) des Urbanistes de l'Association internationale des urbanistes. M. Taupin est aussi membre correspondant du Comité international de bois de l'ICOMOS.

A SURVEY OF THE WOOD PRESERVATIVE INDUSTRY IN CANADA

Gail Sussman 22415

The two main industrial processes for wood preservation in Canada are pressure treatment and the application of liquid preservatives in situ.

In 1910, the first pressure treatment vessel was developed at Dominion Mills, Vancouver, British Columbia, for wood paving blocks. The process was extended to utility poles, fenceposts, pilings and timber. Today, there are 60 treatment plants in Canada, owned by three major companies: Domtar Incorporated (10), Koppers-Hickson Canada Ltd. (34), and Timber Specialties Limited (16). In recent years, new technology has produced waterborne salt preservatives which are replacing creosote and pentachlorophenol. Other trends in the industry are: the demand for railway ties is down, the demand for utility poles remains stable, and there is an increased demand for preserved wood foundations and fire-retardant shingles and shakes.

Capital costs for a new pressure treatment plant, with a cylinder 50' by 6', averaged $700,000 in 1981.

PRESSURE TREATMENT PROCESSES

Prior to pressure treatment, the bark is carefully removed from the logs, leaving as much sapwood as possible. The sapwood absorbs preservatives more readily than heartwood. Next the wood is either kiln-dried or seasoned (air-dried) for four to ten months. Drying produces a lighter, stronger wood, more resistant to decay and which also absorbs preservatives more easily.

Some species of spruce, Douglas fir and hemlock are difficult to treat. Five weeks of **ponding** more than doubles the penetration capacity of spruce.

Steam treatment at 115° C changes the cell composition of wood and increases permeability. This method is useful for jack, red and lodgepole pines.

Incising, puncturing the wood surface with shallow slits, results in uniform penetration. Heavy timbers, bridge and mine ties, marine piles and lumber for foundations are treated in this manner.

The Boulton process was developed for green wood and Douglas fir. The wood is heated to 85° to 95° C, and creosote or pentachlorophenol is forced under pressure into the wood.

The Bethell process is a full-cell process which injects as much preservative as possible into the wood. In a vacuum chamber, most of the air is removed from the cell lumens. Preservatives are forced into the wood under pressure until the level of absorption is reached. The surface is vacuum-dried.

Empty-cell methods (Lowry, at atmospheric pressure; and Rueping, at high pressure) do not obtain as deep a penetration. The preservative is applied under pressure and the surface is vacuum-dried. Some of the preservative is drawn out of the wood. Railway ties, utility poles, lumber and plywood are treated by empty-cell methods.

TYPES OF PRESERVATIVES

Oilborne Preservatives

Creosote (distilled tar mixed with 50% petroleum) is mainly used for railway ties and utility poles. Wood treated with creosote cannot be painted and should not come in contact with sources of food or should not be used where a fire might occur.

Pentachlorophenol often contains dioxin contaminants. It has been banned for interior use in Canada and is being replaced by chromated copper arsenate.

Waterborne Preservatives

Standard waterborne preservative solutions are:
- CCA (chromated copper arsenate);
- ACA (ammoniacal copper arsenate);
- FCAP (fluorchrome arsenate phenol);
- CZC (chromated zinc chloride);
- CuCZA (copperized chromated zinc arsenate);
- ACC (acid copper chromate).

Waterborne preservatives have little odour, are resistant to leaching and are low-cost. However, waterborne preservatives containing chlorides, sulphates, sodium or potassium can conduct electricity, thus giving rise to the transport of moisture and to metal corrosion problems.

FIRE-RETARDANTS

Pressure treatment plants have the capacity to treat wood with both preservatives and fire-retardants, using the full-cell process. Chemicals used for fire-retardation are mono-ammonium and di-ammonium phosphate, ammonium sulphate, zinc chloride, and bora and boric acid. Treatment with fire-retardants can cause some problems. Inorganic salts can increase the moisture content of wood, which causes a reduction in strength. The stress capacity is reduced and gluing properties degraded. Also, ammonium phosphate and zinc chloride corrode metals. Fire-retardants are water-soluble and tend to leach, unless the wood is painted.

PRESERVED WOOD FOUNDATIONS

In Canada, the demand for pressure-treated lumber for foundations is increasing. Preserved-wood foundations have many advantages:
1. they can be assembled in one-sixth the time of poured concrete;
2. specialized workers are not required;
3. they can be installed on steep and remote locations; and
4. they are dry and easy to heat.

On the other hand, international trade in pressure-treated lumber has been low for a number of reasons:
1. concrete and steel are substituted;
2. transportation costs are high;
3. tenders specify species which grow in the United States or Scandinavia;
4. there is insufficient excess to supply the international field; and
5. there is a need for a network of agents to promote pressure-treated lumber.

IN SITU PRESERVATIVES

Wood preservatives for in situ application, using a brush, are generally sold in hardware and paint stores across the country. In comparison to pressure treatment, brush application is relatively ineffective. The depth of penetration is minimal. This type of preservative usually leaches readily and must be applied frequently.

Orthophenylphenol has been used with apparent success in a number of in situ treatments on historic buildings (Weaver, 1979). In these cases, Dowicide 1 has been purchased in bulk from sales agents who carry Dow Chemical Corp. products. This chemical is not generally available over the counter in hardware stores or from building supply companies.

SUPPLIERS OF WOOD PRESERVATIVE EQUIPMENT

Donson Engineering Ltd.,
Sherbrooke Towers,
347 Sherbrooke Street,
North Bay, ONTARIO
CANADA P1B 2C1
Tel: (705) 474-4759

Iroquois Chemicals Ltd.,
Second Street West,
Box 399,
Cornwall, ONTARIO
CANADA K6H 5T1
Tel: (613) 932-8960

Koppers-Hickson Canada Ltd.,
Suite 203, Plaza 1,
2000 Argentia Road,
Mississauga, ONTARIO
CANADA L5N 1P7
Tel: (416) 826-9648

McCall Chemical Co. of Canada Ltd.,
615 - 7th Avenue, Suite 102,
New Westminster, BRITISH COLUMBIA
CANADA
Tel: (604) 525-2603

Mineral Research & Development Corp.,
P.O. Box 31711,
4 Woodlawn Green, Suite 232,
Charlotte, NORTH CAROLINA
USA 28210
Tel: (704) 525-2771

Timber Specialties Ltd.,
1326 Johnston Road, Suite 202,
White Rock, BRITISH COLUMBIA
CANADA V4B 3Z2
Tel: (604) 536-2747

CANADIAN INSTITUTE OF TREATED WOOD, MEMBER PRESSURE-TREATING COMPANIES (WEST TO EAST)

Domtar Chemicals Group,
Wood Preserving Division,
6450 Roberts Street, Suite 450,
Burnaby, BRITISH COLUMBIA
CANADA V5G 4J8
Tel: (604) 299-8471

B.C. Clean Wood Preservers Ltd.,
9815 Robson Road,
Surrey, BRITISH COLUMBIA
CANADA V3V 2H9
Tel: (604) 585-2511

Pacific Wood Preservation Services Ltd.,
9697 - 190th Street,
R.R. #4,
Surrey, BRITISH COLUMBIA
CANADA V3T 4W2
Tel: (604) 888-5433

Rocky Wood Preservers Ltd.,
P.O. Box 1537,
Rocky Mountain House, ALBERTA
CANADA TOM 1TO
Tel: (403) 845-2212

Domtar Chemicals Group,
Wood Preserving Division,
501 - 18th Avenue SW,
Calgary, ALBERTA
CANADA T2S 0C7
Tel: (403) 262-1166

Domtar Chemicals Group,
Wood Preserving Division,
4439 - 127th Avenue,
Edmonton, ALBERTA
CANADA T5A 2K5
Tel: (403) 476-1381

Koppers International Canada Ltd.,
Highway 833 North,
P.O. Box 1876,
Camrose, ALBERTA
CANADA T4V 1X8
Tel: (403) 672-7705

Bay Wood Processing Ltd.,
P.O. Box 3170, Station P,
Thunder Bay, ONTARIO
CANADA P7B 5G6
Tel: (807) 344-8464

John A. Biewer (Canada) Ltd.,
P.O. Box 967,
Cambridge-Galt, ONTARIO
CANADA N1R 5X9
Tel: (519) 621-7701

Toronto Wood Treating,
Wallace Street,
P.O. Box 269
Acton, ONTARIO
CANADA L7J 2M4
Tel: (519) 853-0600

Goodfellow Lumber Ltd.,
5155 Highway 5,
P.O. Box 5001,
Burlington, ONTARIO
CANADA L7R 2Y8
Tel: (416) 335-5800

Domtar Chemicals Group,
Wood Preserving Division,
1136 Matheson Boulevard,
Mississauga, ONTARIO
CANADA L4W 2V4
Tel: (416) 624-5551

TDL Woodtreating Ltd.,
7447 Bren Road,
Mississauga, ONTARIO
CANADA L4T 1H3
Tel: (416) 677-1281

Koppers International Canada Ltd.,
4 Eva Road, Etobicoke Square,
Etobicoke, ONTARIO
CANADA M9C 2B1
Tel: (416) 622-6880

Koppers International Canada Ltée.,
2525, boulevard Daniel-Johnson,
Bureau 350,
Laval, QUEBEC
CANADA H7T 1S8
Tel: (514) 687-5400

Groupe des produits chimiques Domtar,
Division de la préservation de bois,
395 ouest, boulevard de Maisonneuve,
C.P. 7212,
Montréal, QUEBEC
CANADA H3C 3M3
Tel: (514) 282-5571

Les industries de préservation de bois (1979) Ltée.,
9823, boulevard S-Laurent,
Montréal, QUEBEC
CANADA H3L 2N5
Tel: (514) 382-3010

Bois Goodfellow Ltée.,
101, rue Stinson,
St-Laurent, QUEBEC
CANADA H4N 2E4
Tel: (514) 748-6511

Bois Goodfellow Ltée.,
4247, rue du Ruisseau,
Cap-Rouge, QUEBEC
CANADA GOA 1KO
Tel: (514) 651-4745

Atlantic Pressure Treating Ltd.,
P.O. Box 10, Site 7,
R.R. #5,
Fredericton, NEW BRUNSWICK
CANADA E3B 4X6
Tel: (506) 455-7740

Bois Goodfellow Ltée.,
P.O. Box 617,
Bedford, NOVA SCOTIA
CANADA BON 1BO
Tel: (902) 835-3337

Domtar Chemicals Group,
Wood Preserving Division,
P.O. Box 278,
Truro, NOVA SCOTIA
CANADA B2N 5C1
Tel: (902) 893-9456

Marwood Ltd.,
P.O. Box 934,
Truro, NOVA SCOTIA
CANADA B2N 5G7
Tel: (902) 673-2508

Newfoundland Hardwoods Ltd.,
Asphalt & Creosoting Division,
P.O. Box 40,
Clarenville, NEWFOUNDLAND
CANADA AOE 1JO
Tel: (709) 466-7941/3

PRESSURE TREATMENT PLANTS

Map Ref.	Ownership, Location & Rail Lines Serving	Pressure Treatments Available	Other Services
1	Koppers International Canada Ltd., Burnaby, BC BN, CN, CP, BC Hydro	Chromated copper arsenate (CCA), Creosote, Creosote-petroleum, Pentachlorophenol-petroleum	Framing & boring, Machine peeling, Custom planing, Resaving, Kiln drying
2	Domtar Chemicals Group, Wood Preserving Division, New Westminster, BC BN, CN, CP, BC Hydro	Ammoniacal copper arsenate (ACA), Creosote Creosote-petroleum, Pentachlorophenol-petroleum	Framing & boring, Machine peeling, Kiln drying
3	B.C. Clean Wood Preservers Ltd., Surrey, BC BN, CN, CP	Chromated copper arsenate (CCA), Fire-retardant (ULC-approved)	Framing & boring, Kiln drying, Staining, Remanufacturing
4	Pacific Wood Preservation Services Ltd., Surrey, BC CN	Chromated copper arsenate (CCA))	Kiln drying, Precision end trimming, Staining
5	Domtar Chemicals Group, Wood Preserving Division, Prince George, BC BCR, CN	Pentachlorophenol-petroleum	Framing & boring, Machine peeling
6	Rocky Wood Preservers Ltd., Rocky Mountain House, ALTA CN, CP	Chromated copper arsenate (CCA), Pentachlorophenol-petroleum	Framing & boring, Machine peeling, Planing, Resawing, Kiln drying, Sawmills

Map Ref.	Ownership, Location & Rail Lines Serving	Pressure Treatments Available	Other Services
7	Domtar Chemicals Group, Wood Preserving Division, Cochrane, ALTA CP	Creosote, Creosote-petroleum, Pentachlorophenol-petroleum	Framing & boring
8	Domtar Chemicals Group, Wood Preserving Division, Edmonton, ALTA CN, CP, NAR	Creosote, Creosote-petroleum, Pentachlorophenol-petroleum	Framing & boring, Machine peeling
9	Koppers International Canada Ltd., Camrose, ALTA CN, CP, NAR	Chromated copper arsenate (CCA), Pentachlorophenol-petroleum	Framing & boring, Kiln drying
10	Bay Wood Processing Ltd., Camrose, ALTA CN, CP, NAR	Chromated copper arsenate (CCA)	Framing & boring, Planing, Resawing, Kiln drying, Sawmills
11	John A. Biewer (Canada) Ltd., Cambridge, ONT CP	Chromated copper arsenate (CCA), Fire-retardant (ULC-approved)	Framing & boring, Kiln drying, Prestaining
12	Toronto Wood Treating, Acton, ONT CN	Chromated copper arsenate (CCA)	Kiln drying
13	TDL Woodtreating Ltd., Mississauga, ONT	Chromated copper arsenate (CCA), Fire-retardant (ULC-approved)	Kiln drying
14	Domtar Chemicals Group, Wood Preserving Division, Trenton, ONT CN, CP	Creosote, Creosote-petroleum, Pentachlorophenol-petroleum	Framing & boring, Manufacture of wood flooring blocks
15	Nil		
16	Goodfellow Lumber Ltd., St-André-Est, QUE CN	Chromated copper arsenate (CCA), Pentachlorophenol-petroleum Fire-retardant (ULC-approved)	Framing & boring, Machine peeling, Planing, Resawing, Kiln drying, Timber sizing, Precision end trimming
17	Domtar Chemicals Group, Wood Preserving Division, Delson, QUE CN, CP	Ammoniacal copper arsenate (ACA), Creosote, Creosote-petroleum, Pentachlorophenol-petroleum	Framing & boring, Machine peeling, Planing, Resawing
18	Les industries de préservation du bois (1979) Ltée., Sorel, QUE CN	Creosote, Creosote-petroleum, Pentachlorophenol	Framing & boring, Machine peeling

Map Ref.	Ownership, Location & Rail Lines Serving	Pressure Treatments Available	Other Services
19	Atlantic Pressure Treating Ltd., Fredericton, NB	Chromated copper arsenate (CCA)	Machine peeling, Kiln drying
20	Domtar Chemicals Group, Wood Preserving Division, Newcastle, NB CN	Ammoniacal copper arsenate (ACA), Creosote, Creosote-petroleum, Pentachlorophenol-petroleum	Framing & boring, Machine peeling, Planing, Resawing
21	Domtar Chemicals Group, Wood Preserving Division, Truro, NS CN, DAR	Ammoniacal copper arsenate (ACA), Creosote, Creosote-petroleum, Pentachlorophenol-petroleum	Framing & boring, Machine peeling, Planing, Resawing, Kiln drying
22	Maritime Wood Preservers Ltd., Upper Stewiacke, NS	Chromated copper arsenate (CCA)	Framing & boring, Planing, Resawing, Kiln drying, Timber sizing
23	Newfoundland Hardwoods Ltd., Clarenville, NFLD CN	Creosote, Pentachlorophenol-petroleum	Supply of liquid asphalts

CANADIAN PRESSURE TREATING PLANTS

British Columbia

Ainsworth Lumber Co. Ltd.,
P.O. Box 67,
100-Mile House, BC
CANADA VOK 2E0
Tel: (604) 395-2222, Telex: 048-8123

B.C. Clean Wood Preservers Ltd.,
9815 Robson Road,
Surrey, BC
CANADA V3V 2R9
Tel: (604) 585-4411, Telex: 04-351344

Bell Pole Co. Ltd.,
Lumby, BC
CANADA VOE 2G0
Tel: (604) 547-2131

Cranbrook Wood Preservers Ltd.,
1012 - 3rd Avenue,
Cranbrook, BC
CANADA
Tel: (604) 426-6364

Domtar Chemicals Ltd.,
Wood Preserving Division,
6450 Roberts Street, Suite 450,
Burnaby, BC
CANADA
Tel: (604) 299-8471, Telex: 04-356720
Plants at: New Westminster, Burnaby, and Prince George, BC

Falcon Wood Preservers Ltd.,
P.O. Box 1656,
Creston, BC
CANADA V0B 1G0
Tel: (604) 428-9265

Forintek Canada Corp.,
Western Forest Products Laboratory,
6620 NW Marine Drive,
Vancouver, BC
CANADA V6T 1X2
Tel: (604) 224-3221, Telex: 04-508552

Kootenay Wood Preservers Ltd.,
P.O. Box 127,
Cranbrook, BC
CANADA V1C 4H7
Tel: (604) 489-3491, Telex: 041-45213

The MacGillis & Gibbs Company (B.C.) Ltd.,
1077 - 56th Street, #116,
Delta, BC
CANADA V4L 2A2
Tel: (604) 943-0271, Telex: 043-55879

MacMillan Bloedel Ltd.,
Wood Preserving Division,
180 Ewen Avenue,
New Westminster, BC
CANADA V3L 4Y7
Tel: (604) 526-2427, Telex: 0451471

Mardis Logging Co. Ltd.,
P.O. Box 131,
Ta Ta Creek, BC
CANADA V0B 2H0
Tel: (604) 422-3493

Mica Dam Sawmills Ltd.,
P.O. Box 1740,
Revelstoke, BC
CANADA V0E 2S0

Pacific Wood Preservation
Services Ltd.,
9697 - 190th Street, R.R. #4,
Surrey, BC
CANADA V3T 4W2
Tel: (604) 888-5433

Prince George Wood Preserving Ltd.,
P.O. Box 159,
Prince George, BC
CANADA V2L 4S1
Tel: (604) 963-9628, Telex: 047-7560

Princeton Wood Preservers Ltd.,
P.O. Box 1269,
Princeton, BC
CANADA V0X 1W0
Tel: (604) 588-3024

Summit Wood Preservers Ltd.,
P.O. Box 10,
Westwold, BC
CANADA V0E 3B0
Tel: (604) 375-2336

Westcan Wood Preservers Ltd.,
P.O. Box 370,
Chilliwack, BC
CANADA V2P 6J4
Tel: (604) 794-3010, Telex: 04-361535

Alberta

Bell Pole Co. Ltd.,
6400 - 24th Street,
Calgary, ALTA
CANADA
Tel: (403) 279-4491

Branch Pole Co. Ltd.,
P.O. Box 789,
Edson, ALTA
CANADA
Tel: (403) 723-3603

Domtar Chemicals Ltd.,
Wood Preserving Division,
501 - 18th Avenue SW, 3rd Floor,
Calgary, ALTA
CANADA T2S 0C7
Tel: (403) 262-1166, Telex: 038-21772
Plants at: Cochrane, Edmonton, Camrose

Natal Forest Products Ltd.,
P.O. Box 149,
Coleman, ALTA
CANADA T0K 0M0
Tel: (403) 563-3555

Revelstoke Companies Ltd.,
P.O. Box 296,
Sundre, ALTA
CANADA T0M 1X0
Tel: (403) 638-3773

Rocky Wood Preservers Ltd.,
P.O. Box 1537,
Rocky Mountain House, ALTA
CANADA T0M 1T0
Tel: (403) 845-2212

Saskatchewan

B & B Wood Preservers Ltd.,
Box 1535,
Meadow Lake, SASK
CANADA S0M 1V0
Tel: (306) 236-6462

L & M Wood Preservers Ltd.,
P.O. Box 149,
Glaslyn, SASK
CANADA S0M 0Y0
Tel: (306) 342-2080

Langford and Son Wood Preservers,
Prince Albert, SASK
CANADA
Tel: (306) 763-5086

Lehner Wood Preservers,
2690 - 4th Avenue,
Prince Albert, SASK
CANADA
Tel: (306) 764-0996

Saskatchewan Forest Products Corp.,
101 First Avenue,
Prince Albert, SASK
CANADA S6V 2A5
Tel: (306) 764-4266

Summers Wood Preservers,
P.O. Box 88,
Christopher Lake, SASK
CANADA
Tel: (306) 982-2122

Manitoba

Prendiville Timber Preservers Co.,
165 Ryan Street,
Winnipeg, MAN
CANADA R2R 0N9
Tel: (204) 633-7238, Telex: 07-57286

Roblin Forest Products Ltd.,
P.O. Box 830,
Roblin, MAN
CANADA R0L 1P0
Tel: (204) 937-2239

Ontario

Abitibi-Price Lumber Ltd.,
P.O. Box 2990,
Thunder Bay, ONT
CANADA P7B 5G5
Tel: (807) 344-8451, Telex: 07-34570

Ajax Engineering Ltd.,
Acton, ONT
CANADA
Tel: (519) 853-2910

Bay Wood Processing Ltd.,
P.O. Box 3170, Station P,
Thunder Bay, ONT
CANADA P7B 5G6
Tel: (807) 344-8464, Telex: 073-4575

John A. Biewer (Canada) Ltd.,
P.O. Box 967
Cambridge-Galt, ONT
CANADA N1R 5X9
Tel: (519) 621-7701

Domtar Chemicals Ltd.,
Wood Preserving Division,
P.O. Box 460,
Trenton, ONT
CANADA K8V 5R6
Tel: (613) 392-5018

Forintek Canada Corp.,
Eastern Forest Products Laboratory,
800 Montreal Road,
Ottawa, ONT
CANADA
Tel: (613) 744-0963, Telex: 063-3606

Knox Timber Impregnation Ltd.,
P.O. Box 1180,
Kemptville, ONT
CANADA K0G 1J0
Tel: (613) 258-5901, Telex: 053-4804

G.W. Martin Lumber Ltd.,
P.O. Box 1146,
Kirkland Lake, ONT
CANADA P2N 3K4
Tel: (705) 567-5101, Telex: 06-62207

Ontario Pressure Treated Wood ltd.,
P.O. Box 280,
Bancroft, ONT
CANADA K0L 1C0
Tel: (613) 332-1511

Pamour Porcupine Mines Ltd.,
Schumacker, ONT
CANADA
Tel: (705) 267-1141

Ram Forest Products,
P.O. Box 809,
King City, ONT
CANADA
Tel: (614) 833-6111

TDL Woodtreating Ltd.,
7447 Bren,
Mississauga, ONT
CANADA L4T 1H3
Tel: (416) 677-1281

Toronto Wood Treating,
P.O. Box 269,
Acton, ONT
CANADA
Tel: (519) 853-0600

Trent Timber Treating Inc.,
P.O. Box 1766,
Peterborough, ONT
CANADA K9J 7X4
Tel: (705) 745-3223

Trilake Timber Co. Ltd.,
P.O. Box 361,
Kenora, ONT
CANADA
Tel: (807) 548-4333

Québec

Domtar Chemicals Ltd.,
Wood Preserving Division,
Sales Office, Eastern Canada,
395 ouest, boulevard de Maisonneuve,
Montréal, QUE
CANADA H3C 3M3
Tel: (514) 694-3430, Telex: 05821516

Goodfellow Lumber Sales Ltd.,
101, Stinson,
Montréal, QUE
CANADA H4N 2E4
Tel: (514) 748-6511
Plant at Lachute

Les industries de préservation
du bois,
9823, St-Laurent,
Montréal, QUE
CANADA
Tel: (514) 382-3010
Plant at Sorel

La société d'impregnation des bois
de la Maurice, Ltée.,
C.P. 1984,
Trois Rivières, QUE
CANADA G9A 4X0
Tel: (819) 373-5734

Traitement sous pression L.D. Ltée.,
458, St-Pierre,
St-Raymond,
Cté. Confe du Portneuf, QUE
CANADA G0A 4G0
Tel: (418) 337-2286

Wood Preservation Industries Ltd.,
2020 ouest, avenue de l'Université,
Montréal, QUE
CANADA H3A 2A5
Tel: (514) 843-7117,
(819) 373-5734, Telex: 05-25540

Domtar Chemicals ltd.,
Wood Preserving Division,
Newcastle, NB
CANADA
Tel: (506) 622-1303, Telex: 014-46129

New Brunswick

Atlantic Pressure Treating Ltd.,
P.O. Box 10, Site #7,
R.R. #5,
Fredericton, NB
CANADA E3B 4X6
Tel: (506) 455-7740,
(506) 368-3649, Telex: 014-46129
Plant at Tracy

Nova Scotia

Domtar Chemicals Ltd.,
Wood Preserving Division,
Truro, NS
CANADA
Tel: (902) 893-9456

Maritime Wood Preservers Ltd.,
P.O. Box 934,
Truro, NS
CANADA B2N 5G7
Tel: (902) 673-2508
Plant at Upper Stewiacke

Newfoundland

Newfoundland Hardwoods Ltd.,
Asphalt and Coating Division,
P.O. Box 40,
Clarenville, NFLD
CANADA A0E 1J0
Tel: (709) 466-7941, Telex: 0164151

SOURCES OF LITERATURE BROCHURES

Agriculture Canada,
Sir John Carling Building,
930 Carling Avenue,
Ottawa, ONTARIO
CANADA K1A 0C5

Canada Mortgage and Housing
Corporation,
National Office,
Montreal Road,
Ottawa, ONTARIO
CANADA K1A 0P7

National Research Council,
Division of Building Research,
Montreal Road,
Ottawa, ONTARIO
CANADA K1A 0R6

The following is a comprehensive list of the Canadian organizations which are connected to the wood preservative industry.

Alberta Forest Products Association,
11710 Kingsway Avenue, Suite 204,
Edmonton, ALBERTA
CANADA T5G 0X5
Tel: (403) 452-2841, 452-2673

Association de securité des
industriels forestiers
du Québec, Inc.
580 est, Grande-Allée, Suite 260,
Québec, QUEBEC
CANADA G1R 2K2
Tel: (418) 522-2791

Association de securité des
pâtes et papiers du Québec, Inc.,
580 est, Grande-Allée, Suite 550,
Québec, QUEBEC
CANADA G1R 2K2
Tel: (418) 522-1638

Association forestière
québecoise, Inc.,
915 ouest, St-Cyrille, Suite 210,
Québec, QUEBEC
CANADA G1S 1T8

Association of British Columbia
Professional Foresters,
837 West Hastings Street, Suite 406,
Vancouver, BRITISH COLUMBIA
CANADA V6C 1B6
Tel: (604) 687-8027

Association of Registered Professional
Foresters of New Brunswick,
500 Beaverbrook Court,
Fredericton, NEW BRUNSWICK
CANADA E3B 5X4
Tel: (506) 454-8435

British Columbia Independent
Logging Association,
3851 - 18th Avenue, Suite 106,
Prince George, BRITISH COLUMBIA
CANADA V2N 1B1
Tel: (604) 562-3368

Canadian Forestry Association,
185 Somerset Street West, Suite 203,
Ottawa, ONTARIO
CANADA K2P 0J2
Tel: (613) 232-1815

Canadian Forestry Association
of British Columbia,
1200 West Pender Street, Suite 410,
Vancouver, BRITISH COLUMBIA
CANADA V6E 2S9
Tel: (604) 683-7591

Canadian Forestry Association
of New Brunswick, Inc.
43 Brunswick Street,
Victoria Health Centre,
Fredericton, NEW BRUNSWICK
CANADA E3B 1G5
Tel: (506) 455-8372

Canadian Hardwood Plywood Association,
27 Goulbourn Avenue,
Ottawa, ONTARIO
CANADA K1N 8C7
Tel: (613) 233-6205

Canadian Institute of Forestry,
Macdonald College,
C.P. 5000,
Ste-Anne de Bellevue, QUEBEC
CANADA H9X 1C0
Tel: (514) 457-9131

Canadian Institute of
Timber Construction,
100 Bronson Avenue, Suite 702,
Ottawa, ONTARIO
CANADA K1R 6G8

Canadian Institute of Treated Wood,
75 Albert Street, Suite 506,
Ottawa, ONTARIO
CANADA K1P 6A4
Tel: (613) 234-9456

Canadian Lumber Standards
Administrative Board,
1055 West Hastings Street, Suite 1475,
Vancouver, BRITISH COLUMBIA
CANADA V6E 2E9
Tel: (604) 684-0211, ext. 285

Canadian Lumbermen's Association,
27 Goulbourn Avenue,
Ottawa, ONTARIO
CANADA K1N 8C7
Tel: (613) 233-6205

Canadian Paper Trade Association,
55 York Street, Suite 512,
Toronto, ONTARIO
CANADA M5J 1S2
Tel: (416) 363-8374

Canadian Paperworkers Union,
1155 ouest, rue Sherbrooke, Suite
1501,
Montréal, QUEBEC
CANADA H3B 2X9
Tel: (514) 866-6621

Canadian Standards Association,
178 Rexdale Boulevard,
Rexdale, ONTARIO
CANADA M9W 1R3
Tel: (415) 744-4000

Canadian Wood Council,
85 Albert Street, Suite 800,
Ottawa, ONTARIO
CANADA K1P 6A4
Tel: (613) 235-7221

Canadian Wood Preservation
Association,
6620 NW Marine Drive,
Vancouver, BRITISH COLUMBIA
CANADA V6T 1X2
Tel: (604) 224-3221

Cariboo Lumber Manufacturers'
Association,
197 North 2nd Avenue, Suite 301,
Wwilliams Lake, BRITISH COLUMBIA
CANADA V2G 1Z5
Tel: (604) 392-7778

Central Forest Products
Association, Inc.,
975 Corydon Avenue, Suite 14-G
Winnipeg, MANITOBA
CANADA R3P 0R1

Consumers Association of Canada,
200 First Avenue,
Ottawa, ONTARIO
CANADA K1S 5J3
Tel: (613) 238-4840

Council of Forest Industries
of British Columbia,
1055 West Hastings Street, Suite 1500,
Vancouver, BRITISH COLUMBIA
CANADA V6E 2H1
Tel: (604) 684-0211

Fédération des travailleurs
forestiers du Québec,
422 est, Racine,
Chicoutimi, QUEBEC
CANADA G7H 1T3
Tel: (418) 549-7353

Forest Products Accident
Prevention Association,
P.O. Box 270,
North Bay, ONTARIO
CANADA P1B 8H2
Tel: (705) 472-4120

Forintek Canada Corp.,
Eastern Forest Products Laboratory,
800 Montreal Road,
Ottawa, ONTARIO
CANADA
Tel: (613) 744-0963

Forintek Canada Corp.,
Western Forest Products Laboratory,
6620 NW Marine Drive,
Vancouver, BRITISH COLUMBIA
CANADA V6T 1X2
Tel: (604) 224-3221

Interior Lumber Manufacturers'
Association,
333 Martin Street, Suite 295,
Penticton, BRITISH COLUMBIA
CANADA V2A 5K7
Tel: (604) 492-5810

L'association des manufacturiers
de bois de sciage du Québec, Inc.,
(Québec Lumber Manufacturers'
Association),
3555 ouest, boulevard Hamel, Suite 200,
Québec, QUEBEC
CANADA G2E 2G6
Tel: (418) 872-5610

L'association des marchands de bois
en gros du Québec, Inc.,
(Québec Wholesale Lumber
Association, Inc.),
620, rue Cathcart, Suite 316
Montréal, QUEBEC
CANADA H3B 1M1
Tel: (514) 861-7149

L'association des mesureurs de bois
licenciés de la province de Québec,
291, Mgr. Prévost,
St-Eustache, QUEBEC
CANADA J7P 2L2
Tel: (514) 473-1546

The Lumber and Building Materials
Association of Ontario,
4500 Sheppard Avenue East, Unit F,
Scarborough, ONTARIO
CANADA M1S 3R6
Tel: (416) 298-1731

Manitoba Forestry Association Inc.,
900 Corydon Avenue,
Winnipeg, MANITOBA
CANADA R3M 0Y4
Tel: (204) 453-3182

New Brunswick Forest Products
Association, Inc.,
500 Beaverbrook Court,
Fredericton, NEW BRUNSWICK
CANADA E3B 5X4
Tel: (504) 455-0998

Newfoundland Forest Protection
Association,
Department of Forest Resources,
Confederation Building,
St. John's, NEWFOUNDLAND
CANADA A1C 5T7
Tel: (709) 737-3245

Nova Scotia Forest Products
Association,
P.O. Box 696,
Truro, NOVA SCOTIA
CANADA B2N 5E5
Tel: (902) 895-1179

Nova Scotia Forestry Association,
R.R. #1
Debert, NOVA SCOTIA
CANADA B0M 1G0
Tel: (902) 622-3193

Nova Scotia Woodlot Owners and
Operators Association,
P.O. Box 204,
Bridgewater, NOVA SCOTIA
CANADA B4V 2W8
Tel: (902) 543-8085

Office des producteurs de bois
de la région de Québec,
1787, boulevard Hamel,
Duberger, QUEBEC
CANADA G1N 3Z1
Tel: (418) 683-1781

Ontario Forest Industries Association,
130 Adelaide Street West, Suite 1700,
Toronto, ONTARIO
CANADA M5H 3P5
Tel: (416) 368-6188

Ontario Forestry Association,
150 Consumers Road, Suite 209,
Willowdale, ONTARIO
CANADA M2J 1P9
Tel: (416) 493-4565

The Ontario Professional Foresters
Association,
10271 Yonge Street, Suite 303,
Richmond Hill, ONTARIO
CANADA L4C 3B5

Pulp and Paper Industrial Relations
Bureau,
505 Burrard Street, 8th Floor,
Bentall One,
Vancouver, BRITISH COLUMBIA
CANADA V7X 1M4
Tel: (604) 683-8571

Québec Logging Safety Association,
(L'association de securité des
exploitations forestières
du Québec, Inc.),
580 est, Grande-Allée, Suite 550,
Québec, QUEBEC
CANADA G1R 2K2

Saskatchewan Forestry Association,
692 Cuelenaere Street,
Prince Albert, SASKATCHEWAN
CANADA S6V 2S9
Tel: (306) 763-2189

Western Retail Lumbermen's
Association,
228 Notre Dame Avenue, Suite 601,
Winnipeg, MANITOBA
CANADA R3B 1N7
Tel: (204) 958-1077

The Wholesale Lumber Dealers
Association, Inc.,
4195 Dundas Street West, Suite B-6,
Toronto, ONTARIO
CANADA M8X 1Y4
Tel: (416) 232-2042

Underwriters' Laboratories of Canada,
7 Crouse,
Toronto, ONTARIO
CANADA
Tel: (416) 757-3611

Companies Which Produce Wood Preservatives

Benjamin Moore & Co. Ltd., 15 Lloyd Ave., Toronto, Ont. M6N 1G9
Buckman Labs of Canada Ltd., 1600-50th Ave., Lachine, P.Q. H8T 2V5
Canadian Adhesives Ltd., 420 Marien Ave., Montreal East P.Q. H1B 4V6
C.I.L. ICI & Resale Chem., General Chem. Div., P.O. Box 200, Stn. A, Willowdale, Ont., M2N 5S8
Canadian Tire Corp. Ltd., ATTN: G. Leclerc, Box 770, Stn. K, Toronto, Ont. M4P 2V8
Century Paint & Wallpaper, 1514 Merivale Rd., Ottawa, Ont. K2G 3J6
Chapman Chemical Ltd., P.O. Box 9158, Memphis, TN 38109 USA
Cooperative Fédérée de Qué., 1055 Marché Central, Metropolitain, Montréal, Qué. P4N 1K3
Cuprinol Ltd., Adderwell, Frome, Somerset, England BA11 1N1
Currie Products Ltd., 350 Wentworth St. N., Hamilton, Ont., L8L 5H3
Deane & Co., Div. of Isbru Co. Ltd., 190 Oneida Dr., Pointe Claire, P.Q. H9R 1A8
Diachem Industries Ltd., 11420 Blacksmith Place, Richmond, B.C. V7A 4X1
Domtar Chemicals Ltd., Wood Preserving Div., 104 Doyon Ave., Pointe Claire-Dorval, P.Q. H9R 3T5
Domtar Construction Materials, P.O. Box 6138, Stn A., Montreal, P.Q. H3C 3K4
Dow Chemical of Canada Ltd., P.O. Box 1012, Modeland Rd., Sarnia, Ont. N7T 7K7
Drew Chemical Ltd., 1 Drew Court, Ajax, Ont. L1S 2E5
Dussek Bros. Canada Ltd., P.O. Box 385, Belleville, Ont. K8N 5A5
Dural Products Ltd., 550 Marshall Ave., Dorval, P.Q. H9P 1C9
Edoco Healey Technical Proc., 95-1st Ave. E., Vancouver, B.C., V5T 1A2
Ensign Industries Ltd., 33 Carlton St., P.O. Box 405, St. Catharines, Ont. L2R 6V9
Epoch Holdings Ltd., P.O. Box 269, Halton Hills, Acton, Ont. L7J 2M4
Flecto Coatings Ltd., 4260 Varguard Rd., Richmond, B.C. V6X 2P5
General Paint & Wall Cover., Div. of Reed Decorative Prod., 950 Raymur Ave., Vancouver, B.C. V6A 3L
Gibson-Homans of Canada Ltd., 101 de la Barre, Boucherville, P.Q. J4B 2X6
Groupe de Cies de Peintures, Sico et al, 41 ch. Bates, Montreal, P.Q. H2V 1A6
Solignum Inc., 200 Norelco Dr., Weston, Ont. M9L 1S4
Koppers-Hickson Canada Ltd., 2000 Argentia Rd., Plaza 1 Suite 203, Mississauga, Ont. L5N 1P9
Koppers Co. Inc., 2637 Koppers Bldg., Pittsburg, PA 15219 USA
Laten Chemicals Ltd., 12080 Horseshoe Way, Richmond, B.C. V7A 4V5
Société Chimique Laurentide, 4650-12ième Ave., C.P. 367, Shawinigan-Sud, P.Q. G9N 6V2
Lepage's Ltd., ATTN: J. Fernardez, 50 West Dr., Bramalea, Ont. L6T 2J4
W.R. Meadows of Canada Ltd., 130 Toryork Dr., Weston, Ont. M9L 1X6
Mineral Research & Develop., P.O. Box 31711, Charlotte, NC 28231 USA
Mulco Inc., 2433 Sir Wilfrid Laurier, St-Hubert, P.Q. J4T 3K3
Abitibi-Price Inc., Northern Wood Preservers Div., P.O. Box 2990, Thunder Bay, Ont. P7B 5G5
Nuodex Canada Ltd., 34 Industrial St., Toronto, Ont. M4G 1Y9
Olympic Stain, Civ. of Commerce Inc., 2233-112th Ave. N.E., Bellevue, WA 98004 USA
Osmose-Pentox Inc., 1080 Pratt Ave., Montreal, P.Q. H2V 2V2
Peinture Naticrale Ltée, 1556 boul. Hamel, Québec, P.Q. G1N 3Y6
Pole Sprayers of Can. Ltd., 980 Elliott St., Buffalo, NY 14209 USA

La Quinoleine S.A., 43, rue de Liege, Paris, France 75008
Recochem Inc., 850 Montée de Liesse Rd., Montreal, P.Q. H4T 1P4
Peichold Ltd., 50 Douglas St., P.O. Box 130, Port Moody, B.C. V3H 3L9
Roberts Co. Canada Ltd., 2070 Steels Rd., Bramalea, Ont. L6T 1A7
Frank T. Ross & Sons Ltd., Box 248, West Hill, Ont. M1E 4R5
Seymeur Chemicals Inc., 2201 Lakeside Dr., Bannockburn, Il. 60015 USA
Smith-Barregar Ltd., 3350 Bridgeway St., Vancouver, B.C. V5K 4X6
Stan Chem, 60 Tital Rd., Toronto, Ont. M8Z 2J8
Stauffer Chemical Co., 1200 S. 47th St., Richmond, CA 94804 USA
Sternson Ltd., 22 Mohawk St., P.O. Box 130, Brantford, Ont. N3T 5N1
Texas Refinery Corp. of Can., 25 Industrial St., Toronto, Ont. M4G 1Z2
Timber Specialties Ltd., 980 Elliott St., Buffalo, NY 14209 USA
Uniroyal Chemical, Div. of Uniroyal Ltd., Erb St., Elmira, Ont. N3B 3A3
Van Waters & Rogers Ltd., Agricultural Supply Dept., P.O. Box 2009, Vancouver, B.C. V6B 3R2
Thiokol/Ventron Div., 150 Andover St., Danvers, MA 01923 USA
Walker Brother Ltd., 5684 Beresford St., Burnaby, B.C. V5J 1J2
Weldwood of Canada Ltd., 1055 Hastings St. W., Vancouver, B.C. V6B 3V8

Active Ingredients in Wood Preservatives

Explanation of Coding System

Components	Titles
1. registration number	REGN
2. marketing type -see Definitions of Marketing Types Codes	MARK
3. registrant -see Definitions of Registrant and Applicant Codes	REGT
4. Canadian agent	AGNT
5. product name	NAME
6. formulation type	FORM
7. guaranteed (active) ingredient followed by the concentration of active. Where units (such as G/L - grams per litre, or IU/MG - international units per milligrams) are not entered, then the concentration is in percentage. Example: NPV 100 means 100% of n-pentyl valerate.	GUAR
8. product type -see Definitions of Product Type Codes	PRTP
9. host/location -see Definitions of Host/Location Codes	LOCN
10. method of application -a 3-letter code has been assigned -see Definitions of Method of Application Codes	APPN
11. metric status -a 1-letter code "M" was assigned to show that a product had completed a changeover from Imperial or U.S. measure; absence of the letter "M" may mean that the product was already in metric measure.	METR
12. registration status -various codes have been assigned	RENW

Definitions of Marketing Type Codes

CODE	MARKETING TYPE
D	domestic (house and garden)
C	commercial (agricultural, forestry, industrial)
R	restricted

Definition of Formulation Codes

CODE	FORMULATION
DU	dust or powder
DV	device
EC	emulsifiable concentrate or emulsion
GR	granular
IF	impregnated fabric
LI	liquid
MS	microencapsulated suspension
PA	paste
PE	pellet
PP	pressurized product
PT	particulate
SG	soluble granules
SN	solution
SO	solid
SO	soluble powder
SR	slow-release generator
SU	suspension
TA	tablet
WG	wettable granular
WP	wettable powder

CODE	GUARANTEED INGREDIENT
ARP	arsenic pentoxide
BNA	borax, anhydrous
BNS	borax
BTO	bis(tri-n-butyltin)oxide
COA	coal tar acid
CPN	chloropicrin
CRO	chromic acid
CRT	creosote
CUN	copper as elemental, present as copper naphthenate
CUO	copper oxide
CUO	copper 8-quinolinolate
DCA	dichlofluanid
DNP	dinitrophenol
FOL	folpet
KCR	potassium chromate
KDC	potassium dichromate
KTC	potassium tetrachlorophenate plus related chlorophenates
MTM	metam-sodium
PCP	pentachlorophenol plus related chlorophenols
PML	phenylmercuric lactate
PMO	phenylmercuric oleate
SFL	sodium fluoride
SMM	sodium metaborate octahydrate
SPC	sodium pentachlorophenate plus related chlorophenates
STC	sodium tetrachlorophenate plus related chlorophenates
STD	sodium 2,4,5-trichlorophenate
TCM	2-(thiocyanomethylthio)benzothiazole
TCP	techrachlorophenol plus related chlorophenols
ZNN	zinc as elemental, present as zinc naphthenate

	NAME	FORM	GUAR	
arsenic pentoxide				
	TIMBER SPECIALTIES K-33 (72%) WOOD PRESERV	PA	ARP	32.5
			CRO	24.4
			CUO	14.1
	TIMBER SPECIALTIES (C-72) WOOD PRESERVATIVE	SN	ARP	24.5
			CRO	34.2
			CUO	13.3
	TIMBER SPECIALTIES (C-50) WOOD PRESERVATIVE	SN	ARP	17.00
			CRO	23.75
			CUO	9.25
	WOLMANAC CONCENTRATE 50% WOOD PRESERV	SN	APR	17.00
			CRO	23.75
			CUO	9.25
	TIMBER SPECIALTIES (C-91) WOOD PRESERVATIVE	SN	ARP	4.08
			CRO	3.18
			CUO	1.74
	CCA TYPE 'C' WOOD PRESERVATIVE	SN	ARP	19.00
			CRO	22.40
			CUO	8.60
	WOLMAN CCA OXIDE END CUT SOLUTION	SN	ARP	0.925
			CRO	1.700
			CUO	2.375
borax, anhydrous				
	TIMPREG B POL-NU TYPE WOOD PRESERV GREASE	PA	BNA	15.5
			PCP	10
	TIMPREG B (SPECIAL	PA	BNA	15.5
			CRT	15.5
	OSMOPLASTIC-B WOOD PRESERVATIVE COMPOUND	PA	BNA	15
			CRT	15
			PCP	10
borax				
	OSMOSE SPECIAL FENCE POST MIXTURE	PA	BNS	20

Chemical	Product	Form	Code	Amount
			CDA	50
			DNP	2
			KDC	5
			SFL	10
	CHAPMAN PERMATOX 10-5	SG	BNS	57
			SPC	36
	WOODBRITE 24	SN	BNS	2
			SPC	7.68
			STC	16.32
bis(tri-n-butyltin)oxide				
	CCC WOOD PRESERVATIVE	SN	BTO	0.075
			CUN	2.35
	WOLMANIZED OUTDOOR WOOD END CUT PRESERVATIVE	SN	BTO	0.075
			CUN	2.35
	WOOD PRESERVATIVE CLEAR	SN	BTO	0.5
			FOL	0.5
	WEATHER SCREEN 704	SN	BTO	0.50
			FOL	0.50
	WEATHER SCREEN 707	SN	BTO	0.50
			FOL	0.50
	WEATHER SCREEN 709	SN	BTO	0.50
			FOL	0.50
	WEATHER SCREEN 713	SN	BTO	0.50
			FOL	0.50
	WEATHER SCREEN 716	SN	BTO	0.50
			FOL	0.50
	WEATHER SCREEN 717	SN	BTO	0.50
			FOL	0.50
	WEATHER SCREEN 723	SN	BTO	0.50
			FOL	0.50
	WEATHER SCREEN 726	SN	BTO	0.50
			FOL	0.50
	WEATHER SCREEN 911	SN	BTO	0.50
			FOL	0.50
	WEATHER SCREEN 913	SN	BTO	0.50
			FOL	0.50

Chemical	Product	Form	Code	Amount
coal tar acids				
	OSMOSE SPECIAL FENCE POST MIXTURE	PA	BNS	20
			COA	50
			DNP	2
			KDC	5
			SFL	10
chloropicrin				
	TIMBERFUME	LI	CPN	99
chronic acid				
	TIMBER SPECIALTIES K-33 (72%) WOOD PRESERV	PA	ARP	32.5
			CRO	24.4
			CUO	14.1
	TIMBER SPECIALTIES (C-72) WOOD PRESERVATIVE	SN	ARP	24.5
			CRO	34.2
			CUO	13.3
	TIMBER SPECIALTIES (C-50) WOOD PRESERVATIVE	SN	ARP	17.00
			CRO	23.75
			CUO	9.25
	WOLMANAC CONCENTRATE 50% WOOD PRESERV	SN	ARP	17.00
			CRO	23.75
			CUO	9.25
	TIMBER SPECIALTIES (C-91) WOOD PRESERVATIVE	SN	ARP	4.08
			CRO	3.18
			CUO	1.74
	CCA TYPE 'C' WOOD PRESERVATIVE	SN	ARP	19.00
			CRO	22.40
			CUO	8.60
	WOLMAN CCA OXIDE END CUT SOLUTION	SN	ARP	0.925
cesosote				
	PATOX TYPE II - POLE TREATING WRAP	IF	CRT	11.0
			KCR	12.5
			SFL	37.1
			SPC	8.5

		STC	1.0
RECORD'S CREOSOTE WOOD PRESERVATIVE LIQUID	LI	CRT	100
PURE COAL TAR CREOSOTE	LI	CRT	100
DOMTAR CREOSERVE	LI	CRT	99
DOMTAR NO. 1 CREOSOTE OIL	LI	CRT	97
KOPPERS CREOSOTE	LI	CRT	100
OSMOSE PENTOX CREOSOTE WOOD PRESERV LIQ	LI	CRT	99.6
WOODSOL CREOSOTE	LI	CRT	100
DOMTAR NO. 1 CREOSOTE OIL	LI	CRT	97
DOMTAR CREOSERVE	LI	CRT	99
CREOSOTE (WOOD PRESERVATIVE)	LI	CRT	100
TIMPREG PAK	PA	CRT	15
		PCP	10
		SFL	15
TIMPREG	PA	CRT	15
		PCP	10
		SFL	15
TIMPREG B (SPECIAL)	PA	BNA	15.5
		CRT	15.5
		PCP	10
OSMOPLASTIC WOOD PRESERVING COMPOUND	PA	CRT	20
		DNP	2
		KDC	3.1
		PCP	2.21
		SFL	43.7
OSMOBAND WOOD PRESERVATIVE BANDAGE	PA	CRT	15
		PCP	10
		SFL	20
OSMOPLASTIC-B WOOD PRESERVATIVE COMPOUND	PA	BNA	15
		CRT	15
		PCP	10
OSMOPLASTIC WOOD PRESERVING COMPOUND	PA	CRT	20.0
		DNP	2.00
		KDC	3.10
		SFL	43.70
CCC CREOSOTE	SN	CRT	97
SOLIGNUM WOOD PROTECTIVE STAIN 1-1 LIGHT BROWN	SN	CRT	64.5

SOLIGNUM WOOD PROTECTIVE STAIN 1-2 MEDIUM BROWN	SN	CRT	49.0
SOLIGNUM WOOD PROTECTIVE STAIN 1-12 BRUNSWICK GREEN	SN	CRT	14.2
SOLIGNUM WOOD PROTECTIVE STAIN 1-14 WALNUT	SN	CRT	16.5
SOLIGNUM WOOD PROTECTIVE STAIN 1-16 TEAKWOOD	SN	CRT	18.0
SOLIGNUM WOOD PROTECTIVE STAIN 1-23 MAHOGANY	SN	CRT	18.2
SOLIGNUM WOOD PROTECTIVE STAIN 1-22 CEDAR	SN	CRT	16.6
SOLIGNUM WOOD PROTECTIVE STAIN 1-15 BLACK	SN	CRT	31.8
SOLIGNUM WOOD PROTECTIVE STAIN 1-21 REDWOOD	SN	CRT	17.1
RECORD'S CREOSOTE OIL	SN	CRT	50
CREOSOTE	SN	CRT	100
CREOSOTE OIL	SN	CRT	50
BULLDOG GRIP WOOD PRESERVATIVE BLACK CREOSOTE	SN	CRT	50
BULLDOG GRIP WOOD PRESERVATIVE CREOSOTE	SN	CRT	50
COAL TAR CREOSOTE WOOD PRESERVATIVE	SN	CRT	60

copper as elemental, present as copper naphthenate

VITOX VERT 561-904 (ANCIEN 5004)	SN	CUN	2
CUPRINOL GREN LIQ WOOD PRESERV	SN	CUN	2
ROZ TOX GREEN WOOD ROPE FABRIC PRESERVATIVE (COPPER NAPTHANATE)	SN	CUN	2
ENSIGN 320 WOOD PRESERV GREEN	SN	CUN	2
MASTERCRAFT LIQ WOOD/ROPE/FABRIC PRESERV GREEN	SN	CUN	2
COPPER NAPHTHENATE WOOD PRESERV	SN	CUN	2
BULLDOG GRIP WOOD PRESERVATIVE GREEN	SN	CUN	2
30-015 (GREEN) CUPROID NO. 1 LIQUID WOOD PRESERVATIVE	SN	CUN	2
30-016 (GREEN) CUPROID NO. 2 LIQUID WOOD PRESERVATIVE	SN	CUN	2
COPPER NAPHTHENATE GREEN PRESERV	SN	CUN	2
DEANCO TIMBERGARD GREEN WOOD PRESERV	SN	CUN	2
PRESERVATIVE POUR BOIS VERT 511-017 (ANTIEUREMENT G-171)	SN	CUN	2
RECORD'S COPPER II GREEN WOOD PRESERVATIVE	SN	CUN	2
WOOD PRESERV GREEN	SN	CUN	2
CCC WOOD PRESERVATIVE	SN	BTO	0.075
		CUN	2.35
CUPERSEAL WOOD PRESERVATIVE	SN	CUN	2
PENTOX COP-R-NAP	SN	CUN	2

BULLDOG GRIP WOOD PRESERV GREEN	SN	CUN	2
CREO-THANE WOOD PRESERVATIVE GREEN	SN	CUN	1
WOODSOL GREEN PRESERVATIVE	SN	CUN	2
SICO PRESERVATIF POUR LE BOIS SICOP VERT NO. 774-420	SN	CUN	2
PROTOX GREEN (VERT)	SN	CUN	2
PRESERVATIF POUR LE BOIS NAPHTENATE DE CUIVRE VERT NO. 03-024	SN	CUN	2
LIQUIDE PROTECTEUR POUR LE BOIS (VERT)/WOOD PRESERVATIVE (GREEN)	SN	CUN	2
WOLMANIZED OUTDOOR WOOD END CUT PRESERVATIVE	SN	BTO	0.075
		CUN	2.35
HORNTOX GREEN WOOD PRESERV	SN	CUN	2
	SN	PCP	0.06
FIELD CUT SOLUTION	SN	CUN	2
LAITER'S COPPERTOX WOOD PRESERVATIVE (GREEN)	SN	CUN	2
NUDDEXZ COPPER 8%	SN	CUN	8%
SEALTIGHT WOOD PRESERVER	SN	CUN	2
WOOD PRESERVATIVE GREEN	SN	CUN	2
NUDDEX COPPER 2%	SN	CUN	2
PRESERVATIF POUR LE BOIS - NO. 017 VERT	SN	CUN	2

copper oxide

TIMBER SPECIALTIES K-33 (72%) WOOD PRESERV	PA	ARP	32.5
		CRO	24.4
		CUO	14.1
TIMBER SPECIALTIES (C-72) WOOD PRESERVATIVE	SN	ARP	24.5
		CRO	34.2
		CUO	13.3
TIMBER SPECIALTIES (C-50) WOOD PRESERVATIVE	SN	ARP	17.00
		CRO	23.75
		CUO	9.25
WOLMANAC CONCENTRATE 50% WOOD PRESERV	SN	ARP	17.00
		CRO	23.75
		CUO	9.25
TIMBER SPECIALTIES (C-91) WOOD PRESERVATIVE	SN	ARP	4.08
		CRO	3.18

		CUO	1.74
CCA TYPE 'C' WOOD PRESERVATIVE	SN	ARP	19.00
		CRO	22.40
		CUO	8.60
WOLMAN CCA OXIDE END CUT SOLUTION	SN	ARP	0.925
		CRO	1.700
		CUO	2.375

copper 8-quinolinolate

QUINOLATE	DU	CUQ	90
PQ-10 LIQUID FUNGICIDE	EC	CUQ	5.0
	EC	PCP	19.2
NYLATE-10	EC	CUO	10
NYLATE-GD	EC	CUQ	10
PQ-20 WOOD PRESERVATIVE	SN	CUQ	3.7
CUNILATE WOOD SEAL	SN	CUQ	0.75
Q-SAN CONCENTRATE 1-10	SN	CUQ	2.9
PQ-35 WR	SN	CUQ	0.35
PQ-57 WOOD PRESERVATIVE	SN	CUQ	5.00
CUNILATE 2174-P	SN	CUQ	10
VARAPEL-NO. 6000 NATURAL	SN	CUQ	0.1
VAPAREL-NO. 6001 GREEN	SN	CUQ	0.1
VARAPEL-NO. 6003 CHARCOAL	SN	CUQ	0.1
VAPAREL-NO. 600 WALNUT	SN	CUQ	0.1
VARAPEL-NO. 6006 MAHOGANY	SN	CUQ	0.1
VAPAREL-NO. 6007 REDWOOD	SN	CUQ	0.1
VARAPEL-NO. 6008 MAPLE	SN	CUQ	0.1
VAPAREL-NO. 6010 WHITE	SN	CUQ	0.1
VAPAREL-#500 CLEAR	SN	CUQ	0.1
VARAPEL-#6011 NATURAL WOODTONE	SN	CUQ	0.1

dichlofluanid

CUPRINOL TRANSCOLOR WOOD STAIN NO. 2	SN	DCA	0.82
CUPRINOL TRANSCOLOR WOOD STAIN NO. 3	SN	DCA	0.82
CUPRINOL TRANSCOLOR WOOD STAIN NO. 4	SN	DCA	0.82

	CUPRINOL TRANSCOLOR WOOD STAIN NO. 5	SN	DCA 0.82
	CUPRINOL TRANSCOLOR WOOD STAIN NO. 6	SN	DCA 0.82
	CUPRINOL TRANSCOLOR WOOD STAIN NO. 7	SN	DCA 0.82
	CUPRINOL TRANSCOLOR WOOD STAIN NO. 8	SN	DCA 0.82
	CUPRINOL TRANSCOLOR WOOD STAIN NO. 9	SN	DCA 0.82
	CUPRINOL TRANSCOLOR WOOD STAIN NO. 10	SN	DCA 0.82
	CUPRINOL TRANSCOLOR WOOD STAIN NO. 11	SN	DCA 0.82
	CUPRINOL TRANSCOLOR WOOD STAIN NO. 13	SN	DCA 0.82
	CUPRINOL TRANSCOLOR WOOD STAIN NO. 14	SN	DCA 0.82
	CUPRINOL TRANSCOLOR WOOD STAIN NO. 1	SN	DCA 0.82
	CUPRINOL TRANSCOLOR WOOD STAIN NO. 12	SN	DCA 0.82
	CUPRINOL OPAQUE TRANSCOLOR NO. 7 REDWOOD	SN	DCA 0.33
	CUPRINOL OPAQUE TRANSCOLOR NO. 8 EVERGREEN	SN	DCA 0.33
	CUPRINOL OPAQUE TRANSCOLOR NO. 1 BARN BROWN	SN	DCA 0.33
	CUPRINOL OPAQUE TRANSCOLOR NO. 2 WALNUT	SN	DCA 0.33
	CUPRINOL OPAQUE TRANSCOLOR NO. 3 CHARCOAL	SN	DCA 0.33
	CUPRINOL OPAQUE TRANSCOLOR NO. 4 CEDAR	SN	DCA 0.33
	CUPRINOL OPAQUE TRANSCOLOR NO. 5 BURGANDY RED	SN	DCA 0.33
	CUPRINOL OPAQUE TRANSCOLOR NO. 6 COLONIAL GREY	SN	DCA 0.33
	CUPRINOL TRANSCOLOR OPAQUE NO. 9 WHITE	SN	DCA 0.33
dinitrophenol			
	OSMOSE SPECIAL FENCE POST MIXTURE	PA	BNS 20
			COA 50
			DNP 2
			KDC 5
			SFL 10
	OSMOPLASTIC WOOD PRESERVING COMPOUND	PA	CRT 20
			DNP 2
			KDC 3.1
			PCP 2.21
			SFL 43.7
	OSMOPLASTIC WOOD PRESERVING COMPOUND	PA	CRT 20.0
			DNP 2.00
			KDC 3.10
			SFL 43.70

folpet			
	WOOD PRESERVATIVE CLEAR	SN	BTO 0.5
			FOL 0.5
	WEATHER SCREEN 704	SN	BTO 0.50
			FOL 0.50
	WEATHER SCREEN 707	SN	BTO 0.50
			FOL 0.50
	WEATHER SCREEN 709		BTO 0.50
			FOL 0.50
	WEATHER SCREEN 713		BTO 0.50
			FOL 0.50
	WEATHER SCREEN 716		BTO 0.50
			FOL 0.50
	WEATHER SCREEN 717		BTO 0.50
			FOL 0.50
	WEATHER SCREEN 723		BTO 0.50
			FOL 0.50
	WEATHER SCREEN 726		BTO 0.50
			FOL 0.50
	WEATHER SCREEN 911		BTO 0.50
			FOL 0.50
	WEATHER SCREEN 913		BTO 0.50
			FOL 0.50
orthophenylphenol			
	DOWICIDE 1 ANTIMICROBIAL	SD	OPP 98
potassium chronate			
	PATOX TYPE II - POLE TREATING WRAP	IF	CRT 11.0
			KCR 12.5
			SFL 37.1
			SPC 8.5
			STC 1.0

OSMOSE SPECIAL FENCE POST MIXTURE	PA	BNS	20
		COA	50
		DNP	2
		KDC	5
		SFL	10
OSMOPLASTIC WOOD PRESERVING COMPOUND	PA	CRT	20
		DNP	2
		KDC	3.1
		PCP	2.21
		SFL	43.7
OSMOPLASTIC WOOD PRESERVING COMPOUND	PA	CRT	20.0
		DNP	2.00
		KDC	3.10
		SFL	43.70

potassium tetrachlorophenate plus related chlorophenates

PERMATOX 180	SN	KTC	28.34

netan-sodiun

POLE-FUME	SN	MTM	380 G/L
WOODFUME	SN	MTM	380 G/L

pentachlorophenol plus related chlorophenols

PQ-10 LIQUID FUNGICIDE	EC	CUQ	5.0
		PCP	19.2
RCL 49-162 PENTACHLOROPHENOL FOR MANUFACTURING PURPOSES ONLY	GR	PCP	96
POL-NU PAK GROUND-LINE POLE TREAT BANDAGE	PA	PCP	10.21
POL-NU PAK GROUND-LINE POLE TREATMENT	PA	PCP	10.23
TIMPREG PAK	PA	CRT	15
		PCP	10
		SFL	15
TIMPREG	PA	CRT	15
		PCP	10

		SFL	15
TIMPREG B POL-NU TYPE WOOD PRESERV GREASE	PA	BNA	15.5
		PCP	10
TIMPREG B (SPECIAL)	PA	BNA	15.5
		CRT	15.5
		PCP	10
STANGARD PENTA GREASE 10 GROUNDLINE WOOD PRESERV	PA	PCP	10
OSMOPLASTIC WOOD PRESERVING COMPOUND	PA	CRT	20
		DNP	2
		KDC	3.1
		PCP	2.21
		SFL	43.7
OSMOBAND WOOD PRESERVATIVE BANDAGE	PA	CRT	15
		PCP	10
		SFL	20
OSMOPLASTIC-B WOOD PRESERVATIVE COMPOUND	PA	BNA	15
		CRT	15
		PCP	10
DOWICIDE EC-7 ANTIMICROBIAL	SG	PCP	100
PENTA PRESERVATIVE CONCENTRATE 1 TO 10	SN	PCP	41.3
NEVAROT WATER REPELLENT WOOD PRESERV	SN	PCP	4.75
LATER'S PENTACHLOROPHENOL READY-TO-USE WOOD PRESERVATIVE	SN	PCP	5
LATER'S PENTACHLOROPHENOL 1-10 CONCENTRATE WOOD PRESERVATIVE	SN	PCP	40
WOOD PRESERVATIVE CLEAR	SN	PCP	5
BULLDOG GRIP WOOD PRESERVATIVE CLEAR	SN	PCP	4.8
CHAPMAN PENTA WR CONCENTRATE 1-5	SN	PCP	24
ROZ-TOX CLEAR WOOD PRESERV & SEALER	SN	PCP	2.85
CCC PENTOL	SN	PCP	5
STANGARD PENTA WOOD PRESERV CONC 1-10	SN	PCP	41
STANGARD PAINTABLE PENTA CLEAR WOOD PRESERV	SN	PCP	5
STANGARD PENTA WR WOOD PRESERV CONC 1-4	SN	PCP	21
STANGARD PENTA WR WATER REPELLENT WOOD PRESERV	SN	PCP	5
SUPER SOLIGNUM 10-10 CLEAR WOOD PRESERV	SN	PCP	4.8
PENTA-PHENOL CLEAR PAINTABLE WOOD PRESERV & PRIMER-SEALER	SN	PCP	4.8

PRESERVATIF POUR BOIS, CLAIR 511-014	SN	PCP	4.8
MOOREWOOD PENTA WOOD PRESERV CLEAR 456-00	SN	PCP	4.8
MASTERCRAFT CLEAR WOOD PRESERV & SEALER	SN	PCP	2.85
GUARDSMAN PENTAPRESERV CONC 1-10	SN	PCP	42.5
REZ WOOD PRESERVATIVE CLEAR	SN	PCP	5
REZ WOOD PRESERVATIVE GREEN	SN	PCP	5
STANGARD PENTA GREEN WOOD PRESERVATIVE	SN	PCP	5
GUARDSMAN PENTA PRESERVATIVE	SN	PCP	4.25
PENTOX PENTA GREEN WOOD PRESERV	SN	PCP	5
BULLDOG GRIP WOOD PRESERVATIVE CLEAR	SN	PCP	4.8
SUPER SOLIGNUM WOOD PRESERV STAIN 10-14 WALNUT	SN	PCP	3.1
SUPER SOLIGNUM WOOD PRESERV STAIN 10-16 TEAKWOOD	SN	PCP	3.1
SUPER SOLIGNUM WOOD PRESERV STAIN 10-15 BLACK	SN	PCP	3.1
SUPER SOLIGNUM WOOD PRESERV STAIN 10-200 BUNGALD WHITE	SN	PCP	3.1
SUPER SOLIGNUM WOOD PRESERV STAIN 10-66 DRIFT WOOD	SN	PCP	3.1
SUPER SOLIGNUM WOOD PRESERV STAIN 10-63 DARK BROWN	SN	PCP	3.1
SUPER SOLIGNUM WOOD PRESERV STAIN 10-62 BRUNSWICK GREEN	SN	PCP	3.1
SUPER SOLIGNUM WOOD PRESERV STAIN 10-23 MAHOGANY	SN	PCP	3.1
SUPER SOLIGNUM WOOD PRESERV STAIN 10-22 CEDAR	SN	PCP	3.1
SUPER SOLIGNUM WOOD PRESERV STAIN 10-21 REDWOOD	SN	PCP	3.1
STANGARD PAINTABLE PENTA CLEAR WOOD PRESERVATIVE	SN	PCP	5
STANGARD PENTA WR WATER REPELLENT WOOD PRESERVATIVE	SN	PCP	5
STANGARD PENTA GREEN WOOD PRESERVATIVE	SN	PCP	5
PENTOX WOOD PRESERV BROWN	SN	PCP	3.85
PENTA-MIX WOOD PRESERVATIVE	SN	PCP	5
WOOD PRESERVATIVE CLEAR	SN	PCP	4.85
PENTA PRESERVATIVE 1-10	SN	PCP	41.3
WOODSOL PAINTABLE PENTA CLEAR	SN	PCP	4.8
WOODLIFE WATER REPELLENT WOOD PRESERVATIVE	SN	PCP	5
WOODLIFE LIQ WATER REPELLENT WOOD PRESERV	SN	PCP	5
WOODLIFE 3:1 CONCENTRATE WOOD PRESERVATIVE	SN	PCP	17.9
24-12 WOOD PRESERVATIVE SOLUTION	SN	PCP	5
PROTOX CLEAR (CLAIR)	SN	PCP	5.0
POLE TOPPER FLUID WOOD PRESERV	SN	PCP	10
HORNTOX CLEAR WOOD PRESERV	SN	PCP	0.06

			ZNN	2
	HORNTOX GREEN WOOD PRESERV	SN	CUN	2
			PCP	0.06
	WOODLIFE LIQUID WATER REPELLENT WOOD PRESERVATIVE	SN	PCP	4.8
	PCP 1 TO 10 CONCENTRATE WOOD PRESERVATIVE	SN	PCP	35.86
			TCP	4.17
	PENTOX 1+10 PENTA	SN	PCP	40
	UNIROYAL 17039 PENTACHLOROPHENOL OILED	SO	PCP	96
	18-116R WOOD SEALER T-678 GOLD	SU	PCP	4.39
phenylmercuric lactate				
	PERMATOX 100	SN	PML	0.366
			SMM	6.33
			STC	22.81
phenylmercuric oleate				
	STAN-GARD DUAL PURPOSE SASH TREATMENT	SN	PMO	0.35
	DUAL-PURPOSE SASH TREATMENT WOOD PRESERVATIVE R-T-U	SN	PMO	0.07
sodium fluoride				
	PATOX TYPE II - POLE TREATING WRAP	IF	CRT	11.0
			KCR	12.5
			SFL	37.1
			SPC	8.5
			STC	1.0
	OSMOSE SPECIAL FENCE POST MIXTURE	PA	BNS	20
			COA	50
			DNP	2
			KDC	5
			SFL	10
	TIMPREG PAK	PA	CRT	15
			PCP	10
			SFL	15
	TIMPREG	PA	CRT	15

OSMOPLASTIC WOOD PRESERVING COMPOUND	PA	PCP	10
		SFL	15
		CRT	20
		DNP	2
		KDC	3.1
		PCP	2.21
		SFL	43.7
OSMOBAND WOOD PRESERVATIVE BANDAGE	PA	CRT	15
		PCP	10
		SFL	20
OSMOPLASTIC WOOD PRESERVING COMPOUND	PA	CRT	20.0
		DNP	2.00
		KDC	3.10
		SFL	43.70

sodium metaborate octahydrate

PERMATOX 100	SN	PML	0.366
		SMM	6.33
		STC	22.81

sodium pentachlorophenate plus related chlorophenates

PATOX TYPE II - POLE TREATING WRAP	IF	CRT	11.0
		KCR	12.5
		SFL	37.1
		SPC	8.5
		STC	1.0
CHAPMAN PERMATOX 10-S	SG	BNS	57
		SPC	36
WOODBRITE 24	SN	BNS	2
		SPC	7.68
BIOCIDE 209	SN	SPC	8.5
		STD	26.4

sodium tetrachlorophenate plus related chlorophenates

PATOX TYPE II - POLE TREATING WRAP	IF	CRT	11.0
		KCR	12.5
		SFL	37.1
		SPC	8.5
		STC	1.0
PERMATOX 100	SN	PML	0.366
		SMM	6.33
		STC	22.81
WOODBRITE 24	SN	BNS	2
		SPC	7.68
		STC	16.32
DIATOX	SN	STC	24.2
18-706 TETRA CONCENTRATE 18 IG	SN	STC	21.93
18-600R WOODSHEATH CHERRY BROWN 10.0 IG	SU	STC	6.46
18-52B WOODSHEATH SEABRITE - 10.01 G	SU	STC	14.2
18-70B WOOD SHEATH CLEAR 10 I.G.	SU	STC	13.59

sodium 2, 4, 5-trichlorophenate

BIOCIDE 209	SN	SPC	8.5
		STD	26.4

2-(thiocyanonethylthio) benzothiazole

BUSAN 72	SN	TCM	60
BUSAN 30	SN	TCM	30

tetrachlorophenol plus related chlorophenols

PCP 1 TO 10 CONCENTRATE WOOD PRESERVATIVE	SN	PCP	35.86
		TCP	4.17
49-167 TETRACHLOROPHENOL	SO	TCP	94

zinc as elemental, present as zinc naphthenate

VITOX INCLORE 561-903 (ANCIEN 5003)	SN	ZNN	2
CUPRINOL CLEAR LIQ WOOD PRESERV	SN	ZNN	2

ROZ TOX CLEAR WOOD ROPE FABRIC PRESERVATIVE (ZINC NAPTHANATE)	SN	ZNN	2
ENSIGN 320 WOOD PRESERV CLEAR	SN	ZNN	2
30-017 (AMBER) CUPROID NO. 3 LIQUID WOOD PRESRVATIVE	SN	ZNN	2
CIL ZINC NAPHTHENATE WOOD PRESERV	SN	ZNN	2
ZINC NAPHTHENATE CLEAR PRESERVATIVE	SN	ZNN	2
DEANCO TIMBERGARD CLEAR, ZINC NAPHTHENATE BASED WPS, LIQUID.	SN	ZNN	2
MASTERCRAFT CLEAR LIQ. ROPE & FABRIC PRESERV	SN	ZNN	2
CREO-THANE WOOD PRESERVATIVE STAIN	SN	ZNN	2
WOODSOL CLEAR PRESERVATIVE	SN	ZNN	2
SICO PRESERVATIF POUR LE BOIS SICOP CLAIR NO. 774-126	SN	ZNN	2
PRESERVATIF POUR LE BOIS NAPHTENATE DE ZINC CLAIR NO. 03-025	SN	ZNN	2
ZINC II WOOD PRESERVER	SN	ZNN	2
HORNTOX CLEAR WOOD PRESERV	SN	PCP	0.06
		ZNN	2
CUPRINOL EXTERIOR BROWN WALNUT	SN	ZNN	2
NUDDEX ZINC 8%	SN	ZNN	8
561-905 VITOX PRESERVATIF POUR BOIS	SN	ZNN	2
NUDDEX ZINC 2%	SN	ZNN	2
PRESERVATIF POUR LE BOIS - NO. 014 CLAIR	SN	ZNN	2
CUPRINOL CEDAR TREATMENT	SU	ZNN	2