atmospheric pollutants have greatly accelerated stone decay. Architectural ornament which might have survived unscathed in a rural environment for two or three hundred years may succumb to urban industrial pollutants in a matter of decades. Little wonder, then, that research in stone preservation is rapidly expanding and that in the past ten years the application of commercially developed treatments and consolidants has become commonplace. What must be remembered is that while stone may no longer be considered a "maintenance-free" material, preservation treatment itself imposes a cycle of inspection and maintenance.

Cultural differences in the philosophy of preservation: "craft" versus "artifact"

Until relatively recently, traditional craft practices determined what methods would be used to restore an historic monument or building. Through the nineteenth century deteriorated stone elements were typically replaced with new pieces of like or similar material, shaped by skilled hands and tools scarcely different from those which had wrought the originals. Original fabric was lost, but the craft was respected. Not atypically even statuary and elaborate ornament were replaced. Impassioned critics like Ruskin argued that deteriorated stone was an artifact, and that such renewal was no better than destruction. Today the desirability of the retention of historic fabric is widely accepted by western preservation professionals. Nowhere is the "artifactual" approach more firmly entrenched than in Italy, where chemical consolidation treatment is common, even for lineal moldings and other architectural ornament that might be easily replicated (and would, indeed, be in other countries). Some would say that the pendulum has swung the other way, and that altered stone which no longer conveys the architectural intent of the monument is retained solely for antiquarian value. The primacy of this approach in archaeological sites ,at least, is easily understood. After all, heavily damaged marble columns of a first century temple are artifacts as much as they are architectural elements - how could they be replicated or replaced?

There is no disputing, however, that significant cultural differences exist in the philosophies guiding the restoration of stone monuments in the world today. In developing countries a craft approach generally predominates, and replacement and retooling of deteriorating ornament is widely practiced. In northern Italy, similar ornament would most certainly be chemically consolidated. One suspects that differences in approach reflect cost and commercial availability as much as philosophy. In the United States, surprisingly, the use of chemical consolidants is just beginning to see wide use, perhaps because all but the most sophisticated of preservation architects and laymen expect restoration to yield a "like new" appearance rather than one with a significant patina of age. Currently in the U.S. replacement, retooling, and stucco repair are

4. The consolidant must penetrate deeply into the stone and not remain concentrated at surface layers, nor dramatically alter the porosity of treated layers.

5. Ideally, the consolidant must be reversible, that is, capable of being redissolved and removed with a solvent.

In practice, no one material has proven satisfactory for all stones and types of deterioration, and consolidants and treatment methods are selected on a case by case basis. To add to the confusion for an architect or conservator, each method has its own strong adherents, and the personal biases which result quite frequently conflict. The disputes between practitioners may seem arcane and technical, but unfortunately they affect the future of our monuments. For the non-initiate, a brief primer in stone conservation chemistry is in order.

Consolidants in current use may be divided into categories as organic or inorganic treatments. Inorganic consolidants are, in general, more durable than organic resins, but may lack adequate elasticity to give treated stones good mechanical resistance. Inorganic treatments that act through chemical reaction with the stone itself may also have problems of inadequate penetration. Of the two major inorganic systems in use, treatment with silicon esters (generally tetraethyl orthosilicate) is by far the most common. These ethyl silicates are widely marketed for the consolidation of sandstones and function by depositing colloidal silica within the pores of the stone. They are not generally suitable for use with limestones and marbles and do not impart a water repellency to the treated stone. A barium hydroxide treatment for limestones and marbles works through chemical combination/transformation of the calcium carbonate of the stone itself and by depositing interstitial barium carbonate within the pores of the stone. While the barium hydroxide method has some strong proponents, it is not in general commercial use today, in part because it is relatively difficult to apply, requiring lengthy application periods and the use of caustic solutions.

The organic consolidants currently in use may be very generally categorized as acrylic resins, silicone resins, and epoxy resins. Acrylic resins, generally combined with an amount of silicone resin to foster water repellency, have seen extensive use in northern Italy for the consolidation of marbles. Acrylics may be redissolved, and thus theoretically are reversible, although in practice they would be difficult to remove completely. For in situ treatments acrylics may be brush applied.

Different types of silicone resins with greatly variable properties have enjoyed significant popularity as stone consolidants. Alkoxy silanes, one type of silicone resin, has been widely marketed as a sandstone consolidant, often applied in combination with ethyl silicate.