Designing a Quality Framework for Sustainable Heritage Conservation

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Proceedings of:

FABRIC

The Threads of Conservation

Best practice conservation philosophy, heritage management
and skills training in Australia and beyond

Australia ICOMOS Conference
5-8 November 2015
Adelaide Australia

AUSTRALIA ICOMOS
International Council on Monuments and Sites

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Introduction

Australian heritage management systems largely satisfy needs of communities in protecting heritage but they fail to deliver consistently good conservation outcomes. Much high quality conservation planning goes into the front end of projects but it is not matched at the back end with measurably good performance outcomes. This situation could be improved with performance measures and diligent monitoring of all changes.

It is an unfortunate reality that official recognition of the Burra Charter in heritage management processes gives rise to a false understanding that heritage conservation is managed well, when patently this is not so. Indeed, the Burra Charter and the CMP process make provision for things that are routinely neglected, such as detailed analyses, works in accordance with significance, employment of correct skills and techniques, a cautious approach, (safe, reversible, sustainable interventions), minimal works, recording of actions, on-going maintenance and monitoring. There is an inherent weakness in heritage management systems when rely too much on the planning of changes and not enough on the quality of the execution of works. This can be addressed with quality measures to define and determine outcomes and by putting all conservation actions into a self-regulating quality framework.

Throughout history, societies have endeavoured to obtain quality in their personal and collective environments. Prior to the current globalised age, quality was sought and obtained across many fields including construction. However, in the current era, quality often yields to expediency. This is particularly evident in the rapidly urbanising nations of Southeast Asia. In parts of Southeast Asia today immense new developments are displacing traditional communities and natural environments in a process that can be readily identified as unsustainable by all conventional measures. Australia experiences something similar but the impacts are moderated by higher standards of living and a more even distribution of communal wealth

Essentially, sustainability is about endurance over time. It should be remembered that economists invented the concept when it became obvious that rampant twentieth-century development could backfire in the Twenty First century because environmental degradation would ultimately undermine economic success (Holland 2012). This concept is now real, but the human response to date has been somewhat feeble. There is not always clear evidence of concern for quality and sustainability in heritage conservation, urban planning or development, despite the fact that higher quality would lead to greater long-term sustainability.

Climate change and the impacts of salts on sustainability

Climate change is an issue of growing concern, with a direct bearing on the sustainability of the built environment now. Contingent issues such as where people live, where new structures are built and what materials are used in their construction may sometimes be contested, but there is broad consensus that extreme weather events will become more frequent (CSIRO, 2014) and that the built environment will be exposed increasingly to extreme weather events including higher temperatures and flooding. Some of Australasia’s most important sites have already been exposed to extreme flooding. ICOMOS monitoring confirms that some World Heritage sites have been impacted (ICOMOS 2006).

In addition, there are increasing levels of harmful salts in the environment due to human activity. The effects of climate change are causing an increase in the destructive action of salts in porous masonry structures in more places. Salts are impacting greatly on the cultural heritage values of important places, being responsible for high levels of decay in porous masonry structures. Soluble salts, which emanate from many sources, including the ground, masonry elements and the immediate surrounding environment, move through masonry structures under capillary forces towards dry surfaces of structures where they crystallise with immense force upon drying. The forces of crystallisation cause masonry surfaces to disintegrate and erode under the cyclical impacts of seasonal and environmental changes in relative humidity. This process continues until total destruction when salts and moisture are present.

Concentrations of salts in the environment are increasing due to human activity including deforestation, agricultural and industrial practices and fossil fuel burning. Modern cities generate high levels of salts from pollutants in the atmosphere. Some salts derive from human waste. Flooding in low-lying areas usually results in transportation of salts in solution. Floodwaters are often contaminated with industrial, agricultural and human waste, which generate various harmful salts. Over time, salts accumulate at higher and higher levels. When porous masonry structures are examined closely their condition may be revealed to be poor and getting worse due to the impacts of salts and the effects of changes in the environment.

Climate change is also causing natural decay processes to occur in places where they did not previously occur. Pathogens such as decay fungi and insects such as termites are now appearing in places that were formerly outside their activity range due to temperature. Termites, in particular, can cause immense damage in timber structures in relative short time.

One category of cultural heritage places, archaeological sites, is highly susceptible to the impacts of climate change. The following discussion reveals how such sites are vulnerable and how quality measures could be applied to the management of archaeological places to protect them from the impacts of climate change and environmental factors.

Quality management of archaeological sites

Many archaeological sites contain relics of the pre-industrial era. As such they are normally characterised by pre-industrial crafts and materials, including inorganic materials such as hand-carved stone, hand-made bricks, lime mortars and lime stuccoes, all of which are vulnerable to salt attack. They have the potential to yield information about former civilisations. These sites are probably now more vulnerable than they were before they came under formal archaeological management due to changed environmental, social and political factors.

By their nature, archaeological sites demand preservation. All actions that would potentially distort the historical record and diminish the value of the sites should be avoided. Yet natural forces and weather increase their vulnerability to loss of values, requiring responses that would minimise risks and offset vulnerabilities. The preservation of some archaeological sites is made challenging by flooding, like the 2011 flooding in Central Thailand, which impacted some World Heritage archaeological sites. The Culture Minister of Thailand estimated that the 2011 flood damage was comparable to the accumulated water erosion damage sustained over centuries (Global Heritage Fund 2012). The Thai Government's 2012 budget of around $162 million to implement new 'flagship' water management and flood prevention projects included $25 million allocated specifically for repairing and strengthening ancient sites (Global Heritage Fund 2012). It seems unlikely, given the inconsistent standards of the Thai Fine Arts Department that this funding would be used effectively and sustainably without suitable performance measures, whereas, the application of quality measures might guarantee long-turn sustainability of funded actions. Such measures might include the following, for example.

Examples of quality measures for archaeological sites

Quality indicators	Outcome measures
All mechanisms of deterioration been identified.	Accredited experts have surveyed all structures, and the condition of all structures is recorded in detail.
	The actual and potential causes of deterioration have been identified by experts and preservation strategies confirmed by independent expert agencies.
There is a plan for preservation.	A conservation plan has been prepared by qualified experts, endorsed by relevant agencies and adopted by the governing body for implementation.
	The plan includes details for all structures and all materials.
Priorities are assigned for works over the immediate, mid and long terms.	The works have been prioritised based on levels of authenticity and vulnerability.
	Funding has been allocated.
Contingency plans for identified threats are in place.	Threats have been identified, and disaster plans prepared. The plans are endorsed by expert independent agencies.
	Funding for implementation has been secured.

Quality management of Porous Masonry Structures

Pre-War construction of brick and stone masonry buildings involved the use of lime as the binder in most mortars and solid plasters. The addition of cement to plasters and the introduction of cement-based impervious wall and floor surface finishes to traditional porous structures has created a high potential for salt damage to authentic building fabric, including stone carvings and decorative plasters and wall finishes. When floors and walls are covered with impervious materials, walls act like wicks sucking up ground moisture and salts, which then invade vulnerable areas where crystallising salts can cause damage to weak wall surfaces and finishes in direct contact with the salt-laden masonry.

Hard paving contributes to this phenomenon. Most hard paving materials are impervious to the passage of moisture. They act as vapour barriers, preventing moisture from evaporating from the damp ground beneath. When hard paving is required to meet functional needs, other measures must be considered to protect historic porous building fabric from the ingress of salts—measures such as the strategic use of vapour barriers, relief drains and perimeter control zones. The same applies to the use of impervious wall finishes and especially impervious cement plasters and modern polymer paints, which are now commonly used in place of traditional porous lime plasters and colour coatings. These cannot be used safely without other measures to counteract the upward movement of salts into vulnerable fabric.

Quality measures for consideration in protecting authentic fabric and cultural heritage values of porous masonry structures from the worst impacts of climate change and increasing salt levels would need to include the following.

Examples of quality measures for porous masonry walls

Quality indicators	Outcome measures
Ground water and surface water at the place is fully managed and prevented by reasonable controls from entering the porous masonry.	Surface drainage is available to carry away rainwater without opportunity for it to enter the porous masonry.
	Evaporation zones are available to divert moisture from ground and walls, and these are monitored to ensure that they continue to function properly.
	Disaster management processes are in place and actions are undertaken to respond to extreme weather events.
There are effective measures in place to prevent and/or control the movement of salts from the ground into the masonry.	Porous surface finishes allow for evaporation of moisture uniformly without opportunity for salts to concentrate and cause damage.
	Monitoring measures are used to ensure early identification of salts and treatment of salt-exposed surfaces.

Quality management of Weather-Exposed Wooden Structures

Wood obtained from trees is a traditional building material, which is enjoying a revival in cladding and decoration in modern architecture. Wood is an organic material with a finite life in most situations due to natural decay processes that return dead trees to the earth that originally give them life. Natural decay processes are associated with insects and pathogens including a number of decay fungi. Some types of wood are more resistant to decay than others but all wood will decay when conditions are conducive to attack by insects and pathogens. A further decay process, affecting exposed wood, is weathering. Weathering destroys the exposed surfaces of wood through by the combined impacts of ultraviolet light and water. Wood cannot resist weathering, and ultimate destruction, without protection from the harmful effects of sunlight and water, usually by coating with an opaque, water-resistant material such as paint.

With changes in climate, environmental impacts become more severe. Insects and pathogens that attack wood when temperature and moisture conditions are conducive become more active in warmer and wetter climates. Weathering may also become more extreme in situations where rainfall patterns are changing and temperatures are increasing.

Human settlement patterns and climate change also impact on the production of wood from trees. Old growth trees, which are now in serious decline and protected from harvest in most places, are known to produce better, more durable wood for construction than fast-grown plantation trees. Therefore wood produced today for construction is less durable than it was in the past, despite advanced methods used to process wood and supplement its natural resistance to decay. Wood in buildings should be conserved wherever possible for the simple reason that it is most probably more durable than replacement material.

Quality measures to consider in protecting authentic fabric and cultural heritage values of timber and wooden-clad structures should include the following.

Examples of quality measures for weather-exposed wood

Quality indicators	**Outcome measures**
All wood is protected from wetting.	Roof and surface drainage is designed and maintained to prevent rainwater from wetting timber.
	Free air movement around wooden elements allows wood to return to a dry condition following wetting.
	Disaster management processes are in place and actions are undertaken to respond to extreme weather events to restore dry conditions.
All wood is protected from harmful effects of sunlight and rainwater.	Surfaces are protected from sunlight by shading and/or opaque coatings.
	Surfaces are protected from rainwater by shelter and/or water-shedding coatings.
	Renewable coatings are maintained in sound condition under a suitable maintenance regime.
There are effective measures in place to prevent and/or control insects and pathogens.	Conditions are monitored to identify risks and to prevent attack.
	Prompt action is taken to eliminate risks and respond to attacks.

Reinforced concrete

Concrete, as it is manufactured and used today in construction, is less sustainable than the material that was used by the Romans 2,000 years ago. This fact seems counter-intuitive, given the ever-increasing use of concrete in the modern world. The principal reason is that the quality of the modern material is in several fundamental ways inferior to the material used in the past. The combination of concrete cement and steel in modern reinforced concrete causes the material to have a short life expectancy; one for which the future costs of rectification and repair will be far greater than the original cost of construction (Courland 2005, p.342). However, sustainable development is truly about achieving a balance between several objectives over dynamic time and spatial horizons (Sahaley et al 2005, p.73). Concrete is very challenging when considered in the context of sustainability.

The manufacture of concrete cement is the largest contributor of CO_2 into the atmosphere after automobiles and coal-fired power plants (Courland 2005, p.365). The majority of iconic twentieth-century structures employ concrete at least in part. Many are built to high quality standards but others are poorly constructed due to lack of knowledge of the material and/or poor workmanship and are prone to failure. However, premature demolition and replacement of concrete structures is neither economically or environmentally sustainable. Better quality new works and conservation of existing structures is a more sustainable option.

It is widely understood that the Romans used concrete in permanent structures and that the oldest concrete building is the Pantheon in Rome, built almost 2,000 years ago with a concrete domed roof. Less well understood, is that the oldest reinforced concrete building is a mere ‘centenarian’.

Credit for the development of reinforced concrete is usually attributed to Jacques Monier who patented a system of adding iron wires to cement in 1867. Francois Hennebique demonstrated the efficacy of adding iron bands to overcome the weak tensile strength of concrete in 1879 (Courland 2005, p.219). However, the real development of reinforced concrete in construction occurred in the United States with the work of Ernest Ransome in the 1880s and Thomas Edison, who set out to build concrete houses economically by mass production in 1906, foretelling Henry Ford’s mass production of motorcars affordably for the common person.

The American architect Frank Lloyd Wright, who is widely acknowledge as the outstanding architect of the Twentieth Century, was also a pioneer and innovator in the use of mass concrete and reinforced concrete. Both became features of his work as he pushed the boundaries of conventional design little by little in terms of striking visual appeal and through technological advances. It seems certain that his interest in concrete was connected with Edison’s pioneering efforts to build economical concrete houses in Oak Park, Illinois, where

Wright was based at the time. In the same year that Edison built his first affordable concrete houses, Wright built the Unity Temple in Oak Park using poured concrete, one of the first non-industrial uses of the material (Heinz 2002, p.312), considering Edison's efforts were by their nature industrial. By that time the manufacturing of Portland cement in the United States had become superior to British and European cements.

In Australia, a prominent pioneer of reinforced concrete was the former assistant to Frank Lloyd Wright, Walter Burley Griffin. Griffin had worked in the office of Frank Lloyd Wright before relocating to Australia in 1912 to oversee the construction of the new Australian national capital, Canberra, which he had designed as the winning entry in an international competition. However, his career took a turn when the Australian Government chose to build the new capital in accordance with Griffin's plan but not to engage Griffin further in the work. Griffin pursued other avenues instead, including land subdivisions and housing, as well as designing 18 garbage waste incinerators between 1926 and 1938 for the Reverberatory Incinerator and Engineering Company (Birrell 1964). Sadly for Griffin's architectural legacy, many of the incinerators failed spectacularly due to the interaction between the flue gases and the reinforced concrete. The high levels of sulphurous gases corroded the steel reinforcement and caused extreme concrete deterioration, leading to the demolition of several of the structures.

Griffin developed a knitlock system of construction during the 1920s Depression, very similar to Frank Lloyd Wright's 'knitlok textile' system. It allowed roofing and wall units to be easily made, and houses built with them quickly and cheaply (Walker, Kabos & Weirick 1994). However, many of the knitlock buildings performed poorly due to technical flaws with the system, most particularly through inadequate waterproofing.

Concrete deteriorates in a number of ways and for a number or reasons (English Heritage 2012). There are two common elements in all deterioration that leads to structural failure—

water and steel (corrosion). If either or both of these could be eliminated from reinforced concrete it would last for a long time, if not indefinitely.

Research to find ways of reinforcing concrete with a material or technique other than steel continues without success. Therefore all efforts to eliminate water must be vigorously pursued. With structures that have roofs it is not difficult to eliminate water; however, structures with inadequate roofs, or none at all, continue to be built in concrete. They will certainly fail over time. It would be far better, therefore, to follow a quality approach to designing reinforced concrete buildings sustainably and to eliminate water altogether. Nevertheless, when problems emerge they must be quickly addressed to avoid development of decay, leading to possible catastrophic failure. Quality measures to deal with the principal causes of failure might include the following.

Examples of quality measures for reinforced concrete

Quality indicators	**Outcome measures**
The concrete workmanship is of a standard that will endure in its environment.	The correct standard of construction (compaction and cover to reinforcing steel) is verified by core sampling and off-site analysis.
	The condition of the concrete is monitored and treatments implemented in response to emerging evidence of early onset failure.
Measures are available to treat the most likely causes of deterioration and potential failure.	Measures with a proven record of effectiveness have been researched and are available to treat the concrete in the event of deterioration.
	Ongoing research is undertaken to gather data about treatment methods.

Quality management of the built urban environment

The construction of new buildings is a constant in urban and rural environments and is occurring now at a faster rate than at any other time in history. In Southeast Asia in particular, factors influencing this include population growth and rising middle-class wealth. However, the quality and sustainability of new structures and new living environments is not always well consideration in light of diminishing natural resources and rising concerns about long-term environmental sustainability. Issues such as the future costs of maintaining today's new structures are rarely considered. Quality of design is too often seen today as a function of star-like attraction or short-term economic return. Sustainability is an overused term and a poorly respected ideal.

Frank Lloyd Wight's buildings are considered to be amongst the best examples of modern architecture. They continue to inspire and delight decades after their construction. A lesser-known feature of Wright's work is sustainability—or at least Wright's aspirations regarding sustainability.

Wright's holistic approach to design was based on the integration of architectural form and details with building technology (such as materials, systems, construction methods) in response to the local environment. Though these concepts can be considered sustainable, they were not driven by what is currently called sustainability (Geva & Morris 2012). Nevertheless, Wright demonstrated an acute awareness of sustainability in his use of reinforced concrete to construct the Imperial Hotel in Tokyo to withstand earthquake. His decade-long effort to make the design and construction stable in the event of tremor was proven successful when it withstood Japan's worst earthquake in 1923 (Heinz 2002, p.321). It is rare that architects have such opportunities to confirm the quality and sustainability of their buildings within their lifetime.

Wright had a wonderful command of all aspects of design including those aspects that are now associated with sustainability, such as natural lighting and human comfort without undue reliance on artificial measures. His great genius was to realise his ideas in ways that reflect both creativity, adaption to the local environment and the spirit of the age. This is nowhere more admirable that in his design for the Johnson Wax Administration Building in Racine Wisconsin (1936), and specifically the multi-level tower he added to it in 1944. The design of the tower illustrates to current generations of designers how places can be extended creatively in new and different works without destroying the beauty and cohesion of the original place. Others designers do not normally display the skill to add a beautiful glazed high-rise tower to a low-level brick complex without shattering the integrity of the original low-rise place.

The challenge of increasing the yield from existing places by enlarging and extending them is a common enough challenge in the modern era. Depending on the situation, architects have sometimes responded by building on top of existing structures in densely developed urban areas, when there is no more available space, or by excavating and building below them. Most commonly original structures are demolished and replaced with new, bigger structures—a practice that is demonstrably unsustainable in its waste of embodied energy resources.

In some European cities, where great beauty and consistency in architectural style existed long before the advent of high-rise construction, there is no appetite to now introduce high-rise buildings because of the unacceptable visual impact they would have on existing heritage values. In these places there is more subtle upward movement in the form of small, incremental additions on, and in place of, traditional roofs. This zone of new accommodation creates a type of city within a city (Lipp 2005). The new zone is dominated by affluent society. It is an expression of social and economic power—a kind of elevated gated community.

In Sydney, Australia, the State's Conservatorium of Music, which was built 1913 within the redundant 1820 horse stables of the nearby Governor's residence, occupies a beautiful harbour side site set in an important botanic garden. When the need for expansion became urgent, detailed consideration of alternative sites led to decision to develop on the original site. To achieve an outcome that would not have any adverse impact on the garden setting or heritage values, it was decided to build largely below ground and remove two large modern wings that were deemed to be intrusive. Today, the result is a world-class facility well integrated into its beautiful harbour side setting.

Setting, or the way that buildings relate to their environment, is an issue of increasing importance as cities and towns develop. Some cities, including Berlin, go to extreme lengths to recover open space and vegetation. Others, including Singapore, encourage vegetation on buildings. In Seoul, a principal river was rescued from beneath a road and an elevated freeway and now serves as a linear park, providing a new setting for living on both sides and a much appreciated recreation zone for citizens. Whether natural or man-made, settings are an integral and valued component of sustainable urban environments.

Quality measures are required to assure the equity and sustainability of urban environments and their contingent settings.

Examples of quality measures for development in urban environments

Quality indicators	**Outcome measures**
The work contributes to the quality of the urban environment.	The work is planned using sound design principles and receives strong community acceptance and support.
	The work protects and enhances the setting through the removal of visually intrusive elements, and/or the introduction of contributory new elements as confirmed through credible democratic consent processes.
The work does not exclude or displace any community or group.	The impacts of the works are moderated by measures to provide improved and/or alternative accommodation for displaced residents.
	Facilities and access are provided for the local community in response to the community’s expressed needs and aspirations.

Conservation of Heritage Places and Heritage Fabric

The conservation of heritage places and heritage fabric is explained in the Burra Charter in principles regarding doing as little as possible and as much as necessary, ensuring that works are reversible and that records of actions are recorded. In reality these principles are rarely followed. The extent of works are often driven by a desire to recover some assumed former pristine and are therefore more extensive than necessary. Reversibility is more often assumed rather than confirmed. Actions are rarely recorded and the record safeguarded for future reference. In fact, the action of undertaking works often takes on the form of a journey for which the planning is soon neglected in daily challenges of decision making along the way.

For important places and significant heritage fabric this reality should not be accepted. All participants should know at the outset what the end point should be like and all actions and decisions along the way should tested against the aim of achieving the defined quality outcome. When roadblocks are encountered or deviations required, the defined quality end point should still achieved although possibly via a different route. This requires quality measures such as the examples provided below

Examples of quality measures for heritage places and heritage fabric

Quality indicators	**Outcome measures**
The works respect the heritage values of the place.	The work is planned to protect and support the heritage values as defined clearly in the CMP. All significant fabric is retained.
	The works do not introduce any non-reversible forms or materials. There is an established body of sound reference material confirming the reversibility of the materials and processes.
The work does not have any potential to introduce new or harmful conditions.	The behaviour of the materials and processes can be reliably predicted and confirmed by respected research and prior history of safe use over time.

	The materials and processes do not preclude the future use of other materials or processes or require sophisticated technical solutions in the event of unforseen changes to alter or reverse the works.

Why Heritage Management Systems fail to deliver consistent quality conservation outcomes

Our heritage management systems share a common flaw — a disconnection between pre-consent planning processes, which are often costly and time consuming, and post-consent delivery, which can expose heritage-listed places to pragmatic decision making and adverse impacts to heritage values. These two critically dependent parts of the heritage system should be seamless and complementary; however, they are not. This flaw needs to be addressed to enable more sustainable outcomes, including better performance and improved environmental returns, as well as improved community health and wellbeing and higher standards of heritage conservation.

Heritage conservation management in Australia is now experiencing a crisis in the area of specialised trade skills. This demands an appropriate response. There is no point in repeating past failed endeavours such as setting up new training opportunities, or worse, surveying future needs, until there are incentives for training to acquire higher level skills to deliver higher quality works. All parties should align to establish a quality framework for sustainable heritage conservation, with clear objectives based on quality standards for all conservation activities including training to meet standards.

Proposal for a different approach – a Quality Framework

In 2005 the Productivity Commission identified the need for a clear specification of heritage outcomes, in the context of the need for the wider community to bear the costs of actions to promote public-good heritage services (Productivity Commission Draft Report 2005, s.8.3). Clearly, there would be an additional cost to raise the standard of works. However, by mandating higher standards for all works, the costs and benefits would be shared across the whole community. Training and employment of higher skills would be obtained naturally and the quality of the community's heritage assets would be improved and sustained. In addition, heritage management processes could be fast tracked to reduce administrative delays that are causing heritage fatigue and alienating owners. Quality measures would safeguard heritage values and offset concerns regarding due process. Existing processes would not be duplicated but rather supported and made more efficient with the security provided by quality measures in a quality framework.

Quality measures provide the means of assuring desired outcomes by describing what needs to be achieved and how to demonstrate it. Benchmarks in the quality framework would clearly define the standards required with all inputs and the quality of the required outputs, to inform all parties. Owners and managers would know what is required, professionals would know what to specify, tradespeople would know what to price and deliver, certifiers would have something to measure against, and trainees would enjoy a secure future with greater employment rewards for commitment to training to meet higher quality standards. Most importantly, standards could be monitored and consent authorities would regain a greater measure of control over the quality and sustainability of outcomes.

Conclusions

In the modern era it should be considered irresponsible and undemocratic to impose any non-sustainable or low quality structures, developments or works to heritage places on communities without their express informed concurrence. Quality measures could be used to guarantee higher quality standards and greater sustainability of all constructions. Benefits would accrue from the use of quality measures to the wider community and probably, also, to the designers, builders and promoters of works which might be otherwise of poor quality, unsustainable and a potential burden on future populations.

The likely higher initial cost of adoption of quality measures and a quality approach should not be perceived as a cost burden to present-day communities. Higher quality construction and design should deliver longer life cycles and greater sustainability. Immediate benefits of comparably higher standards of liveability would be enjoyed immediately. Quality would not impose a burden; rather, it would allow for more judicious and sustainable use of precious and dwindling resources.

Any perceived cost burden would not be carried solely by the community today because any increase in cost to achieve higher quality would deliver immediate benefits and, over the long term, greater sustainability for future generations.

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