Attending to Engineering Heritage

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Introduction

Engineering heritage encompasses the structures, sites, and objects that have contributed to the history, culture, and ingenuity of the engineering community and of the place—the community at large. Because these resources are subject to change by human and natural causes, attending to them, particularly on the part of the engineering educational and professional establishments, becomes imperative. Engineering heritage thus connotes heritage resources and preservation actions taken on the resources' behalf.

The scope of engineering and industrial heritage is quite broad. It encompasses items that have accumulated significance through time. A physical engineering work, such as a grain elevator or an electrical network, is not only the child of a chain of technical developments, but also an embodiment of historical cultural and social norms of the place in which it is situated. In this sense engineering works qualify as heritage items based on the degree of technical and cultural significance they unfold. This is clear in the information quoted below about two sites of Historic American Engineering Record of the National park Service:[1]

- Potomac Power Plant
  The current structure is the fourth structure to occupy its location. It was originally part of the U.S. Armory at Harpers Ferry and is situated between the Potomac River and the armory canal, whose original head gates still stand two miles upstream. The first building was a tilt hammer shop, constructed c.1830s, which was replaced by a rolling mill in 1854. Following John Brown's raid in 1859 and subsequent burning of the armory, Thomas Savery constructed a pulp mill on the site in 1888. The Harpers Ferry Paper Co. was powered by water from the armory canal, utilizing seven flume bays. In late 1898 plans were made to place a dynamo in the pulp mill to generate electricity for Harpers Ferry. Savery continued simultaneous operations of the electric plant and the paper mill until 1925 when a fire almost completely destroyed the structure.
- Natchez Trace Parkway
  Begun in the 1930s, this parkway follows the route of the historic Natchez Trace, a path used by Native Americans, pioneers and traders of the Mississippi River Valley. The present parkway generally follows the old trace and allows access for interpreting the many historical sites along the route. Beginning in Natchez,

Mississippi and ending in Nashville, Tennessee, the parkway exhibits a variety of unique engineering features and interpretive waysides that contribute to its importance as a historical park road.

The National Register of Historic Places, a respected list of heritage properties, has established engineering as a principal historic theme of significance, side by side American history, architecture, archaeology, and culture. The Register has elucidated a set of criteria against which the significance of historic properties can be measured.

However, the engineering community--academic and professional--has not so far given enough attention to historic engineering structures and sites. Engineering educational philosophies and offerings on engineering heritage are scant. In engineering practice, projects related to heritage resources are, in many instances, dealt with through the eye of new construction. Glimpses of hope for engineering heritage come, however, through Federal programs like the National Register and the Historic American Engineering Record.

Engineering education has a responsibility towards engineering and industrial heritage. This paper advocates introducing the heritage subject in engineering education. The paper will address the following objectives: a) defining heritage and heritage preservation context; b) exploring the status of engineering heritage as an area of study in engineering education, including efforts exerted by professional associations; and c) suggesting ways for engaging in engineering heritage education

Heritage and Preservation Context

Heritage is an elastic concept. In one interpretation it indicates something passing from generation to generation in a social group. This simple definition embodies a series of connotations: the heritage "things" come about under diverse themes, such as literature, art, and engineering; heritage assumes tangible and intangible qualities; it materializes with passage of time; and it develops in a social group—having spatial boundaries. William Faulkner's works are part of the United States people's literary heritage. In the same way, sun-drying food is an appropriate technology tradition for people in some regions of the world. On the more tangible side, rock art, sculptures, buildings, bridges, factories, landscape, and vessels are all potential heritage resources. This study deals primarily with historic sites, structures, and objects associated with civil, mechanical, electrical, and other engineering fields.

The United States Government involvement in preservation has resulted in a wealth of information for understanding and dealing with historic resources in general, and in our case, engineering resources, in particular. The mandate of the National Historic Preservation Act (NHPA) of 1966 is so sweeping that the resulting information is not only extensive in magnitude but also efficient in effect. The purpose and policy of the Act[2] give one a hint as to the impetus behind generating such information. The purpose of the Act

builds on a series of national beliefs and recognitions. The text recognizes the cultural, educational, aesthetic, inspirational, economic, and energy benefits of heritage resources to the public; associates the spirit and the direction of the nation with heritage; recognizes the loss of cultural resources; and requires preservation of the heritage as part of community life and development.

Emphasizing the Federal Government's leadership role in the preservation of historic resources, the Act's policy declares the government's varied support for federal agencies, State governments, local governments, and private sector entities in carrying out their preservation activities. The policy sees the acts of preserving the resources as contributing to the "productive harmony" with modern society. Productive harmony is an expression of the policy's intent of balancing the cultural and the utilitarian benefits of resources.

Attending to heritage, engineering or otherwise, begins with recognizing the resources under consideration as such—heritage. In the United States, such recognition can be achieved in the context of the criteria and procedures laid out by the National Register of Historic Places (NRHP) of the National Park Service,[3] a forefront mechanism to implement the federal NHPA. The language describing the criteria uses the operational term "significance" as the ultimate measure for deciding on listing a property or not. "Significant" historic resources must:

- Fall within one of the "significance" themes: American history, architecture, archaeology, engineering, and culture.
- Fall within one of the resource classifications: districts, sites, buildings, structures, and objects.
- Possess integrity of location, design, setting, materials, workmanship, feeling, and association.

In addition, historic resources should meet one of the following criteria:

- Association with historic events
- Association with important personalities
- Embodiment of distinctive design, construction methods, or artistic achievement
- Provision of information important in history or prehistory

The federal preservation assistance to the owners of historic resources is premised on carrying out the preservation treatment according to established standards. There are four types of treatments, and each has a set of standards. Treatment types include: a) preservation, b) rehabilitation, c) restoration, and d) reconstruction. For example, while preservation is confined to stabilizing and maintaining the materials and features of the resource, rehabilitation allows some changes to meet the practical use. The standards, on the other hand, are the provisions against which the treatment should be carried out. For example, Standard 1 of the Secretary of the Interior Standards for Rehabilitation states, "A property shall be used for its historic purpose or be placed in a new use that requires minimal change to the defining characteristics of the building and its site and environment."[4] The Standards are an effective tool for the protection of historic resources.[5] The federal funding provided critical support for the preservation of National

Register properties.[6]

Engineering heritage has obviously received a considerable attention in the federal preservation plans. Today's heritage was yesterday's mechanism of development. The strength of the United States in the 1800s resulted, to a considerable degree, from the accomplishments in engineering.[7] The National Register has elevated this heritage into a major theme of significance. According to the Register's classification of resource types, engineering heritage items come mostly under the "structure" class. With the creation of the Historic American Engineering Record (HAER) in 1969, the National Park Service added emphasis to engineering historic resources. HAER mission is to document the nation's significant engineering and industrial sites through measured drawings, large-format photography, and written history.[8] Interestingly, the American Society of Civil Engineers (ASCE) and the Library of Congress were partners with the National Park Service in bringing HAER into being. In the ensuing years, other professional engineering association ratified HAER, including the American Society of Mechanical Engineers (ASME), Institute of Electrical and Electronic Engineers (IEEE), the American Institute of Chemical Engineers (AIChE), and the American Institute of Mining, Metallurgical and Petroleum Engineers (AIME).

The Value of Heritage

Heritage is of value to the engineering community on disciplinary and civic grounds. It adds to the vitality of engineering disciplines. A look at engineering projects reveals the significance of existing facilities, structures, and systems as subjects of engineering activity. Engineering facility addition, renovation, and maintenance undertakings continue to drive the profession, side by side new construction projects. While not all existing subjects qualify as "heritage" subjects, the point is that heritage subjects are a significant tributary to the profession.

Heritage is a link with the community at large. Historic structures, sites, and objects are an avenue for the engineering community to channel its civic obligations. "To support the social good of the society" is a stressed point in many engineering schools and professional associations. Curriculum courses, school community outreach programs, engineering firms' practice undertakings, or any other heritage enhancement measures, all converge on addressing the benefits envisaged from identifying and preserving the heritage. In an overall view, historic resource benefits are either humanistic or utilitarian; the argument for each is highlighted below.

The Humanistic Argument

This argument celebrates the cultural, historical, creative, and learning merits inherent in historical resources. Physical resources, as a bridge, a town square, or a factory production line, are the context of the human cultural experiences through time. They emerge from the people's needs and aspiration and, once standing, shape the people's behavior and memory. A small town's historic bridge is more than a link between two

points. It embraces human interaction in otherwise isolated flanks of a barrier. Doing so over a period of time develops a rhythm of behavior or a pattern of events weaving an ingredient of the "way of life", or culture, of the place. Some events, however, are single occurrences that signify a historical benchmark, thus, in addition, contribute to the history of the place.

Some historic works signify binnacles of scientific genius, artistic creativity, or societal leadership. They achieved distinction through a profound concept, a composition, a methodology, or subsequent effect. Recognition is allotted to the work and to individuals behind the work, if known. The Hoover Dam and the Frank L. Wright works are two examples. Historic items of this nature do not only represent benchmarks of scientific, artistic, and leadership history of the place, but also shine as beacons for others to follow.

The Utilitarian Argument

Do the humanistic benefits manifest themselves in economic value?[9] This is where the utilitarian argument comes to the fore. The utilitarian argument is based on appropriateness of use of the historic resources and feasibility of intervention. Use and feasibility are, obviously, intertwined. Depending on many factors, especially the economic, proposals for preservation intervention may keep the original use or shift to a different one, most probably with adaptations to the physical configurations of the resource. Because setting up historic resources into continued or adaptive use involves a variety of issues, it entails the participation of various parties. Beside the economic issues, the technical design and the legal compliance issues are paramount. For example, in order to convert an old factory into a cluster of stores, the proposed design and materials specifications have to meet the Secretary of Interior Standards for Rehabilitation. Without such compliance federal assistance may not be tenable.

For the owner of a historic structure, the question of whether to preserve or build a new facility is most often a matter of economic feasibility. A decision to build (after demolition), rather than preserve, need not to be taken irritably by preservation advocates if the decision making process was well informed. What irritates is the ambivalent, if not hostile, attitude of some decision makers towards the value of historic resources. Dismantling a deserving structure or building under such circumstances halts the economic contribution of preservation and, worse, cast doubts on the economic viability of preservation as a development strategy.

The economic impact of preservation becomes more elaborate when dealing collectively with historical resources. This is evident in area development and tourism. In the United States, many development plans for urban districts and small town centers incorporate the historic resources of the area as a principal element for intrinsic revitalization purposes or, further, for enhancing tourism. Similar development plans have been implemented to revitalize residential neighborhoods physically, and in the end, economically.

Historic resources and economy of tourism have long been associated. Tourism opens the door for a line of activities that add to the versatile use of resources. Outdoor sites,

standing structures, and interior spaces continue to be exhibited for the curiosity and pleasure of the paying visitor. For archeological sites, that cannot otherwise be conventionally reused, tourism is indeed an expedient activity. Regardless of resource type, however, the success of tourism depends to a great degree on integration with the respective heritage and preservation sector.

The association of historic resources and economic tourism is not always benevolent. The reputation of historic resources as a source of revenues comes at a potential cost to the resources themselves. The public's touring rituals inflect commensurate stress on the physical integrity of the resources. The lure of tourism's financial returns to the parties concerned may cause impairment to historic resources, inadvertently through unawareness of the perils of exposing the resources to the tourists' feet, or complacently by ignoring the perils' effect altogether. This scenario can be avoided through the heritage preservation-tourism integration alluded to above.

Engineering Education and Heritage

The American engineering community, schools and professionals, has not so far taken heritage education enthusiastically. Within this general assessment framework, engineering schools lag behind professional associations in attending to engineering heritage. Further, when compared in the same respect with environmental design academe, such as architecture and urban planning, engineering schools largely fail to measure up. Is it that the value of engineering heritage, and for that matter the built environment heritage, is kept out of the educators' realm of thought?

Glimpses of attention to heritage by engineering associations started in the 1960s and have continued since. Of the associations that have added heritage related programs are the following, listed with their heritage programs and year of program establishment:[10]

- The American Society of Civil engineers (ASCE), Historic Civil Engineering Landmarks, 1964
- The American Society of Mechanical Engineering (ASME), History and Heritage Center, 1971
- The Institute of Electrical and Electronics Engineers (IEEE), History Center, 1980

However, such associations' heritage programs have developed with two distinct characteristics:

- Heritage is—understandably—confined to the association's engineering discipline, as clearly inferred from the list of associations and their programs above.
- The objectives are largely informative and inspirational, concentrating on the identification of past engineering works and the engineers behind them. The associations' partnership with HAER, mentioned above, is a measure in the right direction.

The above characteristics are typical of the associations' service mission, but they add little to the tasks of heritage education that need to be undertaken by the engineering

community at large. Particularly missing is information or training on preservation of historic works as professional undertakings within the national, State, and local context of preservation.

The answer for what the engineering community should achieve in the realm of engineering heritage can be attempted only in broad terms. The sheer multiplicity of the engineering disciplines and the education-profession duality of the community make another mode of attempt inconceivable. In this vein, I begin with identifying below a three-tier heritage engagement scheme. Before I discuss this scheme, however, let's keep in mind two points: a) although our focus is "engineering" heritage, the engineer's heritage knowledge and skills are transferable to other built environment heritage, and b) the conventional university course is the yardstick used to measure the educational and training experience for the engagement levels. However, a course "segment' could also be used to express an educational and training experience less than that afforded by a full course, with the understanding that two or more segmental experiences under different courses are equivalent to one course unit. The course segment concept of measurement would prove feasible in an engineering institution where heritage education is thinned over a number of courses. Further, the course unit defined above is not necessarily the unit suitable to measure continuing education experiences.

The scheme of engineering heritage engagement consists of the following:

1. Incipient engagement. This level deals with information about the history of engineering and technology. It is theoretical in nature, involving no technical skills. This level is attainable at the completion of a course in general engineering or technology history.
2. Operative engagement. This level deals with the qualified definition of historic resources, knowledge of the national preservation movement, and understanding of the preservation process. It involves basic technical skills for intervening into the physical resources. Attaining this level positions the engineer for advancement to the professional level (discussed next) after a period of training on the job. It also enables the engineer to participate effectively in community service involving historic resource issues. This level is attainable by the completion of a well-rounded course or two in preservation principles and methods.
3. Professional engagement. This level deals with advanced knowledge and technical skills appropriate to direct professional projects. It develops individuals qualified for leadership roles in heritage preservation. The professional level is attainable at the completion of a series of courses covering most aspects of heritage resources and their preservation. Such courses can form a concentration, most appropriately at the graduate study level.

How can this scheme of engineering heritage engagement be brought to bear on heritage education in engineering schools? To demonstrate, I employ the scenario of a comprehensive engineering college with multiple discipline offerings. A strategy of engagement for this college advances as follows:

1. Incipient engagement education is required. Students in all disciplines complete this requirement for graduation.
2. Operative engagement education is recommended (elective) with an eye of making it eventually required, as applicable. For example, civil or architectural engineering departments might find it appropriate to require the course for their students, or better yet to share a parallel course specially tailored to their interconnected specialties.
3. Professional engagement education is an appropriate initiative only under very special circumstances. More fitting as a graduate concentration or even a graduate degree, such engagement derives student mass from diverse engineering backgrounds.

Concluding Remarks

Within the broad meaning of "heritage", engineering heritage is clearly defined. Engineering heritage encompasses the structures, sites, and objects that have contributed to the history, culture, and ingenuity of the engineering community and of the place. The federal preservation program does not only provide ample information about the philosophical and technical aspects of heritage preservation, but also extends technical and financial assistance.

Benefits of heritage preservation have been established. For the engineering community, heritage is a source of professional and civic activities. On the other hand, the participation of engineering schools and professionals in heritage preservation helps realize the society's humanistic and utilitarian benefits embedded in such resources.

The engineering community's engagement in heritage education is still limited. A scheme of heritage engagement for engineering schools, in particular, has been proposed together with scheme application guiding information. The scheme asserts a) incipient engagement is required, b) operative engagement is recommended with an eye on making it required, and c) professional engagement is to be considered only under very special circumstances.

Guided by the proposed heritage engagement scheme, integrating heritage education into engineering curricula and professional continuing education plans is the first step towards cultivating heritage benefits. This integration is bound to elevate the engineering community's functional capacity in the area of engineering heritage preservation. In the end, integration will be the reason for increased engineering professional opportunities as well as an avenue for serving heritage preservation goals of the society.

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