Transmitting Information Across Time

An Interactive Qualifying Project Report

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Daniel Pacheco-Cruz, Shawn Finnigan, Trevor Ng and Charles West

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Brian Moriarty, Advisor (IMGD)

Abstract

This report explores strategies for transmitting information across generational spans of time. Methods investigated by the project team include time capsules, tradition, rituals and literature, together with mechanical and electronic solutions. By studying historical precedents and human behavior patterns, we identified both problems to be overcome, and opportunities for increasing the likelihood that information consigned to the future will be received as intended.

Contents

1. Introduction

Over time, the environments we live in evolve, slowly or quickly, too often in ways that can leave our past forgotten or unrecognizable. Nevertheless, a desire to preserve our individual and collective stories, and piece together whatever remnants of history can be recovered, seems to be a part of human nature.

Information about the past is maintained in many forms, including oral traditions, written texts, personal memorabilia, and public collections such as museums and libraries, together with various artifacts and messages concealed either by accident or, occasionally, by design.

Motivated by the inevitability of change and the fear of oblivion, certain individuals and groups task themselves with the deliberate transmission of information perceived as valuable into the future, for retrieval by a future generation. Some of these attempts succeed, but most do not. The goal of this project was to study the factors that determine the likelihood that information consigned to posterity will be received as intended, over periods greater than a human lifetime.

Physical changes are the major threat to information transmission, especially if the message is instantiated in some physical form that might be discovered too soon or by the wrong recipients, or (more likely) damaged, destroyed or simply forgotten. However, even if an information carrier survives, cultural and societal changes may cause the transmitted content to lose some or all of its original meaning or value.

To limit the scope of our investigation, we focused our research on the environment being shared by the project team, the WPI campus. It turns out to be a very different place now than it once was. Most of its landscape has been irrevocably altered by relentless expansion, and many of its traditions have likewise been reworked or abandoned. By studying how the campus has evolved in the 150+ years since its establishment, we hoped to identify one or more

locations where a physical information carrier might be deposited and remain undisturbed – but not forgotten – for at least a century.

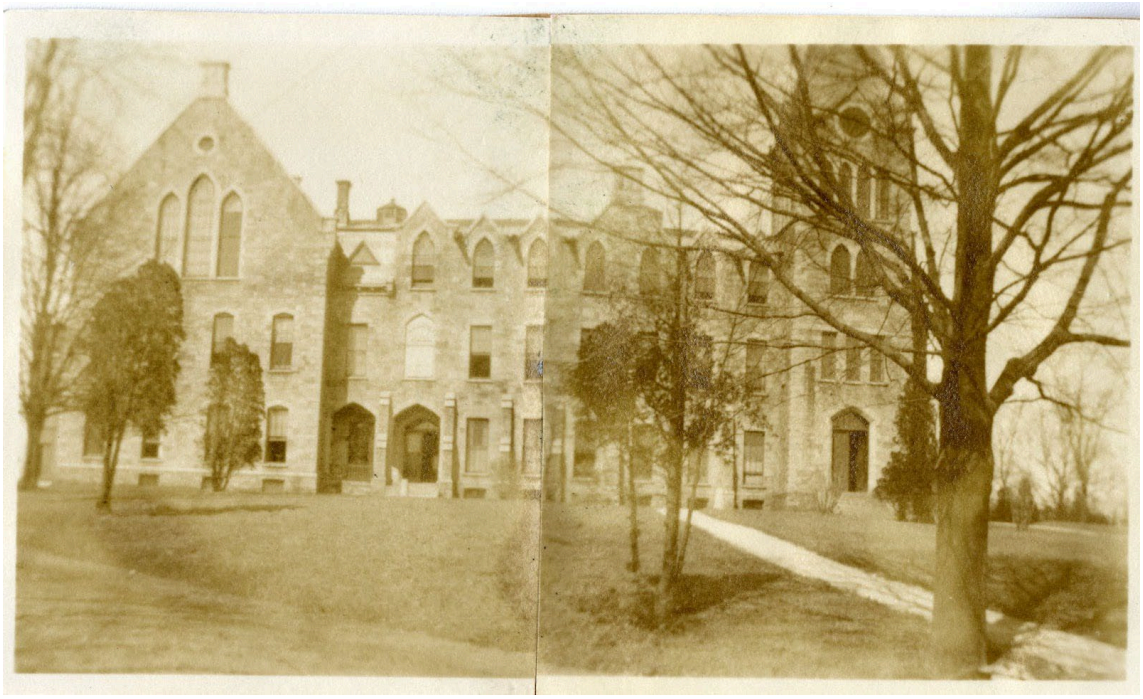

Figure 1. Boynton Hall, Worcester Polytechnic Institute, 1906. Source: URL.

2. Morphology of the WPI campus

WPI's campus was inaugurated in 1868 with the construction of Boynton Hall (Figure 1), named to honor John Boynton, who anonymously donated $100,000 for the building's construction (WPI Tech Bible). The exterior of the structure has changed little over the years, but its interior has been subjected to sporadic renovation.

In the 1920s, a single room in Boynton was significantly remodeled, and subsequently renamed Sinclair Hall (Pervere). The most dramatic changes occurred in 1978, when the building's interior was completely gutted and reconfigured into a space similar to what we make use of today (WPI Tech Bible).

The landscape surrounding Boynton has proven to be highly dynamic in comparison, evidenced by its ever-shifting arrangement of paths, driveways, foliage and ornamentation.

Figure 2. View of campus depicting Boynton Hall (left) and Washburn Shops (right) from Stephen Salisbury's orchard, 1885. Source: URL.

The next building erected on campus was Washburn Shops in 1868 (Figure 2). The three-story, 102 x 44' structure was constructed of manufactured brick to symbolize its forward-thinking purpose. It is the oldest building in the United States continuously used for engineering education (WPI Tech Bible).

In 1882, Washburn became the first campus building to be substantially renovated, including the installation of a hydraulic elevator, a cheaper alternative to the then-common steam elevators (WPI 150 Years).

When required student apprenticeships at WPI (in effect since 1886) were abolished in 1955, much of the space in Washburn became underutilized. A 10-kilowatt nuclear reactor was installed to support a Nuclear Engineering program, followed by a comprehensive interior renovation in 1984, demolishing the areas now occupied by the welding facility and

laboratories, and adding a new structure on the side of the building facing Salisbury Labs ("Washburn Prepares for a Face Lift").

In 2011, security concerns led to the decommissioning and removal of the nuclear reactor (Hamlette, "WPI Construction Project Update"). The large room used to house the reaction chamber was sealed and decontaminated over the course of several years. It was finally reopened in late 2021, and is now being converted into a new lab space.

Figure 3. Exterior of the Magnetic Laboratory, 1902. Source: URL.

Soon after the initial renovation of Washburn Shops, Stephen Salisbury III developed an interest in electricity and magnetism, and donated money to have a building constructed for the purpose of studying them (WPI Tech Bible). To aid its functionality, it was fabricated with a number of curious attributes. The distinctive conical tower was aligned with the magnetic meridian, using methods designed to minimize internal vibration. No iron was used, and its floor was secured with hand cut-brass nails. Salisbury's Magnetic Laboratory was opened for research in 1887 (WPI 150 Years).

Ill fortune fell upon the Magnetic Lab just a few years after its construction. The City of Worcester installed a horse-drawn railway on the adjacent street, resulting in vibrations greater than the building was designed to dampen. In 1891, the clatter of horse hooves was replaced by the even more obnoxious sparking of an electric trolley, soon followed by electric lighting. These interference sources rendered the Magnetic Lab completely useless for its intended purpose (WPI Tech Bible).

In 1911, the neglected Magnetic Lab was given to the *Tech News*, WPI's student newspaper, for use as their main office. They were displaced seven years later by Robert H. Goddard, who utilized a grant to have the Magnetic Lab remodeled so he could perform his historic (and dangerous) experiments with liquid rocket fuel there (WPI Tech Bible).

The Magnetic Lab underwent another remodeling in 1921, when it became the home of Skull, WPI's "secret" senior honor society. These mysterious occupants rebranded their new lair as the Skull Tomb. Its name and tenancy have remained unchanged for over a century (WPI Tech Bible).

Figure 4. Exterior of Salisbury Labs, 1890-1899. Source: URL.

The next building to see construction was Salisbury Labs in June of 1887 (Figure 4). It was built to give WPI more laboratory space, and was funded by a gift from Stephen Salisbury III in honor of his father, one of WPI's original benefactors. The building was dedicated to the Salisbury family during the cornerstone laying ceremony in 1888, and construction was finished in 1889 (WPI Tech Bible).

Salisbury Labs would eventually receive renovations based on plans initially submitted and approved in 1893, with the renovations finally happening in 1939. This was primarily due to a lack of funding. These renovations would enlarge some facilities. It received two new additions. Electrical Engineering claimed much of the new space. Another portion featured a new lecture auditorium, Kinnicutt Hall. The building underwent additional renovations in 1976 and 1998 (WPI Tech Bible).

Stratton Hall was built next to help house the department of Mechanical Engineering at WPI. It accompanied the WPI Power House and Hydraulics Laboratory being built in 1884. Stratton was a four-story building with a footprint of 116 by 53 feet. Originally, the first two floors of this building contained undivided space, with the third floor providing a lecture hall, library, and recreational rooms, and the fourth floor complementing the others with two drawing rooms, a model room, and a machine design room (WPI Tech Bible).

Figure 5. WPI Iron Foundry exterior, 1940-1949. Source: URL.

In 1902, WPI's Iron Foundry was finished (Figure 5). With a footprint of 90 x 52 feet, the foundry allowed WPI to fabricate many of the machine parts it would need on campus, and served commercial needs as well (WPI Tech Bible).

Despite its commercial and campus success, it didn't take long for the Iron Foundry to be converted from a foundry to a forge shop. This significantly bolstered its capabilities, allowing it to aid in creating the parts Robert Goddard would use in his experiments. Later renovations transformed the space into what is now WPI's Project Center (Project Center).

Figure 6. Exterior of Atwater Kent Labs, 1970-1979. Source: URL.

WPI's Electrical Engineering department eventually outgrew its facilities at WPI, leading to the construction of another new building in 1907. Built in the shape of the letter E to symbolize its purpose, it was originally nicknamed the "Great Laboratory" or "EE Building" (Figure 6). The facility was later renamed to honor radio manufacturing mogul Atwater Kent, a WPI dropout who later became a major donor and Board of Trustees member. It included a spacious garage for practicing the operation of electric trolleys, and featured a direct rail connection to the City of Worcester's trolley system (WPI Tech Bible).

After World War II ended, Atwater Kent received its first major renovation to accommodate smaller and more efficient equipment coming into use. Additional renovations occurred in 1961 and 1981 (WPI Tech Bible).

Figure 7. The Alumni Gym with its connection to Harrington Auditorium. Source: URL.

In addition to academic buildings, WPI also established athletic facilities, beginning with the purchase of Bliss Field in 1909, followed by Alumni Field in 1914 and the adjacent Alumni Gym in 1916 (Figure 7) (WPI Tech Bible).

In 1927, WPI's first student residence, Stanford Riley Hall, was completed. Its four and a half stories housed 115 men in 66 rooms, with a dining hall in the basement. Renovations in 1970 replaced the dining hall with the Goat's Head Pub, reflecting an era when the minimum drinking age in Massachusetts was 18 (WPI Tech Bible).

The Goat's Head was rebranded as Gompei's Place, a deli and pizzeria, in 1986. It maintained this function until the completion of the new Campus Center in 2001. The space was converted into what is now the Little Theater in 2005 (WPI Tech Bible).

Figure 8. Aerial view of campus depicting West Street cutting though the middle, April 18th, 1968. Source: URL.

As more and more buildings appeared to support WPI's mission, the problem of crossing West Street, a public way running through the center of the campus, became increasingly urgent (Figure 8). Access was improved by the Earle Bridge, completed in 1940 together with the adjacent Alden Memorial Hall. Alden initially served as WPI's main auditorium, cinema and library (WPI Tech Bible).

In 1996, WPI negotiated a deal with the City of Worcester, trading land in what is now Institute Park in exchange for control over West Street, which was then closed to public traffic. This arrangement finally joined the two halves of the campus. Reunion Plaza, with its fountain and seating areas, now occupies the center of the former West Street passage. (WPI Tech Bible)

The Mechanical Engineering department got a new home in 1942 with the construction of Higgins Laboratories, which included facilities for studying heat transfer, lubrication, fuels, metal structure analysis, refrigeration, internal combustion, aerodynamics and eventually laser technologies (WPI Tech Bible).

Kaven Hall opened in 1954 as the new home of WPI's Civil Engineering department. Following the design lead of Atwater Kent, Kaven was built in the shape of the letter C. It underwent a complete interior reconfiguration in 2021, and is now equipped with more energy-efficient windows and HVAC systems, new classroom and office spaces, together with numerous improvements (including an elevator) required to make the building fully ADA-compliant (Q&A with Carrick Eggleston).

A need for more student housing space resulted in the construction of Morgan Hall in 1958. It originally contained 92 double rooms and eight singles housing 192 students, along with a large, multi-room cafeteria with a capacity of 575. In 1999, the interior of Morgan was reconfigured to allow both women and men to occupy the building (WPI Tech Bible).

1958 also saw the construction of Olin Hall, an academic facility intended primarily for the Physics department, including 17 laboratories, 13 offices, six classrooms, a large 208-seat lecture hall, a dedicated Physics library and a seminar room, together with a Van de Graff accelerator (WPI Tech Bible).

Daniels Hall became WPI's third residence building in 1963, designed to house 180 students and provide office space for the *Tech News* and *Peddler*. In 1973, Morgan and Daniels were physically connected by The Wedge, a common area featuring new study and activity spaces. (WPI Tech Bible)

In 1965, Goddard Hall was constructed to support WPI's Chemistry and Chemical Engineering programs. Its interior received a $3M renovation in 2005, including extensive equipment upgrades and a new set of laboratories known as the Fuller Chemistry Complex. Further improvements in 2008 added the George I. Alden Life Sciences and Bioengineering Educational Center. (WPI Tech Bible)

In 1967, WPI finally constructed a dedicated library facility on the hillside adjacent to Washburn and Salisbury Labs. The five-story Gordon Library accommodates up to 600 students. It was followed a year later by the Harrington Auditorium, built beside the Alumni Gym. Harrington received numerous renovations over the following decades, including new flooring, bleachers and a scoreboard (“Harrington Auditorium”). WPI’s rapid building phase continued with the appearance of its fourth residence, the apartment-style Stoddard Hall, in September of 1970 (WPI Tech Bible).

Figure 9. Higgins House, circa 1979. Source: URL.

1970 was also the year WPI acquired its most unusual structure, an authentic recreation of an English manor house (Figure 9). Originally built in 1923 by WPI alumnus Aldus Higgins, ownership of this elaborately ornamented complex of buildings and gardens was transferred to WPI upon the death of his widow. Over the years, WPI has utilized Higgins House to accommodate various offices and dining facilities. Its Great Hall and Library regularly host meetings and performance events. Extensive maintenance has been required to keep the facility in service, including the replacement of many of its period windows (WPI Tech Bible).

The Ellsworth/Fuller Apartments became WPI's fifth residence facility in 1973. Each of its living suites accommodates three to seven students. On-campus housing capacity was augmented again in 1993 with the purchase of Institute Hall, an apartment building originally owned by the Pi Chapter of the Lambda Chi Alpha fraternity (WPI Tech Bible).

Recent additions to the WPI campus include Fuller Laboratories in 1990, which originally included the Perrault Lecture Hall, a 400-seat classroom/cinema that was subsequently divided in two. The current Campus Center opened in March of 2001, followed a year later by the Bartlett Admissions Center (WPI Tech Bible).

In 2007, an expansive Life Sciences and Bioengineering Center was constructed a short distance from campus in the newly acquired Gateway Park property. The following year, East Hall became WPI's seventh residence facility, with apartment suites capable of housing 232 students (WPI Tech Bible).

Anticipating the demolition of the aging Alumni Gym, WPI began construction of a gigantic new athletic facility on May 16th, 2010. It opened as the Sports & Recreation Center in 2013 (Moynihan et al.) The same year, an eighth residence building, Faraday Hall, opened in Gateway Park, together with a badly needed parking facility, the Rooftop Garage, constructed beside the new Sports and Rec Center.

The Foisie Innovation Studio (since rebranded as the Innovation Studio after an unfortunate scandal involving its namesake) opened on the site of the former Alumni Gym in 2018, topped by yet another residence facility, Messenger Hall ("WPI Opens the Foisie Innovation Studio and Messenger Hall").

The most recent addition to the WPI campus is Unity Hall, a five-story complex of laboratories and classrooms which opened on the hillside beside the Gordon Library on January 11th, 2022 (Graves).

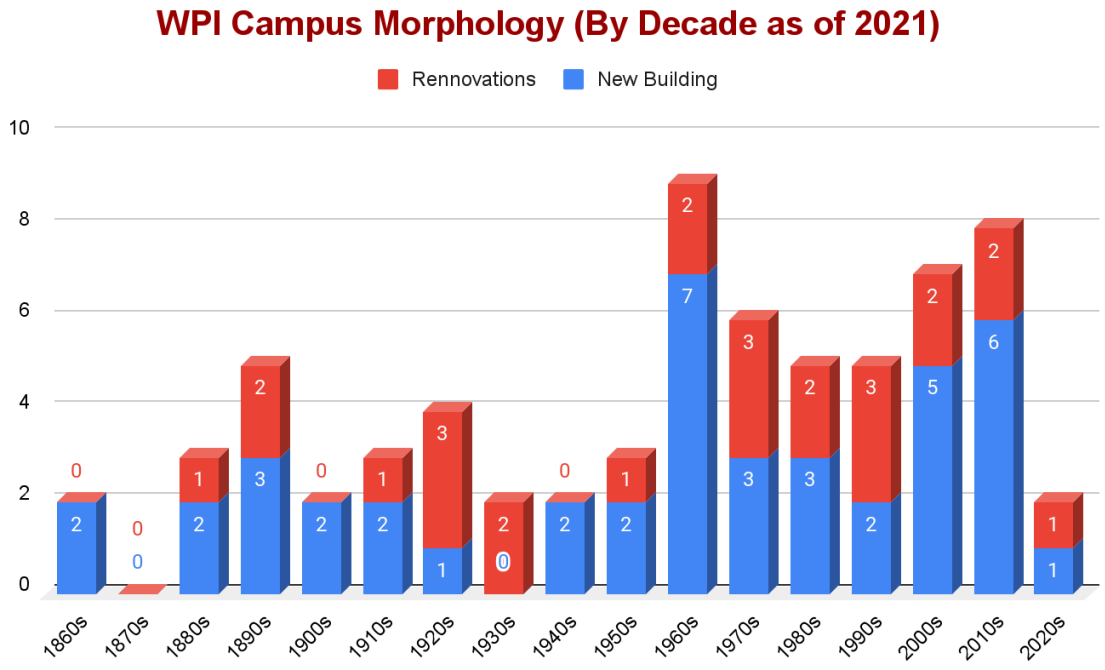

Figure 10. Decade-based timeline of WPI construction to February 2022. Source: Authors.

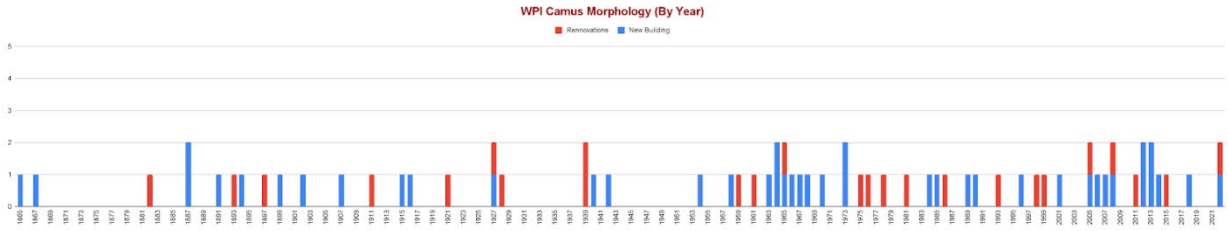

Figure 11. Year-by-year timeline of WPI construction to February 2022. Source: Authors.

Figures 10 and 11 above visualize the morphology of the WPI campus by decade and by year, respectively.

2.1. Potential capsule locations

As the above morphology demonstrates, WPI tends to favor renovation over demolition. Several buildings, including Boynton and Stratford Halls, the Washburn, Salisbury and Atwater Kent Labs, the Power House, the Skull Tomb and the Knowlton Wall are well over a century old. Higgins House, which is included in the US National Registry of Historic Places, turns 100 in 2023 (National Archives Catalog). None of these iconic structures seems likely to face a wrecking ball anytime in the foreseeable future. Only one major campus facility, the Alumni Gym, has ever been demolished, after serving the community for exactly 100 years (1916-2016). The unique grotesques that covered this building were carefully removed for preservation, together with the building's cornerstone and the time capsule it contained (Hamlette, "Grotesque Departure").

WPI has never hesitated to gut the interior of a building for desired renovations (Boynton Hall in 1978, Kaven Hall in 2021, etc.). Major renovations make building interiors a potentially risky place to deposit a time capsule, which might be moved, damaged or even lost in the rubble of construction.

The grounds immediately adjacent to campus buildings pose a similar risk, as some buildings (such as Atwater Kent) have been expanded to provide more room. However, Boynton and Stratford Halls, the Washburn and Salisbury Labs, the Power House and the Skull Tomb are all included within a US National Historic District, which somewhat limits their eligibility for exterior modification (MHC Historic Inventory).

The hillside northeast of Boynton Hall, leading down to the corner of Institute Road and Boynton Street, offers a picturesque, flattering view of the campus that seems likely to escape significant tampering for a long time. This hillside, already scattered with numerous memorials and class gifts, is among the most promising locations for a potential time capsule installation.

2.2. Gatekeepers

The installation of a time capsule on campus property presumably requires permission from appropriate authorities. Initially, we assumed there was a high-level administrative committee tasked with greenlighting such projects, and attempted to find someone who could identify the gatekeepers and explain the procedures needed to obtain their blessing.

Initial attempts to contact and meet with various officials fell through, delaying progress on the project. Luckily, we were finally put in touch with Nick Palumbo, Director of Design and Construction for WPI's Department of Facilities. Our interview with him gave us valuable insight into WPI's capital project approval process, which involves both short-term (one year) and long-term (five year) planning and budgeting cycles.

> "We're in the process of putting together the [project] list for FY23. Through the fall and over the winter, Finance solicits requests from the campus community. We now have that list and are aggregating that, along with the projects we want to see go forward from a Facilities standpoint … There's [also] a five-year capital plan, which has major items on it, like new buildings." (Palumbo interview)

We also solicited Palumbo's views concerning how future development of the WPI campus might affect the durability of a prospective time capsule.

Likely trends in campus development can be identified. Despite its status as a nationally recognized historic landmark, the land around Higgins House has been steadily encroached upon by various development projects. It's not impossible that WPI (or some subsequent owner) might someday attempt to claim some or all of the property for new construction. Other ageing buildings, such as the Gordon Library and several residence halls, are already in need of extensive renovation, and may be subjected to dramatic reconfiguration or outright demolition in the coming decades.

Time capsule projects often encounter problems with gatekeepers. A NASA team working on a 1970s mission to Titan, one of Saturn's moons, ran into such issues when they attempted to design and install a marker on the spacecraft that would identify its builders to any person (or species) who might discover it in the distant future. One team member, Carolyn Porco, was considered an essential political ally for getting the marker approved. Unfortunately, her desire to secure sole credit for the venture, together with her attempts to monetize the effort, discouraged and drove away most of the project team. The diamond disc manufactured to bear the original message was eventually shelved, replaced by a marker bearing the names of individuals who paid to have their names sent to Titan (Benford, 129).

It is also reasonable to expect external forces, both large and small, to affect the future of the campus. As Palumbo noted,

> "Overall, it is hard to say what the future holds for the campus. It could remain an institution, and merely continue to grow, renovate, and improve its campus. Or it could fall, and completely change the occupation of the land it is on." (Palumbo interview)

A large war could break out, dividing or destroying the society we live in today. Natural disasters, such as Great New England Hurricane of 1938, or the 1953 F4 tornado that missed WPI by barely a mile (and destroyed the campus of nearby Assumption College) are an eventual certainty. Over longer spans of time, attempts to transmit information to future generations need to account for changes in language and/or culture that might compromise a recipient's comprehension of the message.

2.3. Existing WPI time capsules

Our research verified the existence of five time capsules formerly or currently deposited on the WPI campus. Three of these had been previously forgotten.

Figure 12. The time capsule once sealed within the cornerstone of the Alumni Gym. Source: WPI Archives.

One capsule, a small aluminum box, was sealed in the cornerstone of the Alumni Gym (1916). Its presence was recorded by multiple photographs taken during the dedication ceremony and related newspaper articles. The box was successfully retrieved when the building was demolished to make way for the Foisie Innovation Center. It has not yet been opened. However, the WPI Archive has preserved a list of its contents prepared before it was deposited, together with the capsule itself (Figure 12).

Figure 13. This 1958 photo of the dedication ceremony for Olin Hall depicts Allen Parker applying mortar to the top edge of the cornerstone. The rectangular gap visible in the rear underside of the stone may be the resting place of the time capsule it is believed to contain. Source: WPI Archives.

The WPI Bible briefly notes the presence of a time capsule deposited in the cornerstone of Olin Hall (WPI Bible). This is the only record of the capsule known to exist. The capsule itself is unmarked, and its contents (provided by the Olin Foundation, which funded the construction of the building) are unknown. However, a photograph of the dedication ceremony we discovered in the WPI Archive shows the cornerstone just prior to its installation (Figure 13). A curious rectangular gap, visible in the underside of the stone, may indicate the place where the capsule was eventually hidden.

Figure 14. This photo of the Goddard Hall dedication ceremony on 16 March 1965 shows an unidentified official placing items into a metal box presumed to be a time capsule, which was probably sealed within the building's cornerstone. Source: WPI Archives.

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Figure 15. A sealed box similar to the one appearing in Figure 14 rests beside the cornerstone of Harrington Auditorium during its dedication ceremony on 1 February 1968. A compartment for enclosing the capsule is visible on the back of the stone. Source: WPI Archives.

Further research in the WPI Archive unearthed photographic evidence for the likely presence of two additional time capsules. One appears to be deposited in the cornerstone of Goddard Hall (Figure 14). Another, nearly identical in size and appearance, is probably preserved within the cornerstone of Harrington Auditorium (Figure 15).

2.4. A mystery solved

The discovery and positive identification of a fifth WPI time capsule turned out to be a dramatic highlight of this project. The story began with our team investigating the status of the Alumni Gym's capsule. In conversation with WPI Archivist Arthur Carlson, we learned about the recent discovery of a sealed, unmarked time capsule by workers undertaking the construction of Unity Hall, adjacent to the Gordon Library.

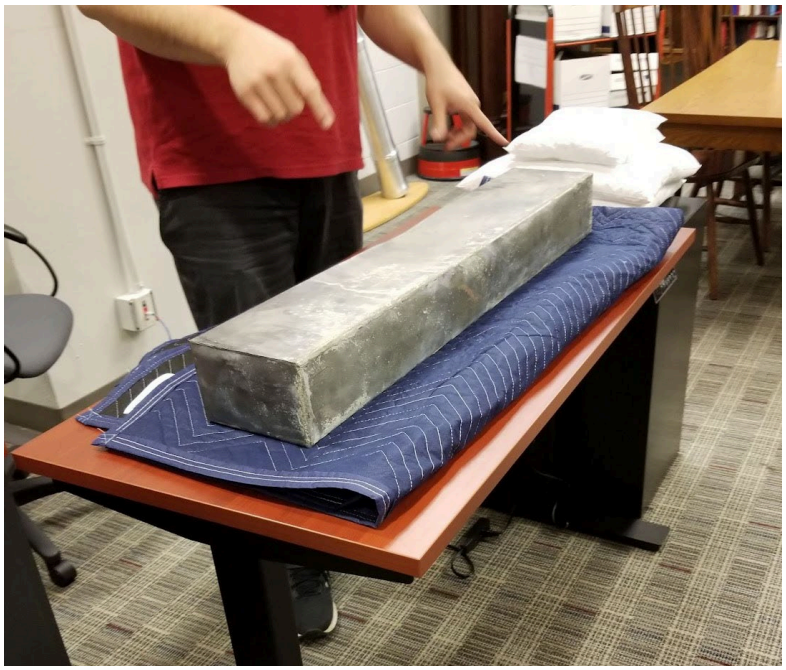

Figure 16. A sealed, unmarked box discovered by the construction crew of Unity Hall. Source: Authors.

On November 18th, 2021, a meeting in the WPI Archives gave us an opportunity to inspect this mysterious artifact firsthand. It is a weld-sealed metal box, probably made of aluminum, measuring approximately 36 inches long, 6.5 inches high and 4.5 inches wide (Figure 16).

The box felt surprisingly lightweight, considering its size. No movement or sound was detectable when it was tilted or moved around. Could it be empty?

The box was delivered to the Archives for safekeeping shortly after its discovery. Mr. Carlson reported being told that it had been found “in the wall that contained the capstone,” which was being electronically scanned for plumbing or electrical lines before demolition (Carlson interview).

The side of the Gordon Library which faces Unity Hall is located several dozen yards away, so it seemed unlikely that the wall enclosing the box could have been the wall of the Library itself. Instead, we speculated that it was probably found in the extensive brickwork associated with a long stairway that formerly descended from the northeast corner of the Library to the parking lot below. The stairs and brickwork (including a patio adjacent to a Library exit on the first floor) had been completely demolished to prepare for Unity Hall’s construction.

That stairway was rather unusual. Built at the same time as the Library in 1966-67, it was notoriously treacherous during the winter months, when snow and ice often made it too hazardous to climb or descend.

Sometime in the 1980s, an MQP engineering team devised a way to connect the Library’s heating system to a network of conduits installed directly under the cement steps, warming them sufficiently to keep their surfaces dry and clear even in the worst weather conditions.

We initially suspected that the MQP team who built the stairway’s heating system might have hidden the box inside the area where they had been working. However, just a few days after inspecting the box in the Archives, Mr. Carlson made a discovery that threw our suspicion into question.

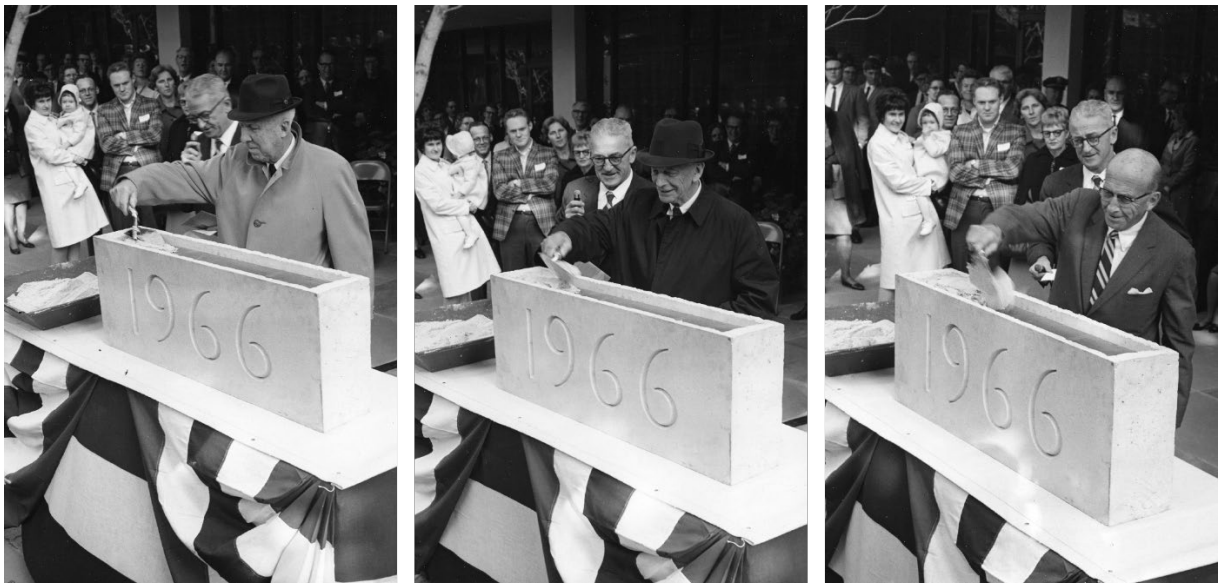

Figure 17. A long metal box is clearly visible within the cornerstone of the Gordon Library in these photos taken during its dedication ceremony in 1967. Source: WPI Archives.

A series of photographs taken during the Library's dedication ceremony in 1967 shows officials applying cement to the top of the building's cornerstone (Figure 17). The top of a long metal box, similar in shape to the one found decades later by the Unity Hall construction crew, is clearly visible inside the hollow stone.

The Library's cornerstone was later installed in the front (east) wall of the building, *not* in the north wall facing Unity Hall. None of us could imagine any reason why the workers building Unity would have any need to disturb the cornerstone, much less remove it, which would be necessary to retrieve the box sealed inside.

Several theories were tossed around. Was the newly discovered box an empty prototype for the one enclosed in the cornerstone, or a near-duplicate assembled for some unknown purpose? If so, why would it be secretly hidden within the stairway or patio?

We asked Mr. Carlson to inquire further about the *exact* location where the mystery box had been discovered. But the query proved to be unnecessary. A careful search of the Library's archives soon turned up another photo that suggested a solution to the puzzle.

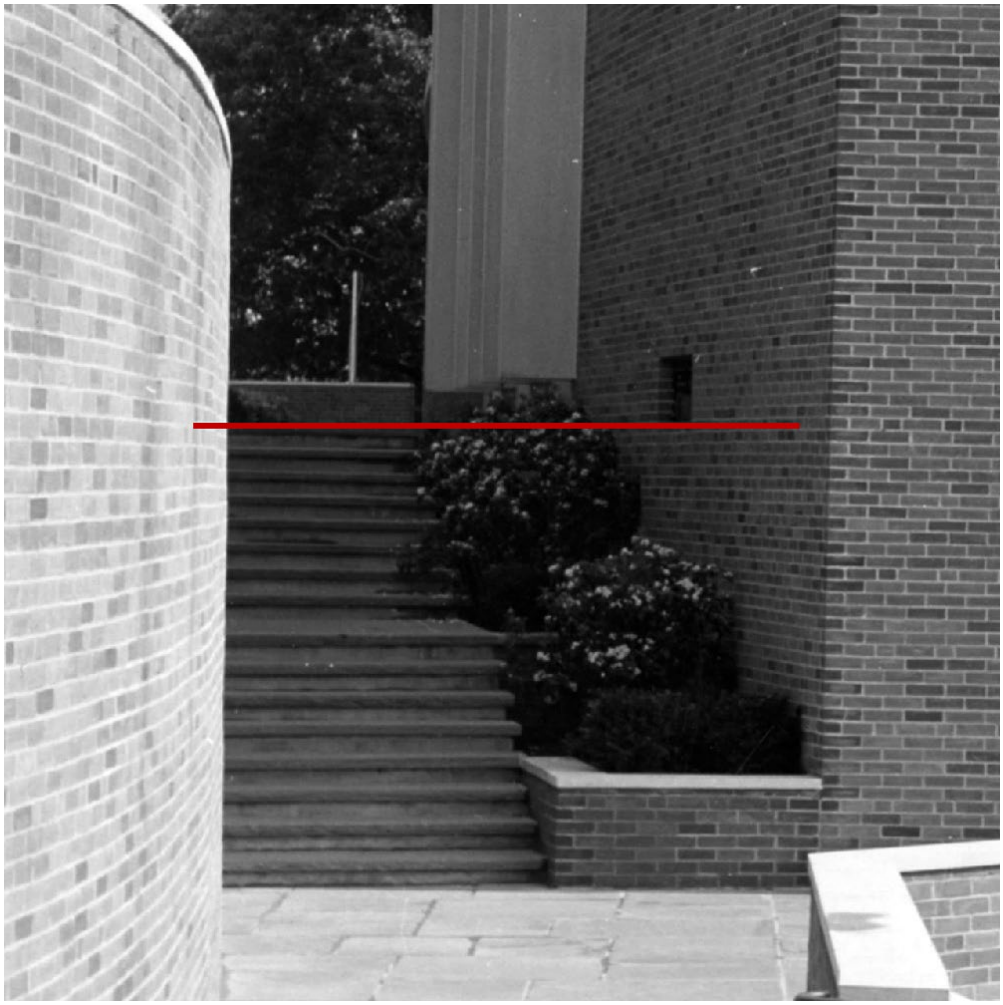

Figure 18. The northeast corner of the Gordon Library, prior to the construction of Unity Hall, showing the cornerstone's original location adjacent to the first flight of steps descending to the parking lot below. Source: WPI Archives.

Figure 18 shows the configuration of the northeast corner of the Gordon Library prior to the construction of Unity Hall. The location of the cornerstone can be seen in the north wall, adjacent to the first flight of steps leading down to the parking lot.

The red line added to the photograph demonstrates that the bottom edge of the cornerstone was, *originally,* almost perfectly aligned with the level of the topmost stair. But the *current* location of the cornerstone is about three feet *higher* than it appears in this image.

The area shown in Figure 18 was eventually buried to accommodate the broad plaza constructed in front of Unity Hall's upper entrance. If the Library's cornerstone had remained in its original location, it would have been partially or completely buried as well. It now seemed likely that somebody had decided to elevate the historic cornerstone to avoid burying it. And when it was removed to raise its position, the box sealed inside, forgotten for decades, was accidentally rediscovered.

Later, Nick Palumbo confirmed to our team that this is exactly what had taken place.

The report Arthur Carlson originally received about the box being found "in the wall that contained the capstone" was, aside from the erroneous use of the term "capstone," somewhat misleading, but technically correct.

This incident provided the team with a vivid, real-life demonstration of just how easy it is for a time capsule to be forgotten, inadvertently moved, misplaced or misidentified.

3. Methods

Attempts to transmit information across time may serve a variety of purposes. In some cases, it is done to safeguard (or conceal) information until some point in the future. Time capsules are a common means for achieving this goal. Other methods include the practice of tradition and ritual, along with various mechanical and electronic technologies.

Figure 19. A Westinghouse time capsule being lowered into the ground at the 1939 New York World's Fair.
Source: URL.

3.1. Time capsules

Time capsules are the chief technique we studied for transmitting information across time. They are frequently used to send messages into the future because they are easy to create. The only materials needed are a suitable container and the artifacts to be placed inside.

The most common objects placed in a time capsule are contemporary documents, photographs, recordings and other artifacts deemed representative of the time of deposit.

> "The term "time capsule" is comparatively recent and was coined by the Westinghouse Company when it buried a seven-foot long, torpedo-shaped time capsule 50 feet under the grounds of the 1939 World's Fair in New York City [Figure 19]. Instantly, a new term was added to the English language." (History Magazine)

Author William Jarvis makes an important distinction regarding different kinds of time capsules. According to Jarvis, a true "time capsule" is (1) intended to be *remembered*, (2) *clearly marked* to identify its location, and (3) intended to be *opened* at or after a *specific* future date, which is usually indicated on its marker. By contrast, an artifact or container placed within a cornerstone (such as the five time capsules currently known to exist at WPI) or some other place that is *not explicitly marked* as the location of an artifact or container, and bearing *no indication of an intended opening date*, is more properly called a "foundational deposit" (Rothman).

There are many variables to consider when selecting a location for a time capsule, and many potential challenges that must be faced.

The period a capsule will remain concealed largely depends on the reason the capsule was created. For example, in time capsules created by elementary schools, children often deposit letters to themselves about their future goals. The idea is for the children to open the capsule after they graduate from high school. The unearthed messages demonstrate how the passage of time can affect personal priorities and goals.

Time capsules are frequently deployed when a new building is constructed. They may contain blueprints, contracts, contributor lists and other documents related to its construction. Unless such a capsule is clearly marked, it is highly likely that it will be forgotten when the last witness of its deposit passes away, and may not be rediscovered until the building is subsequently renovated, repaired or demolished … if it is found again at all.

Well-marked capsules that are intended to be remembered and opened at a specific later date are relatively easy to deposit, and reasonably secure. If its location is threatened by later development or renovation, the capsule can be recovered and relocated if desired.

Finding a secure location for a time capsule that is neither marked nor intended to be found after a specific date is much more difficult. The longer such a capsule remains hidden, the more likely changes will occur in the vicinity that will affect its secrecy or integrity.

Locations prone to frequent development or renovation are obviously poor candidates. Capsules deposited in such places are likely to be accidentally discovered, rendered inaccessible, damaged or destroyed. This is the fate that eventually befalls most time capsules.

A copper box initially placed within the cornerstone of the Massachusetts State House by Paul Revere and William Scollay in 1795 was lost to memory until it was rediscovered during emergency building repairs in 1855. The box was inspected, resealed and replaced, and promptly forgotten *again* until 2014, when workers accidentally unearthed it while repairing a structural leak (Rothman).

Careful consideration of the morphology and probable future development of a potential time capsule location increases the probability that it will remain undisturbed. However, this strategy also makes it more likely that the capsule will be forgotten or lost.

Figure 20. NASA's 50-year-old time capsule and plate. Source: URL.

Markers are often placed on or near time capsules to indicate the creators of the capsule, the date it was deposited and when it is intended to be opened. The durability of the material used to create a marker is important. Durable metal or stone materials are often chosen for capsules expected to remain untouched for a lengthy period (Figure 20). Nevertheless, such markers may be inadvertently obscured or damaged, or may deteriorate beyond legibility, depending on how long the capsule has been hidden away.

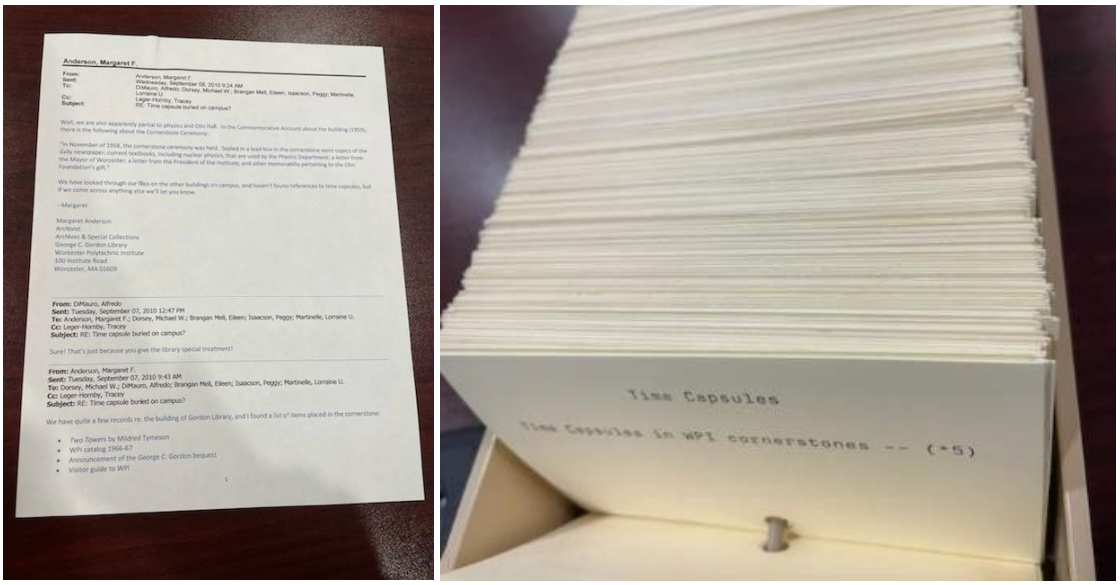

Figure 21. Printed email messages and index cards about time capsules placed in cornerstones at WPI. Source: WPI Archives.

In many cases, supplementary documentation of a capsule's existence (aside from any markings it may bear) is preserved. Photographs of the time capsule and/or its contents may be taken, or a mention of the capsule may be included in a record about an event associated with its deposit. Such traces of a capsule's existence are important, as they reduce the likelihood that the capsule will be forgotten (Figure 21). However, history shows that it is all too common for documentation regarding the existence and location of a time capsule to be inadvertently lost.

In rare instances, information regarding the existence and/or contents of a time capsule is deliberately obscured or obliterated. The creators of such a deposit may wish to prevent the capsule from being traced back to them. Or they may prefer to rely on the vagaries of chance to reveal the existence of the capsule over the course of time.

3.2. Tradition

Tradition can also serve to transmit information across time, intentionally or not.

WPI has seen the rise and fall of many traditions related to initiatory events, rivalries between classes, and various other circumstances. The lasting traditions appear to have survived more through habit of practice than any particular urge to preserve them. Nevertheless, their influence on the campus community has been, and continues to be, significant.

Many early decades of WPI Freshmen and Sophomores fostered a powerful class rivalry. Freshmen were forced to wear special caps, bowties, or weaning boards listing their name and where they came from. These humiliations would continue until Homecoming, when a Freshman vs. Sophomore rope pull was hosted. If the Freshmen won, they could take off their caps. However, if the Sophomores won, the hats had to stay on until Thanksgiving. There was also the Goat's Head Trophy, a realistic goat head with a tiny body, which was awarded to either the Freshman or Sophomore class depending on who earned the most points during various games played between them. Afterwards, the class holding the trophy would be forced to display it at certain times, giving the rival class opportunities to steal it for themselves (WPI Tech Bible).

Other, more durable WPI traditions include the Earle Bridge crossing, in which incoming students walk across the span towards Boynton Hall, signifying their entrance to the Institute. Seniors cross in the opposite direction on Graduation Day, signifying their departure. There is also a long-running superstition that anyone who treads upon the stone seal of the Institute located on the Quad will fail to graduate.

Figure 22. A sundial outside Boynton Hall, gifted by the Class of 1910. Source: Authors.

Another tradition still practiced at WPI is class gifts. These have assumed a variety of forms. The Alumni Gym and Field were mainly funded by the Class of 1886 (WPI Tech Bible). A sundial adorning a path outside Boynton Hall was a gift of the Class of 1910 (Figure 22).

Figure 23. A monument to the WPI Plan from the Class of 2016. Source: Authors.

More recently, a monument commemorating the 50th anniversary of the WPI Plan was erected outside the Washburn Labs by the Class of 2016 (Figure 23).

Figure 24. Boulders which formerly marked the location of trees planted by various WPI classes.
Source: Authors.

Many of the trees shading the hill leading up to Boynton Hall were also class gifts. These were originally marked by large boulders, dated with the year they were planted (Figure 24). However, most of the boulders (including those from the classes of 1890, 1896, 1899, 1900, 1908 and 1909) have been moved to the top of the hill over the years, leaving the location of the associated trees unrecorded and forgotten. The reason for moving the boulders is unclear, though it has been suggested that it was done for the convenience of groundskeepers tasked with mowing the grass on the hillside (Carlson interview).

Figure 25. A painting used to identify a tree gifted by the Class of 1915, displayed by its discoverer, WPI Archivist Arthur Carlson. Source: Authors.

The removal of one of these markers recently led to the loss of a magnificent tree originally donated by the Class of 1915, which was planted on land destined to be cleared over a century later to build Unity Hall. This inadvertent desecration was discovered by WPI Archivist Arthur Carlson, who found a vintage painting showing the doomed tree standing beside its original dedication boulder (Figure 25). Carlson speculates that “They didn’t realize what it was at first. But they repurposed the tree into the building” (Carlson interview). The location of the tree’s boulder is currently unknown.

Figure 26. A sitting area outside the Gordon Library, gifted by the Class of 2012. Source: Authors.

Many other class gifts may be found scattered around the campus. The Goddard Library gained both an interior viewing area and a sitting area outside its main entrance, each funded by a different class (Figure 16). Other features have been donated as memorials dedicated to individual members of the community. For example, Boynton Hall's entrance stairway commemorates Dean Zealotes W. Coomes, and was provided by the Class of 1901.

3.3. Ritual

Ritual is a form of tradition that offers a powerful strategy for transmitting information across time. Social institutions such as religions, cults, fraternities and sororities use rituals to pass on information using standardized gestures, words or objects. The aim of these institutions is to keep their rituals active in hope of perpetuating their beliefs and purposes.

Figure 27. Totem Pole in British Columbia, located at the original 'Namgis Burial Grounds.
Source: URL.

Figure 28. These totem poles at Alert Bay, British Columbia are believed to be among the tallest in the world. Source: URL.

The origins of ritual are unknown. Some believe they began with totemism, the belief that humans share a connection with totems (Figures 27 and 28). These totems represent plants, animals and other beings or phenomena that are regarded as spiritually significant.

Totemic cults are also known as the animal symbolic clan. Such cults typically developed in communities with a background of hunting and gathering. Warriors who worship totems, also known as totemistic warriors, value strong animal such as wolves and bears, and believe that the spirits of these animals will aid them by giving them strength during battles. Totemistic warriors often imitated these animals in ritualized combat.

> "*Rapto vivere*, to live in the manner of wolves, is the beginning of this initiation. The bond with the savage world is indicated not only on the geographic plane – life beyond the limits of the civilized life of the towns – but also on what we would consider a moral plane: their existence is assured by the law of the jungle." (Briquel)

Initiation is a ritual performed to actualize or commemorate a particular goal or standard attained by an individual or group. In most cases, an initiation marks the beginning or staging of a relationship between a person and an organization. Initiations often involve trials or sacrifices that must be completed before an organization will accept a person into their group.

Figure 29. Young Monk having his head shave during his initiation ceremony. Source: URL.

Initiation rituals vary widely, depending on their purpose. In some Buddhist initiations, prospective monks must shave their heads to show they are giving up their connection to the world and freely choosing to pursue the demanding monastic lifestyle (Figure 29).

Many organizations, including most fraternities and sororities, attempt to keep the details of their initiation rituals a secret, sharing information only among their own members. This exclusivity serves to magnify the perceived importance of the private experiences shared between an organization and those who hope to establish a formal affiliation with it.

Figure 30. Pope Francis worshiping in the Vatican. Source: URL.

Worship is another type of ritual. It represents formal respect for an entity that bears particular importance to a culture. Common subjects of worship include deities, historically influential individuals or groups, and significant places, objects and symbols.

Offerings are frequently made to entities that are worshipped (Figure 30). Common offerings include food like bread, cakes, fruits and nuts, incense, precious oils and minerals, flowers and money. Animals are still ritually sacrificed in some cultures. Human sacrifice has also been practiced among various cultures over the course of history.

Figure 31. Hinduism's funeral Rite of Passage. Source: URL.

Funeral rituals commemorate the death of a being, usually a person or animal, either real or imaginary (Figure 31). They are typically practiced by people who shared a relation with the deceased, and often involve an intention to ease the transition of the deceased to another realm of existence, or to attain peace in their final rest.

Unless there is an end to humanity, tradition and ritual will continue to serve as primary forms of cultural memory, effectively transmitting information across generations.

> "Judaism says, 'The Messiah is going to come, and that's the end of history;' Christianity says, 'The Messiah is going to come back, and that's the end of history;' Islam says, 'The Messiah came; history is irrelevant.'" (Brand, 55)

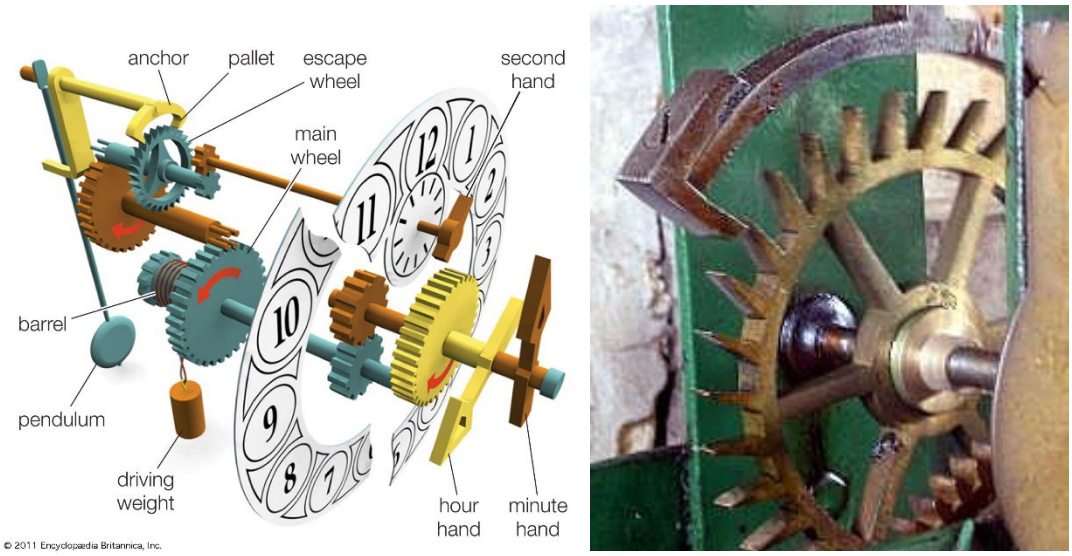

Figure 32. Mechanical clock components. Source: URL.

3.4. Mechanical technologies

Mechanical methods of transmitting information across time typically require periodic human maintenance to function correctly. This may be why such methods are relatively uncommon, with the notable exception of mechanical clocks (Figure 32). These devices employ various forms of active or latent physical energy to record and display information *about* time.

> "Every mechanical clock needs energy to run. Winding your clock winds an internal mainspring. When the mainspring slowly unwinds, it puts a series of parts in motion which results in the turning of the gears" (Chelsea Clock).

Figure 33. A recent restoration of London's iconic Big Ben clock tower. Source: URL.

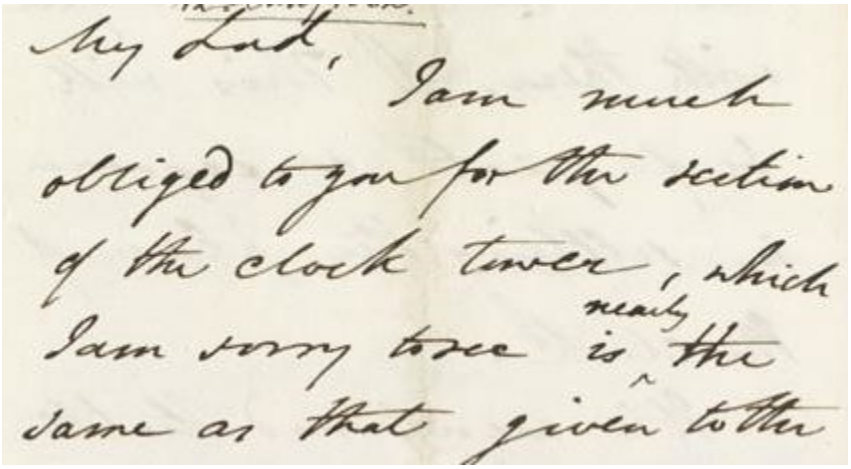

Figure 34. Letter from E B Denison, Queen Anne Street, London to Lord Seymour, sent 12 Jan 1852. The letter proposes potential locations and construction details of Big Ben, and talks about the pendulum and weights to be used. Source: URL.

Many mechanical clocks are capable of producing sounds at programmed intervals. For example, there are clocks that chime every hour, like the English House of Parliament Tower in London, popularly known as Big Ben (Figures 33 and 34). There are also clocks that chime only at noon and midnight.

Over time, the accuracy (and therefore usefulness) of mechanical clocks can be compromised as their parts become worn or damaged. Regular maintenance is essential for such instruments.

Figure 35. Prototype of the 10,000 Year Clock being constructed by the Long Now Foundation.
Source: URL.

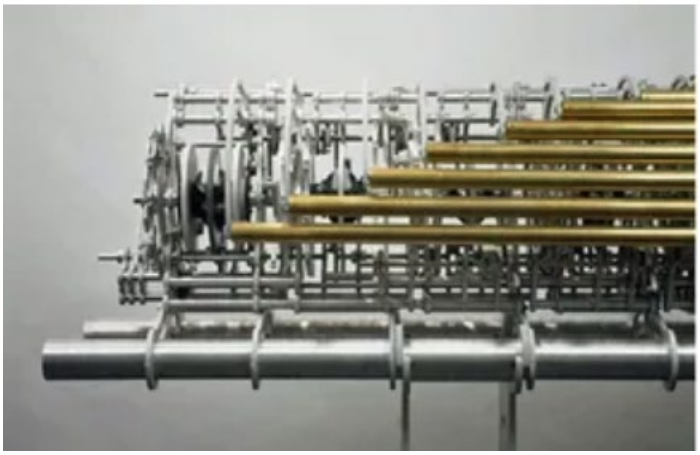

Figure 36. The chimes for the 10,000-year-old Clock were designed by Brian Eno, a British musician, composer, record producer and visual artist. Source: URL.

Figure 37. The tortional pendulum that will maintain the timing of the 10,000 Year Clock. Source: URL.

Figure 38. An orrery that employs mechanics similar to those being used to construct the 10,000 Year Clock. Source: URL.

One device that aspires to minimize the need for human maintenance is the Clock of the Long Now, also known as the 10,000 Year Clock. This ambitious project is being administered by the Long Now Foundation. Standing 60 feet tall, the Clock is designed to keep accurate time for 10,000 years using a combination of solar and mechanical power (Figures 35-38). Stewart Brand, co-founder of the Foundation, explains its purpose:

> "Civilization is revving itself into a pathologically short attention span. The trend might be coming from the acceleration of technology, the short-horizon perspective of market-driven economics, the next-election perspective of democracies, or the distractions of personal multitasking. All are on the increase. Some sort of balancing corrective to the short-sightedness is needed — some mechanism or myth that encourages the long view and the taking of long-term responsibility, where "the long term" is measured at least in centuries." (Brand, 2)

3.4. Electronic technologies

Electronic methods of transmitting information across time offer intriguing possibilities.

Figure 34. The Earth Black Box in Tasmania. Source: URL.

The Earth Black Box is an example of using advanced technologies to send a message to the future (Figure 34). Located in Tasmania, its purpose is to document human affairs, particularly those related to anthropogenic climate change.

> "The steel monolith will document all climate-related conversations and artifacts from the past, present and future including land and sea temperature changes, ocean acidification, the amount of greenhouse gas in the atmosphere, human population, energy consumption, military spending, policy changes and more." (Ramirez)

A major goal of the project is to record information in a secure manner that can withstand any event, including an apocalypse that wipes out the human species.

There are many challenges that needed to be overcome in the design of the Earth Black Box, including how to insure it will operate reliably with little or no human intervention, and how it might eventually be opened.

Jonathan Kneebone, an artist and director of the Glue Society, states that “It is impossible to anticipate who or what will find [the box], but it can be assumed that it will not be of any use unless it is discovered by someone or something that is intelligent and civilized, with the capability of understanding and interpreting basic symbolism” (Kneebone).

When completed, the Earth Black Box will act like a time capsule hidden in plain view. It operates openly, constantly gathering information for use by whoever -- or whatever -- may discover and open it in the distant future.

4. Success stories

While there are many ways to transmit and preserve information, each method has unique advantages and disadvantages. In this section, various successful instances of information preservation and what they accomplished are examined.

4.1. Time capsules

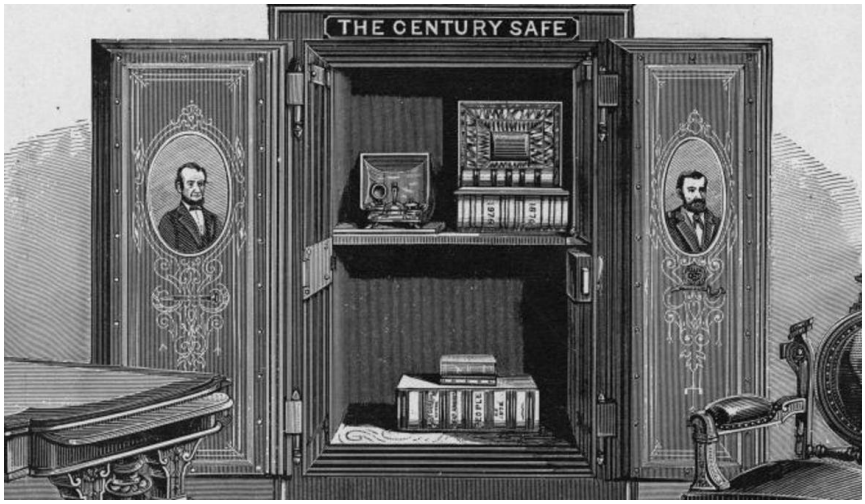

Figure 35. Contents of the 1876 Century Safe. Source: URL.

As previously noted, time capsules are one of the more accessible and popular ways to transmit information across time. A famously successful example is the Century Safe (Figure 35), created by Anna Deihm in 1876 to commemorate the 100th anniversary of the United States.

The Century Safe was faithfully delivered to the US Capital Building and placed under the East Portico. Its existence and location were promptly forgotten for an entire century. When it was accidentally rediscovered and opened in 1976, various artifacts, including pens and photographs, were found inside.

Figure 36. Officials consigning opera recordings to a Paris Opera House time capsule. Source: URL.

The acclaimed Paris Opera House time capsules were almost as fortunate. In 1907, a group of music aficionados stored 24 historic opera recordings beneath the building in sealed canisters, hoping to preserve them for future generations (Figure 36). More recordings were added to the cache in 1912, together with a gramophone for eventual playback of the discs.

Following a familiar pattern, the existence of these treasures was soon forgotten, but not before somebody managed to make off with a portion of the deposit. The remaining items were finally rediscovered in 1987. Sadly, the stolen articles have never been located.

4.2. Accidental time capsules

There are also instances of unintentional time capsules. In these cases, artifact containers are preserved for posterity despite the lack of any intent (or reasonable hope) of transmitting the information they contain to anyone.

Figure 37. King Tut's tomb. Miraculously unmolested by graverobbers, the tomb and its associated artifacts preserved many important details regarding ancient Egyptian society. Source: URL.

Graves and tombs attempt to safeguard the identity of the deceased, but are generally not intended for later inspection, at least by mortal eyes. Many contain artifacts bearing valuable information about the period and culture in which they were buried (Figure 37).

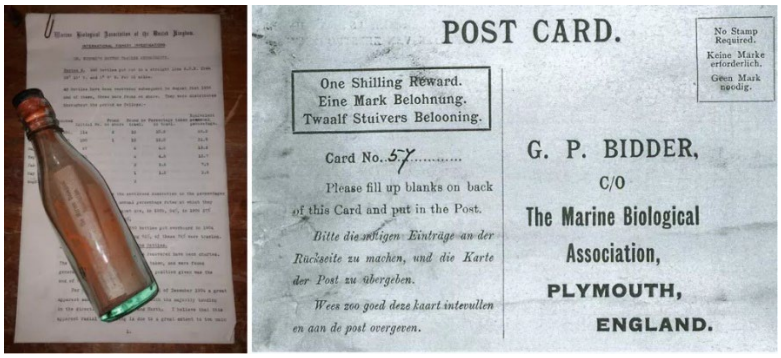

Figure 38. The documents contained in this bottle drifted in the Atlantic Ocean for 109 years. Source: URL.

Messages in bottles thrown into the ocean may also preserve information for a while, but cannot be expected to transmit that information reliably. Figure 38 displays a remarkable exception. Released in 1906 by the UK's Marine Biological Association in hope of studying ocean currents, it was lost at sea for well over a century. Its rediscovery in 2015, fully intact, provided an astonishing relic from another era.

Figure 39. Madame de Florian's Paris apartment, untouched for nearly 70 years. Source: URL.

Then there's the case of Madame de Florian, a woman who occupied a lavishly-appointed Paris apartment in the 1940s. Facing the threat of Nazi invaders, she fled the city and moved to Southern France, never to return. The residence she left behind remained locked and untouched for nearly 70 years. When she died in 2010, the executors of her estate rediscovered her former home, perfectly preserved in its original state (Figure 39). One executor described the experience of entering it as "like walking into Sleeping Beauty's apartment" (Carey).

4.3. Historical records

For millennia, various forms of inscription and writing have been used to transmit information across time. Surviving records have not only taught us about the past, but also helped to shape our present lives and future destinies.

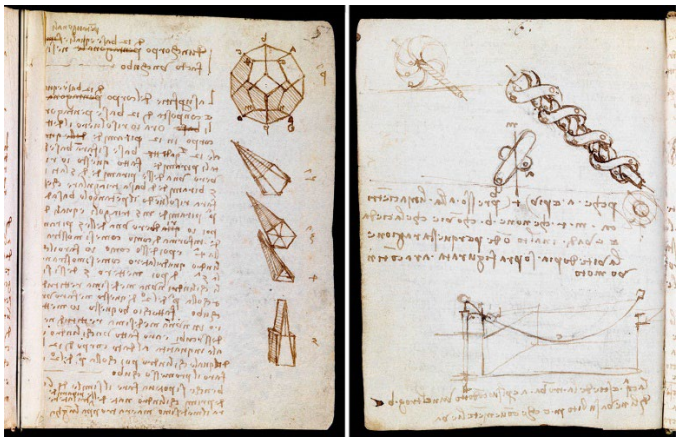

Figure 40. Pages from one of Leonardo da Vinci's notebooks. Source: URL.

The journal shown in Figure 40 once belonged to Leonardo da Vinci. In it are various diagrams of his research, offering valuable insight into his thought processes.

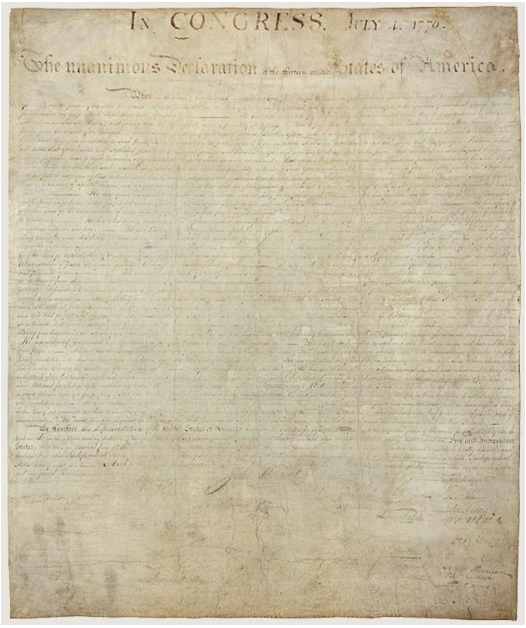

Figure 41. An image of the US Declaration of Independence. Source: URL.

Although the US Declaration of Independence is just a few centuries old, even non-citizens recognize its importance to the history of the world. The original document, together with the Constitution and Bill of Rights, is preserved for public viewing at the National Archives in

Washington DC (Figure 41). They are enclosed in a massive vault that can be retracted deep underground in minutes, and is claimed to be capable of surviving a direct nuclear strike.

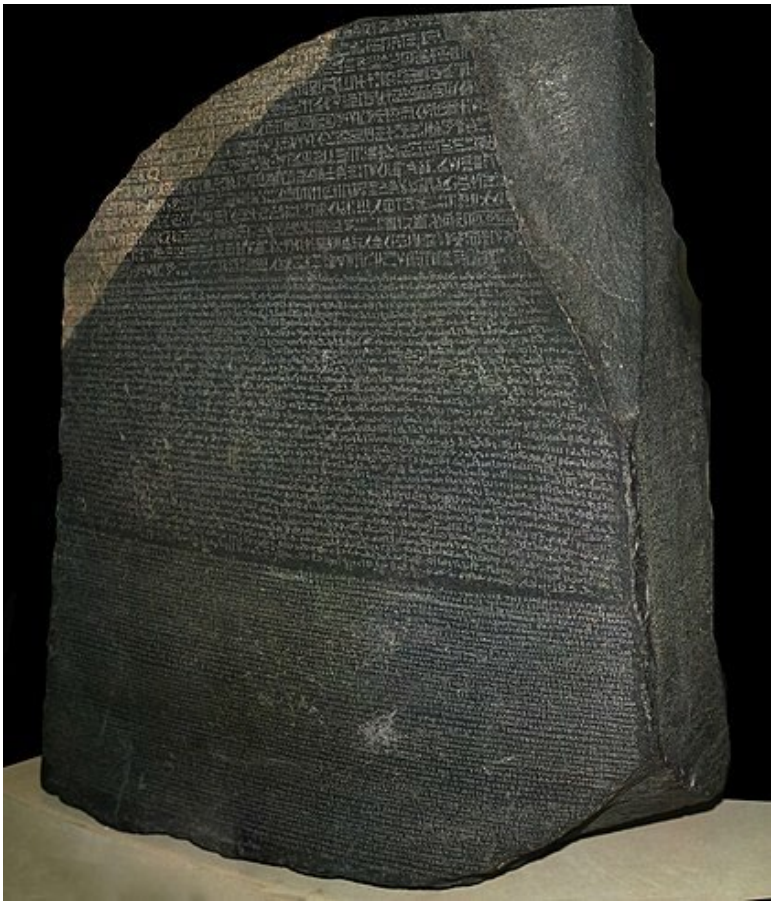

Figure 42. The Rosetta Stone. Source: URL.

The legendary Rosetta Stone is a centerpiece exhibit of London's British Museum (Figure 42). It records a decree regarding the royal cult of a Ptolemaic dynasty in three different ancient languages, and provided the elusive key needed to translate Egyptian hieroglyphic script.

Figure 43. The Cone of Urukagina. Source: URL.

The Cone of Urukagina is a stone artifact inscribed with descriptions of various reforms King Urukagina of Mesopotamia attempted to bring to the city-states of Lagash and Girsu around 2400 BCE (Figure 43). This record of an early attempt at government restructuring has yielded a wealth of information regarding the operation and values of early societies. For example, archaeologists have determined that Urukagina took preventive measures against various crimes, and even attempted to reduce wealth inequality.

Figure 44. A sculpture of Aule Metele. Source: URL.

Not all successfully transmitted records involve containers or written inscriptions. Sculpture provides durable likenesses of long-dead individuals, allowing us to get a rough idea of their physical appearance. Figure 44 showcases a statue of Aule Metele, a Roman senator. While the statue is believed to have been created as a religious offering, today it suggests details about the society in which its subject lived.

In particular, the statue appears to demonstrate the clash between the senator's Etruscan roots and his Roman affiliation. Although his name is inscribed in the Etruscan language, he is clothed entirely in Roman attire. This may have been intended to symbolize Rome's assimilation of the Etruscan territories.

5. Failures

While some means of transmitting information across time are more effective than others, none are without flaw. Regardless of which method is chosen, there is always a risk that the information will be corrupted or lost due to accident, deliberate interference, or mistaken interpretation.

5.1. Human interference

Historically, human interference has been a leading cause of information failing to withstand the test of time. Thieves are constantly plundering information deposits around the world. Artworks, books and even entire libraries have been burned as a means of oppression or out of ignorance.

Unintentional actions also affect the transfer of information through time. The cave paintings of Lascaux and numerous historic sites of Egypt have been significantly damaged due to careless tourism. Information intended to be faithfully preserved via tradition and ritual inevitably decays over time due to evolving priorities, lapses in translation or understanding, or loss of cultural context.

By looking at specific occurrences that happened throughout history, we gained a better understanding of how humans impact the transfer of information and specific factors to consider when trying to transmit information through time successfully.

5.2. Interception

Transmitted information is often intercepted before it makes it very far into the future. This can happen both accidentally and by intent.

The WPI Gordon Library time capsule that was forgotten for decades, unexpectedly rediscovered and then deliberately removed from its intended location is a prime example of human activity short-circuiting an attempt to preserve historic information.

Most interception of information takes the form of simple thievery. Ancient Egypt is the poster child for this dismal activity. Despite a culture with a robust bartering system and no set currency, the graves of deceased royalty were routinely raided by the very people who built them.

Figure 45. The Valley of Kings, adjacent to the village of Deir El-Medina. Source: URL.

The thieves took more than just gold. Pottery, papyrus scrolls, clay tablets, even the corpses of the deceased were considered fair game. Robbery was so rampant that King Amenhotep I commissioned a village be built near Thebes with easy access to a new, well-guarded burial ground, later known as the Valley of Kings (Figure 45). This strategy did little to deter the thieves, and probably helped them in the long term by concentrating the wealth available for plunder.

Had we full access to the original contents of these tombs, our knowledge about ancient Egyptian history and culture would be immeasurably greater.

In more recent history, a time capsule's message was intercepted before the capsule could even be sealed. On July 4th, 1976, President Gerald Ford arrived for the sealing ceremony of a time capsule which held, among other things, the signatures of 22 million Americans. As he waited, the event team struggled to find the time capsule, which had inexplicably vanished from the Bicentennial train used to transport it. Eventually, it was concluded that the capsule was stolen while left unattended. It has never been recovered.

A major consideration for successfully transmitting information through time is making sure that the means of conveying the message isn't forgotten. As we researched these historical incidents, the magnitude of the threat posed by interception became starkly apparent. We found ourselves forced to deliberate factors such as how much an attempt to transmit information across time ought to be publicized, as doing so increases the likelihood of sabotage, deliberate or otherwise. On the other hand, an overabundance of caution increases the risk that the message will be lost or forgotten. In his book *Deep Time*, Gregory Benford succinctly notes, "This is a classic dilemma of deep time: safely buried, how does the object announce itself to its intended audience?"

5.3. Willful destruction

Inscribed or printed literature, a key means of transferring information through time, is destroyed with depressing regularity, either by the ravages or war or by attempts to suppress ideas considered tasteless or subversive by authoritarian governments and/or reactionary citizens. In some cases, this only prevents information from reaching certain people. In others, it erases knowledge forever.

Figure 46. Nazi book bonfire conducted in Berlin, 1933. Source: URL.

Nazi book burnings are a familiar example. In the 1930s, Germany began pushing Nazi propaganda particularly hard, going so far as to burn any text that might be interpreted as opposed to their ideologies. The frenzy peaked in May of 1933, when over 20,000 books were burned (Figure 46). These actions targeted any glimpses Germans might have had into "non-Aryan" culture, consigning them to the flames of hate and ignorance. In particular, many irreplaceable studies on race, sexuality and gender were hauled out of the German Institute of Sex Research and reduced to ashes. Had these documents survived, it might have been possible to discuss their contents openly a lot sooner.

Two millennia previously, in 48 BCE, Julius Caesar was in the midst of a civil war against his political rival, Pompey. He pursued him into Egypt, and eventually to the port of Alexandria. When he ordered the Egyptian boats burned, the flames spread to the city's library, home to the world's greatest collection of ancient manuscripts, and the reason Alexandria was considered the capital of knowledge and learning.

Figure 47. A 19th century illustration of the burning of the Library of Alexandria. Source: URL.

Despite a significant decline in upkeep and scholarly attendance before the arrival of Caesar, it's certain that innumerable unique documents were lost to the flames, cementing this event as one of the greatest losses of information known to human history.

Astronomer Carl Sagan once remarked, "If I could travel back into time, it would be to the Library of Alexandria. All the knowledge in the ancient world was within those marble walls … We must never let it happen again."

5.4. Signal loss

Information intended to be transmitted through time can be lost simply because the party "responsible" for preserving and passing it on fails to complete their duty. This easily happens in cases when the desired communication spans several generations. While the originators will have an intimate bond to the message, their descendants may not. The generational degradation of value for the information they're tasked with transmitting can result in the message being misrepresented, hopelessly corrupted or totally forgotten.

Folks tales and legends are instructive in this regard. They say a lot about the values and culture of the people that devise them, but older tales are rarely recorded in documents dating back to their conception. They rely almost entirely on word of mouth to survive. As a result, the vast majority of these stories are altered almost beyond recognition over the course of time.

5.5. Capsule loss

Given how practical time capsules are (relative to other methods) as a means of transmitting information across time, and supported by their surprisingly rich history on WPI's campus, our research focused more extensively on time capsules than other techniques.

Despite their practicality, time capsules require careful planning to operate reliably. The vast majority are lost due to thoughtless placement or inadequate precautions to prevent them from being prematurely accessed, moved, damaged, destroyed or forgotten, inadvertently or by deliberate intent.

Figure 48. Oglethorpe University, where the International Time Capsule Society is headquartered. Source: URL.

The International Time Capsule Society, founded in 1990 at Oglethorpe University with the purpose of establishing a database of all known capsules (Figure 48), estimates that "there are approximately 10,000 capsules worldwide, most of them lost." More specifically, they estimate that approximately 90% of attempted deposits are doomed to oblivion.

One of the most common reasons time capsules are lost is modification of its immediate environment by people unaware of its existence. Once a capsule is deposited, subsequent landscaping, construction or renovation can make it difficult or impossible to recover.

Figure 83, The Aspen Time Tube, buried in 1983. Source: URL.

One particularly iconic time capsule was "lost" for this reason. In 1983, the International Design Conference in Aspen, Colorado concluded with the burial of a time capsule. While the capsule contained artifacts contributed by numerous attendees, one item of note was a Lisa mouse Steve Jobs had used for a presentation. This led to the deposit acquiring the nickname "The Steve Jobs Time Capsule."

The 13-foot-long, 1.5-foot-diameter tube was intended to be unearthed 17 years later (in 2000). As it turned out, the massive capsule wasn't recovered for another 30 years.

The delay was caused by subsequent landscaping that obscured the original location of the capsule. Despite attempts by several teams, the tube resisted discovery until 13 years beyond its intended recovery date.

Occurrences like this highlight the importance of selecting time capsule sites with care, marking their location clearly and durably, and taking into consideration potential changes that may occur in the vicinity of the deposit before the intended recovery date. Smaller capsules of less repute are almost certain to be lost unless these precautions are taken.

Another way time capsules are lost is via physical damage. This can occur because of inadequate container design or construction, unexpected trauma, and human interference.

Because time capsules so often consist of paper artifacts packed into a less-than-secure container, it's common for their contents to be found soaked and degraded by muddy water. If the container is not watertight, moisture will eventually seep into any crack it can find. Even even if a container is watertight, content made of poorly-chosen materials will degrade over time. This often happened to early American time capsules, which typically consisted of copper or tin boxes. Even if they were sealed properly - which they often weren't – the fragile materials they enclosed were not likely to survive for centuries underground or sealed in a wall.

Figure 84. The sad remains of the “At Ready” time capsule. Source: URL.

One such example is a time capsule sealed under the “At Ready” statue in Albemarle County, Virginia. During the century following the capsule’s deposit in 1909, the statue’s foundation had expanded, compressing the copper box to its breaking point When unearthed in 2020, the vintage books, papers, and clothing it once contained had essentially dissolved in a soup of muddy water (Figure 84).

6. Modern methods

In the contemporary world, where information is key and new ideas are constantly being developed, preservation of data plays an important role. Numerous researchers are looking for improvements to current preservation methods, and are also attempting to identify artifacts worth dedicating the resources required for adequate protection.

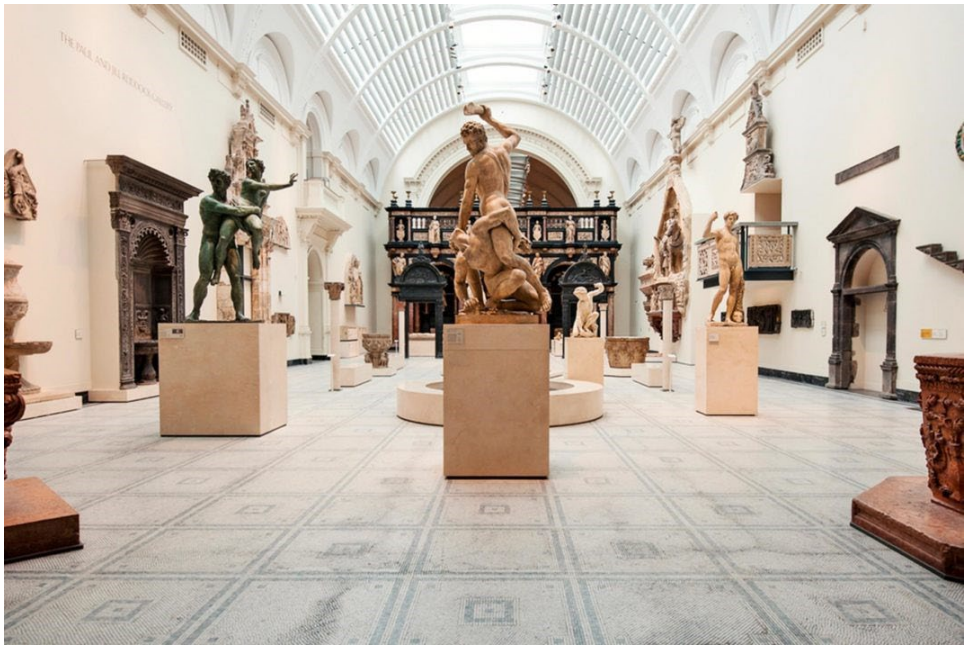

Figure 85. A museum containing various statues and sculptures. Most have plaques that contain details regarding their creation, design, and purpose. Source: URL.

Our interest in rare and valuable items has resulted in creation of social and physical structures specifically designed to preserve them safely. Museums are a commonplace example (Figure 85). Not only do these cultural institutions help protect these artwork, documents and other relics from the ravages of time and malicious people, but they also help to spread awareness about them to the public.

Figure 63: One of the Expo '70 time capsules. Source: URL.

While new methods of transmitting information are being developed, old methods are still used. Time capsules have not lost their popularity. In 1970, Panasonic Corporation and the Mainichi Newspapers collaborated to deposit a pair of time capsules in Osaka, Japan (Figure 63). Both capsules are supposed to remain unopened until 6970, although one capsule is opened at the start of every century to ensure intact preservation.

Because the Osaka time capsules contain various trinkets that were "chosen by a team of scientists, engineers, historians, and many of them were suggested by the public" (Radeska), they will someday bring to light many cultural aspects of Japan as it was in the 1970s.

Figure 64: An image from the ITCS showing the locations of various time capsules around the world. Source: URL.

On a global scale, the establishment of groups such as the International Time Capsule Society (ITCS) have made time capsules less likely to be forgotten (Figure 64). Previously lost capsules have been unearthed, and information regarding new time capsules is regularly stored for future reference. These organizations are also researching improvements in conventional time capsule design, as well as other methods of reliably transmitting information across time, including digital recording technology.

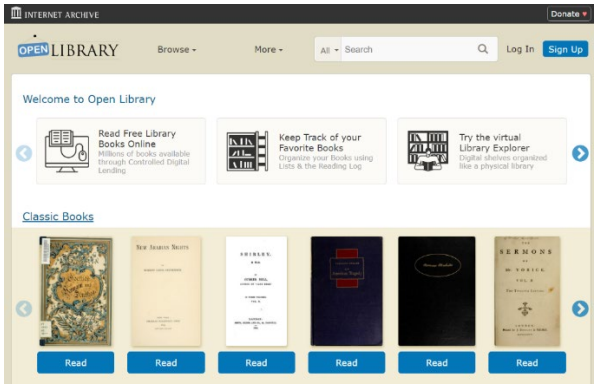

Figure 65: Archive.org is a website that preserves both digital media (such as movies) and physical content (such as books). Source: URL.

Digital records have the potential to preserve vast amounts of information and make it readily accessible, making it less likely to be forgotten (Figure 65). While this technology holds great promise, serious reliability challenges involving data corruption, network/power failures and technological obsolescence must be addressed.

7. Conclusion

With a long history of intercepted, destroyed, and forgotten messages, those who want to successfully transmit information across time must consider the future. Even if your deposit seems durable now, will it survive the conditions and events it may eventually encounter?

The problem is prediction. You need to send your message on a course in which it can avoid obstacles that don't yet exist. While some aspects of the future can be accurately predicted - such as the course of the stars – most aspects will always be a mystery. As human values and technologies evolve, and cultural forces pull in different directions, any "certainties" we hold about the future grow blurrier the farther ahead we look.

Yet, through educated guesses or perhaps sheer quantity, we continue sending information into the future with faith that it will reach its destination. Gregory Benford touches on this in his book *Deep Time*, saying "Managing the entire planet, and so ensuring an enduring legacy, is surely a more striking prospect than the makers of any deep time message have ever contemplated."

Transmitting information across time can be attempted via many different means, each with pros and cons. The likelihood of successful transmission can be increased by mitigating the risks associated with a given method, and predicting future events via directed research and well-educated guesses. No foolproof method exists for achieving this goal. However, new developments in engineering and materials science, combined with an improved understanding of human psychology and behavior, seem likely to improve the availability of secure, durable solutions. Someday, we may possess a reliable way to preserve human artifacts and stories across timespans measured in eons, even if humanity itself fails to survive.

Works cited

Andrews, E. “America's oldest known time capsule was made by Paul Revere and Samuel Adams.” History.com. Web. URL.

Benford, Gregory. Deep Time: How Humanity Communicates across Millennia. Perennial, 2000.

Brand, Stewart. *The Clock of The Long Now: Time and Responsibility.* New York: Basic Books, 1999. Print.

Carey, Ella. “Marthe de Florian's abandoned apartment in Paris.” Ella Carey. Web. URL.

Carlson, Arthur. Personal interview conducted by Brian Moriarty, Daniel Pacheco-Cruz, Charles West, Shawn Finnigan, and Trevor Ng, 18 November 2021.

Connor, Fiona. “Big Ben Finally Unveiled after £80m Refurb - but Everyone Is Shocked by the Result.” London: *The Sun,* 13 Jan. 2022. Web. URL.

Deamer, K. “108-year-old message in a bottle is oldest ever found.” LiveScience, 21 April 2016. Web. URL.

Hamlette, Barry. “Grotesque Departure.” *WPI: Beyond These Towers.* Worcester Polytechnic Institute, 16 Aug. 2016. Web. URL.

Hamlette, Barry. “WPI Construction Project Update.” *WPI: Beyond These Towers.* Worcester Polytechnic Institute, 27 June 2017. Web. URL.

Hoenig, John M. “History of the Time Capsule.” *History.* March 2005. Web. URL.

Graves, Deborah. Email to WPI employees and students, 8 January 2022.

Moynihan , Patrick, et al. “New WPI Sports & Recreation Center III: Construction Management and Constructability Analysis.” Worcester Polytechnic Institute, 2011. Web. URL.

Ovenden, Richard. “The Story of the Library of Alexandria is Mostly a Legend, But the Lesson of Its Burning Is Still Crucial Today.” *Time*, 17 Nov. 2020. Print.

Pearlman, Robert Z. “50-Year-Old Time Capsule Shows Glimpse of NASA's Past.” *CBS Interactive,* 25 Apr. 2016. Web. URL.

Palumbo, Nick. Personal interview conducted by Brian Moriarty and Charles West, 9 February 2021.

Pervere, Leah. "The Lesser Known History of WPI." *University Wire,* Feb 12, 2013. Web. URL.

Pruitt, Sarah. “Time Capsule Buried by Paul Revere and Sam Adams Discovered in Boston.” *History.com,* A&E Television Networks, 12 Dec. 2014. URL.

Radeska, T. “8 of the best time capsules left for mankind.” The Vintage News, 12 July 2016. Web. URL.

Ramirez, Rachel. “A Giant 'Black Box' Will Gather All Climate Data for Future Civilizations to Learn From.” *CNN,* 7 Dec. 2021. Web. URL.

Riding, A. “From a vault in Paris, sounds of opera 1907.” *New York Times.* Web. URL.

Rothman, L. “Boston's Paul Revere Time Capsule isn't really a time capsule.” *Time.* 6 January 2015. Web. URL.

Stamberger, Linda. “How to Understand Clock & Chime Mechanisms.” *Our Pastimes,* 10 Jan. 2019. Web. URL.

Terdiman, Daniel. “After 30 years, lost “Steve Jobs Time Capsule” finally recovered.” *CNET*, 20 Sept. 2013.

Wamback, Colleen B. “WPI Breaks Ground on New Building.” *WPI: Beyond These Towers.* Worcester Polytechnic Institute, 9 Oct. 2019. Web. URL.

“Harrington Auditorium.” *WPI Athletics,* Worcester Polytechnic Institute. Web. URL.

ITCS. (n.d.). Time Capsule: International Time Capsule Society: United States. *ITCS.* Web. URL.

“Massachusetts MPS Higgins, Aldus Chapin, House (Identifier 63792843).” *National Archives Catalog.* Web. URL.

“MHS Historical Inventory.” *Mass.gov*. Web. URL.

“Project Center.” *WPI: Beyond These Towers.* Worcester Polytechnic Institute. Web. URL.

“Q&A With Carrick Eggleston, Professor and Department Head of Civil and Environmental Engineering.” Worcester Polytechnic Institute, 12 Aug. 2021. Web. URL.

“Sports & Recreation Center.” *WPI Athletics,* Worcester Polytechnic Institute. Web. URL.

“Washburn Prepares for a Face Lift.” *WPI Newspeak,* 23 Feb. 1983, pp. 1–17. Web. URL.

WPI Tech Bible. Worcester Polytechnic Institute. Web. URL.

“WPI 150 Years: Imagine More.” Worcester Polytechnic Institute. Web. URL.

“WPI Opens the Foisie Innovation Studio and Messenger Hall.” *WPI: Beyond These Towers.* Worcester Polytechnic Institute, 31 Aug. 2016. Web. URL.