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Building Digital Projects to Outlive Their Funding

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Abstract

Sustainability is a well-known issue in the digital humanities, but it is rarely discussed in print. Too many valuable online research tools struggle to secure the funding to remain available indefinitely. This problem is especially pronounced in the case of short-term, grant-funded projects, which face the dual problem of limited development time and a horizon of active support. Yet these projects often produce bodies of knowledge that remain useful long after the project ends. Taking one specific case as a prototypical example, The Zodiac Glossary, this paper examines various strategies for ensuring the longevity of online digital resources. What works in extremis is easier to implement in other circumstances. This paper is, on one hand, an implicit call for better funding for digital projects. On the other, it is a brief guide to navigating the situation as it stands. Those working on digital projects may find strategies here to guide their own decision-making processes.

Keywords: *Digital humanities; academic funding; online databases; linguistic data; ancient astronomy*

Introduction

Creating a unique and fully customized data-driven website for an ancient-world project is a daunting prospect in the best of circumstances. The required technical expertise, domain-specific knowledge, and data-entry person-hours strain even the most generous academic budget. Building such a resource for a grant-funded project is especially challenging. The time required just to provision server space at even the most efficient and technologically

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advanced university can easily stretch from months to years, bumping against the limits of the entire project's lifetime before the real work has even begun.[2] Provisioning resources more quickly costs money, and even when funding is available during the term of the project, the money cannot be expected to last forever. Once a project's original grant ends, there are few options available for extending support for the maintenance of existing resources.[3] As a result, many research tools disappear when their funding runs out, leaving whole communities of scholars scrambling for a replacement.[4] Given the stated purpose of such grants to fund innovative research,[5] it follows that replacements for these resources cannot be found because they do not exist.

There is no single solution to this problem. Instead, researchers must make thoughtful decisions based on the specific needs of their project, weighing multiple costs and benefits simultaneously while considering the limits of the available technologies in a rapidly changing landscape. The challenge is increased by the difficulty of bringing together the available options at any given moment. Few academic studies lay out the nature of the problem in a way that humanities researchers can easily evaluate. The purpose of this paper is to do just that. Taking as a case study the glossary of ancient zodiacal terms created through the ERC-funded Zodiac Project,[6] this paper will

[2] This has been true in my experience at multiple institutions, all of them well funded and with highly competent technology staff. The situation may be better or worse elsewhere, but a full survey of university IT departments and their typical response times is beyond the scope of the present discussion.

[3] James Smithies et al., "Managing 100 Digital Humanities Projects: Digital Scholarship and Archiving in King's Digital Lab," *Digital Humanities Quarterly* 13, no. 1 (2019), http://www.digitalhumanities.org/dhq/vol/13/1/000411/ 000411.html.

[4] Robin Camille Davis, "The Final Death(s) of Digital Scholarship—An Ongoing Case Study of DH2005 Projects" (Digital Afterlives Symposium, Bard Graduate Center, March 1, 2019), https://robincamille.com/presentations/death_of_digital_scholarship/; Smithies et al., "Managing 100 Digital Humanities Projects."

[5] "ERC at a Glance," accessed February 27, 2023, https://erc.europa.eu/about-erc/erc-glance.

[6] "ZODIAC – Ancient Astral Science in Transformation," September 15, 2021, https://www.geschkult.fu-berlin.de/e/zodiac/index.html.

consider multiple complementary approaches to the problem of producing free online research tools given the state of technology at the time of writing. When we planned the Zodiac Glossary, we considered every option detailed in this paper and weighed the benefits of each against our project's requirements and limitations. Our sources include technical documentation, advice from colleagues, and formal interviews with leaders of some of the most prominent websites in the study of the ancient world.[7]

The resulting list addresses a substantial proportion of scenarios for building online tools to serve the study of the ancient world. It is not complete in any sense, nor is it intended to be. Instead, the goal here is to offer various strategies for creating sustainable online resources given real-world limitations—to ground our heady dreams for the digital humanities in the mundane reality of technical requirements and budgetary limitations. If this paper has a central thesis, it is this: an imperfect academic website that stays online indefinitely is better than a perfect one that disappears after only a few years. The priority of sustainability in this domain cannot be overstated.[8] Flashy technical wizardry appeals to those of us who celebrate new digital resources, but it is relatively worthless next to the importance of building tools that last. Here, the evaluation of strategies is rooted in this philosophy.

The Zodiac Project and the Glossary of Ancient Zodiacal Terms

ZODIAC – Ancient Astral Science in Transformation (the Zodiac Project) is a five-year ERC-funded academic project that investigates the rise of the zodiac in Mesopotamia in the 5th century BCE and its

[7] Special thanks are due to Mark Depauw of Trismegistos and Leigh Anne Lieberman of the Alexandria Archive Institute for agreeing to be interviewed for this paper and providing feedback crucial to the early development of the Zodiac Glossary. Every expert who was interviewed or consulted for this paper was provided a final draft and confirmed the accuracy of the information reported here.

[8] Roger S. Bagnall and Sebastian Heath, "Roman Studies and Digital Resources," *Journal of Roman Studies* 108 (2018): 172.

rapid spread through the ancient world in subsequent centuries. While it is not yet understood why this suite of astronomical and astrological concepts traveled so widely and so quickly, much evidence appears in ancient texts written in a variety of languages and scripts. Correlating this evidence calls for a database of related words. Such a database allows a diverse group of researchers—all of whom specialize in distinct areas of ancient world scholarship—to quickly collect and evaluate textual evidence across a variety of disciplines. No single researcher on the project knows every language included in our sources, but the database allows each member of the team to access and compare information generated by experts in that subdomain.

This is a rather straightforward prospect in technological terms. A standard relational database makes it easy to collect words from ancient texts, provide them with verification from both primary and secondary sources, and link them to one another across linguistic divides. We can then query the data for connections that reveal cross-cultural influence and reinterpretation among diverse traditions. The data are relatively consistent from one word to the next, and even from one language to the next, with a bit of restructuring and data cleaning along the way as we learn more about our subject and adapt to new discoveries.

Naturally, such a tool is not only useful to the Zodiac Project itself. Many scholars study ancient astral texts, and any of them might benefit from the ability to compare terms across cultures and time periods. In keeping with the original grant proposal, the Zodiac Glossary is intended to become a free public resource, which should remain available long after the five-year term of the Zodiac Project itself comes to an end. But this raises some difficulties. While it may be easy enough to create a database for a small team of researchers, making those same data accessible to the general public requires a great deal more time and effort, and it inevitably costs money. How to

pay for it—and most importantly, how to prevent it from dying when the Zodiac Project can no longer pay for it—became our first major challenge. Because this challenge is shared by most digital humanities projects, the lessons we learned along the way are here laid out for the benefit of others.

The Fundamental Problem

Research grants are not designed to fund websites. The reason for this is obvious but packed with explanatory power: academic production has historically taken the form of printed pages. Printed pages are paid for, in one way or another, by the people who read them. Either an individual scholar buys a book and maintains its usefulness in the long term by storing it in a safe environment, or an institution does so on behalf of its members.[9] Even though the annual cost of climate-controlled spaces for the storage of books is undoubtedly enormous, creators do not pay it. From the perspective of a funding agency, it makes sense to provide for the creation of an academic work and then let the work's audience fund its maintenance forever after.

Websites do not work this way. Short of placing a paywall on every single academic site, at present there is no way to transfer the costs of maintaining an online resource to the consumer. Creators of academic websites must pay for both the creation of the resource and its preservation in perpetuity.[10] Failure to do so means accepting that the work will eventually cease to exist. Grant funding organizations have not adapted to this new state of affairs, and there is little indication that the situation will change anytime soon.

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[9] Jennifer Edmond and Francesca Morselli, "Sustainability of Digital Humanities Projects as a Publication and Documentation Challenge," *Journal of Documentation* 76 (2020): 1019-31.

[10] This is common knowledge in the world of digital humanities, but the problem is laid out clearly here: Mark Depauw, "Keep TM Alive!," July 22, 2019, https://www.trismegistos.org/ keeptrismegistosalive.php. Depauw also reiterated the problem during the interview I conducted with him for this paper: Mark Depauw, "Interview with Mark Depauw about Funding for Trismegistos," Zoom meeting, May 23, 2022.

Without upending the status quo, there are at least six ways of addressing the problem:

1. Employing a paid-service model
2. Taking advantage of university webhosting
3. Paying for a permanent online publishing service
4. Securing grant funding on an ongoing basis
5. Setting aside money to fund fixed-cost services for a period of time
6. Leveraging free services to keep long-term costs to a minimum

In conjunction with all of these approaches, strategic choices on the design side can offload some of the work onto the user, approximating the print model by letting the audience's infrastructure shoulder some of the burden (more on this in the section below: Leveraging Free Services).

Each of these approaches brings its own unique set of advantages and disadvantages. Choosing the right one depends on the needs of the specific project. In the following sections, we will consider each in turn and highlight some cases where it represents the best choice. At each point, the specific but highly translatable needs of the Zodiac Project will provide a solid point of comparison to illustrate how to evaluate the needs of a project against the various cost-benefit analyses required when choosing an approach.

A Paid-Service Model

The logic of a paid-service model is perhaps the most straightforward of all: visitors to a website must pay a fee in order to access its most valuable materials. In many cases, the visitors themselves pay nothing and instead belong to an institution that pays the fee on their behalf. In either case, this approach is obviously similar to the manner in

which the maintenance of academic material has been supported historically: the resource is paid for by those who use it.

Given the analogy to print resources, it would be reasonable to imagine that this model might be widely used and accepted as a matter of course. However, due to the open nature of the internet, researchers tend to believe that online content should be free to access, even when the cost of producing and maintaining it is no different from a comparable print resource, and even when the value added to their research is considerably higher. As a result of this widespread perception, researchers grumble about having to pay for online resources. Often, they feel that no one should have to pay because paying indefinitely is unjust, decreasing the likelihood that they will petition their institutions for access. The result is that it is unusually difficult for online academic projects to fund ongoing costs by charging their users, even when their resources are markedly superior to a comparable print work. Ironically, these same projects would have little trouble finding an academic press to print and distribute their work for the cost, plus profit, and then they could comfortably rely on readers and their institutions to fund preservation indefinitely.

This problem is perhaps best illustrated by the recent struggle to "Keep Trismegistos Alive." In 2019, the Trismegistos website,[11] an online database of hundreds of thousands of ancient texts, used by researchers in multiple ancient world disciplines, faced extinction because it could no longer secure the necessary funding to keep its servers online. Up to this point, Trismegistos had survived for more than a decade on research grants and institutional support.[12] When the news broke that Trismegistos was planning to switch to a subscription

[11] "Trismegistos Home," accessed February 27, 2023, https://www.trismegistos.org/.

[12] Depauw, "Keep TM Alive!"

model, the general feeling among its users was that they should not have to pay for something they had previously accessed for free.[13]

Nevertheless, Trismegistos moved to a paid-service model and now boasts 129 institutional and 8 individual subscribers. At the current (2023) annual price of 1110€, this income of approximately 150 thousand euros provides not quite enough money to pay its essential staff a decent wage and maintain its servers. Such an arrangement enables those affiliated with its member institutions to access all of its valuable resources, but this approach is not without major drawbacks. The first is the additional overhead of accepting payments and managing finances—something that smaller projects with fewer active members often lack the will and experience to take on. This arrangement also inevitably limits access for those without subscriptions, creating an unequal landscape where certain scholars have privileges not afforded to everyone in the academic community. Finally, this arrangement all but guarantees that the project cannot remain fixed at some point of development, but instead must constantly grow in order to justify the continued cost (a problem that academic books can safely ignore).

The paid-service model also raises an issue that is particularly problematic in an academic context: only the largest, most widely-used resources can operate this way. Scholars of niche subjects cannot rely on their institutions to fund a subscription to a service with far fewer users. Only a resource with a scope approaching that of Trismegistos can attract enough subscribers to remain financially viable, but one of the primary advantages of digital projects is their promise of making rare materials available to a small but highly

[13] This claim is based on personal experience but should be easy to confirm by asking Trismegistos users. Depauw was fully aware of the academic community's reaction when I interviewed him for this paper. He offered a thoughtful response, which I have endeavored to convey throughout these paragraphs. Depauw, "Interview with Mark Depauw about Funding for Trismegistos," May 23, 2022.

interested audience scattered around the globe. Smaller projects of exactly the sort that might benefit most from digital access face similar requirements in terms of overhead but a much smaller base of potential subscribers. If such a model were the norm, competition for finite resources would ensure that only the largest projects could survive, impoverishing and severely biasing the academic landscape.

There is no reasonable expectation that the Zodiac Glossary will attract a broad enough user base to justify a paid-service model. Additionally, the data we collect will either remain static after the five-year term of the Zodiac Project's lifetime, or will be maintained by a small group of volunteers who contribute data while simultaneously using the project for their own purposes. It is very likely that our user and contributor bases will overlap substantially, making it unreasonable to ask this group to pay for the privilege of accessing the data they themselves curate. Even so, we hope that the Glossary will prove a useful tool to many people at any given moment, and consequently we resist any approach that would limit access.

University Webhosting

Many universities provide webhosting services to researchers and their projects or, at a minimum, some form of database archiving, which ensures that data collected remain accessible to the academic community indefinitely (though often in a raw form that requires substantial technical skill to make use of). On the surface, this approach seems both natural and ideal. Universities host scholars who produce research data. These data reflect the university's effectiveness in fostering productive scholarship. It seems therefore logical that the university would want to promulgate the data of its scholars as a credit to itself. Further, universities have funding earmarked for exactly this purpose, infrastructure for employing staff and maintaining equipment, and the longevity to keep data safe and accessible over the

timespans required, which can stretch to decades. From the researcher's perspective, this alignment in interests means that webhosting is stable, reliable, and free.

But there are major drawbacks to this approach. In-house webhosting services can never match the scale of large industry providers (e.g., Amazon Web Services) and, consequently their offerings lag the state of the art by years. The amount of work required to build dynamic, data-driven websites has decreased dramatically over time as new tools have become available to take some work out of the developer's hands.[14] University hosting solutions adopt these advancements slowly, thereby increasing the amount of technical proficiency needed to build an academic website. Ironically, those least equipped to work with obsolete systems—researchers in niche academic subjects with little training in web development—have less access to new techniques that would make their task easier.

Even when help is available through a university IT department, it can sometimes be slow and limited. The recent pandemic put a great deal of pressure on universities to provide tools for remote learning in a short timeframe. The aftershocks of this upheaval continue to reverberate, stretching already limited physical and human resources even thinner. In some cases, provisioning server space for a project can take up to a year or more, a serious drawback for grant-funded projects with a maximum lifetime of only a few years. Opening a help ticket for even a small issue means days of patiently waiting for a response,

[14] Perhaps the best example of this is the recent advent of serverless web hosting. While the name is slightly inaccurate because servers are still involved at a basic level, in practice, serverless hosting allows developers to ignore the task of setting up the hosting equipment. They can create a web page and add functionality through an interface that handles all of the low-level setup behind the scenes. This approach is especially ideal for scholars with some programming experience related to their research subject but little experience with web development. Researchers write their own small code snippets that do only what they want, while the hosting provider's system handles all of the background tasks. University research projects are exactly the sort of use case that this technology was designed for but, as of today, universities have not yet embraced this approach. For more on serverless hosting, see, e.g.: Diego Zanon, *Building Serverless Web Applications* (Birmingham, UK: Packt Publishing Ltd, 2017).

which halts forward progress in academic projects with little time to spare. University IT departments are chronically overburdened and understaffed.[15] Even with ample support, researchers cannot expect university staff to build their websites for them, so they must instead devote their limited time to learning how to build websites on their own, or they must employ their own developers, paying them out of limited research funds.

University hosting solves only part of the problem and adds an additional one: security. Universities are prime targets for malicious cyberattacks. Nefarious entities constantly probe the defenses of university servers in hopes of gaining access to sensitive data, usually related to medical research or industrial applications.[16] Ironically, many academic projects have nothing to fear from unregulated access. Their overt purpose is to share data with the world, and the main danger they face is equivalent to petty vandalism—malicious actors modifying or deleting data. Still, embedding any project in a university system turns it into a soft entry point to other sensitive data. As a result, even the most free and open research project must constantly maintain robust security infrastructure, adding significant overhead and access limitations that have nothing to do with the needs of the project itself.

The choice to use university webhosting entails exchanging control and ease of use for low cost, stability, and some technical assistance. The Zodiac Project is hosted by the *Freie Universität Berlin* (Free

[15] Though I have no hard evidence to back up this claim, I suspect that university IT departments are not so much understaffed as they are underfunded. There are plenty of skilled IT workers in the world, many of whom trained at universities, where they feel happy and comfortable as part of a vibrant community. How many talented people would eagerly continue working for their alma mater if it did not require a significant pay cut compared to a career in private industry?

[16] Eric C. K. Cheng and Tianchong Wang, "Institutional Strategies for Cybersecurity in Higher Education Institutions, " *Information* 13 (2022): DOI: 10.3390/info13040192. Mayieka Jared Maranga and Masese Nelson, "Emerging Issues in Cyber Security for Institutions of Higher Education, " *International Journal of Computer Science and Network* 8 (2019): 371-79, 372.

University Berlin), which boasts an extensive technical infrastructure, free webhosting and data-archiving services, and a dedicated, highly competent IT staff.[17] Given the advantages of university webhosting, we initially planned to build the Zodiac Glossary using this approach. However, we were forced to abandon this strategy as the time spent negotiating with the university for server space stretched from weeks to months to now over a year and counting. University hosting services are equipped to support long-term projects with large staffs, but the short time allotted to the Zodiac Project in total and the need for a limited number of researchers to begin entering data as quickly as possible made a faster solution essential to the requirements of the project as outlined in the grant proposal. We simply cannot wait for the university to hand us the tools we need to do our job—a problem familiar to most who work on small-scale digital-humanities projects. Instead, we opted to design our website to take advantage of free services, an approach that will be outlined in detail in the section below: Leveraging Free Services, Free-tier Hosting for Small Projects.

Permanent Online Publication

The leader in online publication for ancient-world digital projects is Open Context,[18] a service of the Alexandria Archive Institute.[19] For a fee approximately equivalent to the cost of publishing a book open access, they publish academic data online permanently. The critical downside to this approach is that the frontend, or user interface, is generally not part of the online publication.[20] User interfaces often provide critical functionality during the lifetime of a research project. However, these

[17] More information is available through the IT department at FU Berlin, ZEDAT: "Home < ZEDAT," accessed February 27, 2023, https://www.zedat.fu-berlin.de/Home.

[18] "Open Context: Publisher of Research Data," accessed March 6, 2023, https://opencontext.org/.

[19] "The Alexandria Archive Institute," The Alexandria Archive Institute, accessed March 6, 2023, https://alexandriaarchive.org/.

[20] Leigh Anne Lieberman, "Interview with Leigh Anne Lieberman about Funding for Alexandria Archive," Zoom meeting, August 17, 2022.

interfaces may not provide much value after a research project has concluded. User interfaces are also much more vulnerable to obsolescence due to changes in technology than are databases, which tend to remain very stable over time. For any project whose data have value in perpetuity, where those data are not expected to change after the project's conclusion, permanent online publication represents an ideal solution to the hosting problem.

For the Zodiac Glossary, this approach solves none of our hosting problems that cannot be solved using free tools. Our data are primarily textual, which allows them to be hosted using a free static approach. At the same time, the functionality required for members of the project to use the site is incorporated into the user interface, which a data-publishing solution would not include. However, this is only true in our specific case. In many other cases, especially for projects with images and maps, where the data input is complete, online publication represents a significant improvement over the other available options. It ensures that data remain available indefinitely without being tied to a specific university hosting solution. The publishing process at Open Context also provides much more help with making the data accessible to scholarly audiences than is typical for university IT departments.

Grants for Website Maintenance

With few exceptions, academic grants are designed to fund the creation of new knowledge, not the preservation of existing knowledge. Many large-scale academic projects, such as the creation of an online dictionary for an ancient language, require decades of continuous development by an entire team of scholars. Such projects can easily demonstrate partial progress during the time afforded by one unit of funding, estimate the work still to be done, and apply for more grants to continue the project. In these cases, the need to acquire grant money to create new knowledge is an advantage—there is always

more to be done. But for a smaller project with a limited and well-defined scope, there is no such argument to be made to funding agencies. The data entered at the end of the original grant are by definition the complete goal of the project. In such cases, applying for further funding entails one of two strategies: 1) acknowledging that the money will be used to preserve resources that already exist, or 2) deliberately modifying the goals of the project to justify additional work. Using the first strategy, funding is difficult to come by. Using the second, the scope of the project must change in ways that no longer serve its original purpose.

Neither of these strategies is appropriate for the Zodiac Project. The glossary of ancient astronomical terms is being developed for the purpose of supporting specific research agenda. Whatever data have not been added when the term of the grant ends is by definition not within the scope of the project. It is, of course, always possible that the Zodiac Glossary will prove useful in ways that we have not yet anticipated, but we cannot plan for such an eventuality from our current position. We must instead assume that the goals we set out in our original proposal will remain constant over time. When the project ends, its researchers will move on to work on other things, leaving no one to continue to apply for grants to expand on the work we will have done. Instead, all that is needed is that the data remain accessible to researchers. There are ways of achieving this without grant funding.

Only projects with unbounded scope and a real possibility of indefinite continuous development should plan to apply for additional grants to maintain their websites. This approach is generally not appropriate for smaller fixed-term grant-funded projects.

An Endowment Model

So much in academia operates on endowments that this naturally seems an attractive option for funding research projects. Further, the

low cost of maintaining a single website over many years brings the total price of an endowment down to an amount that could reasonably fit within the research budget of a short-term project. Here it is necessary to distinguish between two superficially similar variations on this theme: 1) a long-term investment where returns provide funding while the principal remains untouched indefinitely, and 2) a budget in which both principal and any accrued interest provide funding for a limited but long enough duration of time. The first is probably overkill for an academic website. Without trying to predict the future, we can feel confident that technology and the state of knowledge will change enough that no research project's website will need to be maintained forever. The second is not an endowment in the strict sense, but in practice it is similar enough to be grouped under the same heading. In both cases, the idea is the same: set aside some money from the grant to pay for the maintenance of an online resource for its entire lifetime.

The problems of this approach should be obvious enough. The money must be taken from a research budget, limiting funds available for other activities, and it must be invested and managed for a much longer duration than that of the project itself. Someone must curate the funds and disburse them as needed, meaning that a treasurer will need to keep working on the project in a reduced capacity long after it has ended. This person would either have to volunteer their labor, or their wages would need to come out of the endowment itself, thus increasing its cost and reducing its longevity. Logistic difficulties aside, funding agencies typically have their own endowments. Providing those funds for research projects to set up new endowments of their own fragments the funding without providing any obvious benefit.[21]

[21] Eric Kansa, "Endowment Funding for Academic Projects," Email, March 9, 2023.

Considering such difficulties, creating an ongoing fund for a project like the Zodiac Glossary is a daunting prospect. Further, setting up a fund like this is not within the standard skillset of most scholars. None of the current members of the Zodiac Project knows how to go about doing such a thing. While this may seem a poor reason to reject the approach at the outset, this is surely a problem faced by many others. The process is too unfamiliar and too complex to be a reasonable option for projects like ours at the present time. Without a service to handle the logistics, endowments will remain the prerogative of large, well-staffed organizations, not small teams of scholars.

Leveraging Free Services

There is a natural tendency to prefer the newest, most advanced technological approach. Researchers want their online projects to be as sophisticated as possible, and this desire for sophistication too readily leads to the pursuit of the novel. This problem is only exacerbated by a journey into the world of web development, where tech-savvy coders habitually overstate the advantages of new tools and hastily label older approaches obsolete, when in fact they are still perfectly functional.[22] Whenever the desire to build the all-singing, all-dancing website of the future needles us, we would be wise to remember that academics made productive use of the internet (and its predecessors) long before dial-up modems started appearing in

[22] A generalization, and a difficult one to prove, but easy enough to observe by reading posts on forums frequented by professional developers. For instance, a question by a TypeScript developer asking how to cope with a job that required them to work with older JavaScript libraries was met with responses such as: "Run." Whether tongue-in-cheek or not, this hyperbolic reaction makes it clear that only the very newest approaches are to be tolerated, ignoring the fact that the older technologies still work just fine. FunkyPanda, "How to Deal with Going Back to JavaScript?," Reddit Post, *R/Typescript*, February 23, 2023, www.reddit.com/r/typescript/comments/119tzss/ how_to_deal_with_going_back_to_javascript/. When people who are not so familiar with the social norms of coders (e.g., academics working on digital-humanities projects) encounter these attitudes, they predictably ask for the latest thing. Who would want to risk being laughed at by all the hip young experts? Perhaps it helps to remember that, in the digital humanities, our purpose is to share information, not take up a position on the bleeding edge of new technology.

homes.[23] There is nothing inherently wrong with doing things the old-fashioned way, and such approaches become especially advantageous when they reduce the cost of webhosting to zero.

Many times, choosing a less advanced but easier to implement approach can drive down both the cost and the technical debt needed to create an online resource. When students who know nothing about programming can easily add data to the website using standard tools, everyone wins (even, ideally, the students). When there is no need to implement a webserver with its own custom scripts and database operations, costs drop dramatically.

Somewhat paradoxically, new technological approaches can be strategically interwoven to minimize costs. Combining a flagrant abuse of free online tools, client-side scripting, and free static webhosting can approximate the functionality of a highly sophisticated dynamic website with none of the costs. When this approach fails to provide all the necessary functionality, it is still possible to take advantage of free tier services on webhosting platforms to host lean dynamic websites.

In all these cases, the essence of the strategy is to tuck an academic website into the tiny spaces hiding within the massive flow of communication and commerce happening on the global internet. Our projects are typically small and lightweight, while the tools and services we need to make them work are designed for huge commercial operations. We can go along for the ride like seagulls on a container ship, without anyone noticing a few stowaways that have no impact on their bottom line. Discovering and enumerating some of these opportunities is the purpose of this section.

[23] Johnny Ryan, *A History of the Internet and the Digital Future* (London: Reaktion, 2010): 115.

Static Websites and Free Hosting

The first question any researcher should ask when setting out to build an online resource is: Does this project really require a dynamic website? After instinctively and thoughtlessly answering "yes," that researcher should then ask themself the question again. Perhaps a third time, if necessary. The answer to this question is all too often "no." Most online resources do not actually need huge databases and expensive, error-prone, difficult-to-maintain server-side programming. Most research data in the digital humanities change relatively slowly and require very little technological infrastructure to be useful.[24]

It is perhaps best to think of static websites as the old internet. Before interactive webapps became commonplace, most websites served webpages directly without any database queries or server-side processing. A user typed a URL into a browser, and the website sent back a premade HTML file with all of the information hardcoded into it. These days, such websites do not need to be clunky and inelegant, they merely cannot use server-side processing to generate pages on the fly. Webpages must be prepared in advance and remain static, but they can still include attractive styling and embedded JavaScript for interactivity.

More importantly, static websites can be built upon well-organized, structured data. Static site builders, such as Hugo and Jekyll, create stylish, current-looking websites from collections of text-based data. Although these sites look as though they were generated dynamically from information stored in a database, the data are all stored in text files. The difference is primarily one of software, not underlying information, and it is a straightforward task to convert between these different digital representations. The technical skills required to

[24] That is, not minute by minute.

scrape a website (or, better, parse a repository of text files) are largely commensurate with those needed to manage a database. For the average user accessing the information through a web browser, the difference is invisible.

Static websites offer two main advantages to researchers: 1) they are easy to build, requiring little to no programming experience, and 2) they can be hosted for free indefinitely. For the Gardens of the Roman Empire project,[25] the static approach proved ideal. The website is a collection of encyclopedia-style entries on excavated Roman gardens. Each entry includes a similar set of data: a name, geographic information, keywords, a description, images, and a bibliography. In other words, each entry is identical in structure, but contains varying information. This is a possible use case for a database, but there is no need. No highly-efficient queries ever need to be run on this dataset, and entries do not need to be updated from minute to minute. Most researchers want to find and read the information relevant to them, and anyone who does need to analyze these data on a broad scale can download the repository from GitHub. Perhaps most significantly, the project had no budget and its data-entry team was a small group of students and their professors. Free and stable were crucial features, while technological sophistication would have been an impediment. In our age of highly-interactive dynamic websites, static pages might go underappreciated, but Roman Gardens stands as a testament to the sophisticated, future-proof projects that can be built this way with considerably less overhead than other approaches.

However, the Zodiac Glossary would be impossible to implement with this approach. Each lemma would require a separate static file, resulting in many thousand files with a tiny amount of highly

[25] "Gardens of the Roman Empire," September 22, 2022, https://roman-gardens.github.io/. For more insight into how such a project looks under the hood, explore the repository on GitHub: "GitHub - Roman-Gardens/Gre: Gardens of the Roman Empire," September 22, 2022, https://github.com/roman-gardens/gre.

redundant information in each one. There would be no straightforward way to efficiently search the entire dataset. The separate researchers working on the project would not be able to add and edit lemmata simultaneously, and the entire data-input process would become maddeningly complex. The structure of the data in static form would erase much of the ontology we are deliberately designing into the database. Most importantly, it would become difficult to create linkages between lemmata and track networks of relationships, the primary purpose of the glossary for the Zodiac Project's research agenda.

Static websites are no panacea, but thinking carefully about a project's needs and how a static website might meet them is always a useful exercise. Even if the approach is not practicable, reanalyzing the project in such terms can help reveal other ways of simplifying and promoting sustainability.

Pseudo-dynamic Websites

In many cases, static webpages lack the range of capabilities to serve the needs of a project, or their use would add too much complexity. In such cases, the unavoidable need for a dynamic website can be cleverly circumvented. This approach, which I have christened "pseudo-dynamic" for convenience, entails mimicking the functionality of a dynamic website using free tools and frontend code. Pseudo-dynamic websites work best when the data involved are relatively small and conceptually simple. For instance, a very useful but niche website, such as the Polychrome Hieroglyph Research Project,[26] might consist of only a list of entities with some words of description and links to relevant images. Such data can easily be organized into one or two database tables. In this case, a pseudo-dynamic site would be undetectable to the

[26] "The PHRP Home Page," 2020, https://www.phrp.be/.

site's visitors, while demanding only a fraction of the technical overhead and none of the cost.

Many digital-humanities datasets take the form of one or a few tables of information. In other words, much of the time, the data could be contained in a Microsoft Excel-style spreadsheet. By contrast, databases used for large commercial websites typically consist of dozens or hundreds of tables interconnected in complex ways. Often there is a mismatch between the capabilities of database software and the needs of the small academic project. Whenever this is the case, it is worthwhile to consider whether organizing the data into a spreadsheet might fully serve the needs of the project. If so, it becomes possible to replace the overhead of a database with any of the many free online spreadsheet services (e.g., Google Sheets, Grist).[27] This saves on the cost and work hours of provisioning a webserver and maintaining a database, making all backend operations virtually free indefinitely. This approach has the added benefit of opening the data to all members of a project with an ordinary level of computer literacy. No one needs to have experience designing databases or writing SQL queries. Basic knowledge of Excel-style spreadsheets is enough for anyone who would be working with the dataset.

In order to make these data accessible to users on the internet, the process becomes more complex, but well within the capabilities of any programmer who would be employed to create a fully dynamic website. Instead of building server-side scripts to query a database, JavaScript contained within static webpages can load, organize, and display the data. The content is dynamic in the sense that it is

[27] Here it is worth remembering the popular adage: "If it's free, you are the product." This is certainly true when it comes to services such as Google Sheets. It should be assumed that any data added to a Google Sheet is visible to many people aside from their creator. However, generally speaking, the purpose of any academic website is to make data publicly available, which means that they would be accessible to Google whether hosted through Google Sheets or anywhere else on the public internet. A project relying on sensitive data should take extra caution when considering any approach discussed here.

generated on the fly from a dataset. However, from the perspective of the webserver, the files themselves are static. This means that the site can be hosted for free indefinitely, but can still mimic the interactivity, flexibility, and underlying organization of much costlier, more technically sophisticated options.

The full potential of the pseudo-dynamic approach has yet to be realized, perhaps because the tools needed have only recently become available, but perhaps, also, because there is a scrappiness to doing things this way that makes it seem unorthodox. Nevertheless, the potential for forever-free digital-humanities is here. No project should proceed past the planning stage without at least considering it.

Free-tier Hosting for Small Projects

Having earnestly striven to envision the project as a static website and rejected that option because it fails in some crucial way, then having considered the pseudo-dynamic approach and having been forced to abandon it, the researcher is left with no other choice but to plan for a database and a dynamic website. Such sites are notoriously complex and expensive. Programmers able to build them from scratch (full-stack developers) are consistently in high demand, meaning that academic projects can expect to pay a premium for their work. On top of this, the hosting solutions for dynamic websites are almost never free, with the cost depending on multiple factors including server-side computing demands and number of site visitors. Building a dynamic site that remains free in perpetuity requires care and forethought, but it can be done.

Many webhosting services, such as Amazon Web Services, provide a free tier designed to attract new customers to their platform. These services are highly profitable, but much of their revenue comes from large-scale commercial operations. They can afford to give away a little bit of server time in the interest of increasing their share of the market.

Small academic projects can often function well below the threshold of services that constitute free tier. At times, a bit of clever engineering is required to ensure that this remain true. For instance, instead of instantly transmitting changes to the server to be stored in the database, making changes only when the user manually clicks a "save" button reduces the amount of traffic and the number of database operations. Similarly, instead of implementing a search that queries the database directly, a small summary of the data can be transmitted once and filtered on the client side. These and many other optimizations help ensure that a website demands as few server resources as possible, thus making it more likely that it can function with only free-tier services.

However, this approach is not without certain risks. Firstly, keeping things under the free-tier threshold is not always easy. A mistake by the developer can lead to unexpected charges. Secondly, free services often fail to deliver the expected benefit to the company that provides them, leading to their eventual deprecation. A well-known example is the case of Heroku, a cloud hosting provider whose free service rapidly became the backbone of hobby projects and educational programs. On November 28, 2022, this service officially ceased to exist, forcing all of its users to find alternatives.[28] Though many alternatives exist, the risk that they will eventually disappear requires that anyone depending on such services be always prepared to move the entire project somewhere else at short notice. Planning for such eventualities adds complexity and overhead to the project in exchange for lowering costs. It also requires that at least one member of a project maintain its viability in perpetuity lest it disappear when the hosting provider changes its policy.

[28] "Deprecation of Heroku Free Resources | Heroku Dev Center," August 25, 2022, https://devcenter.heroku.com/changelog-items/2461.

As of today, the Zodiac Glossary is hosted by a free service, Fly.io.[29] Every aspect of the site and its database operations have been designed to remain well under the threshold established by that service for free usage. It remains to be seen whether this solution will continue to be viable indefinitely, but for now the members of the project are entering data and using the site for their research with no difficulties. It functions as well as any costly hosting provider. Our hope is that this will remain true so that the Zodiac Glossary can continue to serve the academic community long after the Zodiac Project has come to an end.

Conclusion

The problem of sustainability for online academic projects cannot be overstated. The most innovative and exciting academic work in the digital humanities is plagued by an out-of-date funding system that undermines its greatest promise: to make unique, irreplaceable, highly-specialized research available to the entire world. Though there is no completely satisfactory solution to this problem, there are steps that can be taken to optimize the approach to a project's specific usage and needs. Ultimately, an overhaul of academic research funding is needed to replace an idiosyncratic set of imperfect options, but as of now the best action is to consider the various approaches in light of each individual project, aiming always for low long-term cost and maximum longevity.

[29] "Fly.Io," 2023, https://fly.io/.