Little Ivy Creek Bridge Replacement using Accelerated Bridge Construction Methods
(Technical Report)

Slowing Down Innovation to Ensure Safety
(STS Paper)

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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General Research Problem: Slowing Down Innovation to Preserve Society

Can the need for innovation be a hindrance to society?

In the present undergraduate engineering curriculum, students are taught that they should strive to be innovators; that they should always be asking questions and trying to push the envelope of engineering. This ideology, that we, as engineers, should always be looking for ways to improve a process, is definitely a valid one. However, it's important to ask how much further can we actually push the boundaries of technology and if society could ever suffer from said innovation? As a society, we live for innovation. This is why Apple never fails to make a huge impact on the market whenever they release a new iPhone or major accessory, even if it's just a slightly better version of its most recent predecessor. Anything that makes any function in life even slightly easier, more efficient, or more enjoyable, will be desired and eventually developed to fit that need; this applies to every and all aspects of life, and we can observe acceleration in all aspects of life. German sociologist Hartmut Rosa talks about the theory of dromology, or the science or logic of speed when he answers the question "What is social acceleration?" He notes that there are three types of acceleration that we see in Western societies; technological acceleration, acceleration of social change, and acceleration of the pace of life (Rosa, 2003).

Technology has continued to advance at a rapid pace. To bring forward the potential problem acceleration in technology again, I'd like to touch on the ever growing generational gap caused by innovation in technology. These days, it is not uncommon for kids to be smarter or more tech savvy than adults. Take the internet for example; something that my colleagues and I use on the daily and have become proficient at; while a great deal of our parents have difficulties navigating the web. This separation in society poses problems. This excerpt taken from Forbes explains a problem within the generational gap. “One example is the change to having mobile devices at meetings where there used to be nothing but a pencil and legal pad. Millennials see this as an advantage and use the Internet, email and Twitter during meetings to capture notes, find information that may be helpful to the conversation, and more. Gen X’ers, who aren’t used to this technology, may perceive these actions as rude” (Savitz, n.d.). In this instance, technological advancements have caused a substantial divide in society.

French culture theorist and philosopher Paul Virilio coined the term “dromology.” He believes that history progresses at the speed of its weapons systems. In many ways, the theory of dromology can be related to the speed of innovation. Just as technology advances, society itself advances, not in lock step, but at unknown, differing rates. With one innovation, Henry Ford and the Model T shaped transportation and shifted society as a whole. The use of the assembly line created the mass-production process that we see today, ultimately bringing about the “machine age”. The car itself, being so affordable and efficient, brought mobility and prosperity to many who could only dream of such liberties. In 1908, Ford had created an affordable personal vehicle that would go on to influence every automobile in production to this day. Not every new technology will make leaps and bounds like the Model T or Elon Musk’s Tesla, but with innovation comes change; change that will influence the three forms of acceleration that Rosa outlines. Progress in society can be attributed to innovation, based on these theories (Virilio & Polizzotti, 2006). “The effects of technological acceleration on social reality are certainly tremendous” (Rosa, 2003, p. 6).

It is a common saying that we must first know failure in order to succeed, and this translates to the engineering world. With innovation comes experimentation, and it is in the process of experimentation where I draw concern. In recent history, there have been instances in which we have experimented with new technologies, with the intent of improving a function, but result in failure, not excluding people getting hurt. Progress requires experimentation, that much is understood, but it is in the process of experimentation where we, as a whole, may get carried away or complacent. Being an emerging engineer, I've learned that being overambitious or complacent in the world of engineering can have disastrous outcomes. It is important to find a balance between the two extremes. It is a common saying that we must face the consequences of our actions. If this is true, then it would be logical to put significant thought into the possible consequences that may arise in any case. The implementation of accelerated bridge construction at Florida International University is an example that I want to use as a case study to illustrate the argument of progress vs consequence. This is a topic that I intend to expand upon in my prospectus to further understand some of the anxiety towards technological advancement. Through these analyses, I hope to shed light on the balance between the speed of innovation and the preservation of society.

Integration of Accelerated Bridge Construction

How can accelerated bridge construction improve construction efficiency/productivity as compared to older traditional methods?

My technical topic deals with accelerated bridge construction and gauging whether or not it would be suitable for the reconstruction/rehabilitation of a 30 ft wide bridge spanning over Ivy Creek off of US Route 250. Accelerated bridge construction (ABC) methods are "bridge construction methods that use innovative planning, design, materials, and construction techniques in a safe and cost-effective manner to reduce the onsite construction time that occurs when building new bridges or replacing and rehabilitating existing bridges" (Bos, 2019, p.4). In other words, ABC focuses on offsite construction of the bridge and its sections, which will eventually be carried off to the site using heavy machinery and carefully assembled. In doing this, we are greatly limiting the amount of time and money it takes to have work zones in place, while simultaneously reducing the possibility of traffic that would surely accumulate when construction is being done. By eliminating evident and probable traffic jams due to construction work zones, we are both increasing safety by moving construction away from traffic and preventing the Earth from further exposure to hydrocarbons emitted from our vehicles. The three main benefits of using ABC methods include minimized impact to traffic, increased safety during construction, and a decreased impact on the environment. Where conventional bridge construction takes months or years, a bridge utilizing ABC may be placed in a matter of weeks, days, or even a few hours depending on the methods used. (Bos, 2019, p.3-4) Through this technical project, we plan to use data taken from field tests given to us to analyze and design a replacement for the bridge. These data include boring logs from standard penetration tests conducted, field diagrams, structural inspections, analysis reports, etc. Basically, we were given all the standard data that a team of engineers would need in order to analyze and plan a replacement method. Pertinent information that we have derived from the data at this point include bearing capacities for the soil (the maximum allowable loading), soil conditions on the site, and typical loading conditions (what is acting on the bridge). Ultimately, by the time we are done, we will have designed a bridge replacement, most likely compatible with ABC methods; meaning that it will adhere to all geotechnical and structural guidelines including adequate strength and deflection in both the soils and the materials being used in construction. While the Virginia Department of Transportation has already completed this project using ABC, our advisors were reluctant to let us simply pull information from and make assumptions about work already completed. Using the values that we derive from the data, we can assess the different paths for design and choose the most efficient option to be designed next semester. It is to my understanding that our findings will be published at UVa but may not reach VDOT, since the bridge has already been replaced.

New Technology and Experimentation

Can the argument be made that innovation is moving too fast for society?

Accelerated Bridge Construction is still a fairly new practice in construction. It has really only been introduced in the last couple decades and is rapidly gaining attention. ABC, until recently, has been glorified to both the public and the engineering world. Not only does it save time by avoiding traffic impeding work zones and allowing a more contained work space; it substantially cuts construction costs due to how fast the process is. There are also multiple engineering specific reasons why ABC is beneficial, including improved constructability ("EDC-2: Accelerated Bridge Construction (ABC) | Federal Highway Administration," n.d.).

With that being said, through my limited research, it seems as though ABC should be the preference when building bridges.

For the most part, DOTs have seen much success, but it only takes one mistake in the engineering world to be put under a scope. On March 15, 2018, a pedestrian bridge built using ABC collapsed at the Florida International University in Miami, killing multiple people. Just as construction is different for this type of project, as opposed to traditional processes, inspection for the bridge must also be done differently. With limited knowledge on the design of bridges, I can say that there are several different joints, connections, and other parts that are used when simply placing a prefabricated bridge in place; parts that may not replicate those found in traditional design. Ultimately, it was the unfamiliarity of the engineers inspecting the bridge that allowed it to collapse (Ayub, 2018). In this particular instance, it is not wrong to question the training and knowledge that these engineers must have and implement to avoid these sorts of things. I would like to draw on this example of acceleration, and bring forth the issue of haste in engineering. Had more traditional methods been used or proper procedures been made and upheld for dealing with new technology, it is possible that this accident could have been avoided. ABC is very much a sociotechnical system, in that it is a form of process innovation with the potential for societal impact, good and bad as I've laid out. It is out of this reasoning, and others similar to it, that it can be asked if innovation is moving too fast, against the good of society.

Following the collapse, engineers were hesitant to adapt ABC methods. This bridge had been built in part off site, with some of the span being cast in place onto/along the transported segment. Based on a report I found investigating the collapse, the bridge was inspected by engineers hours before it happened, but they neglected several problems with the structure;

details that would have saved lives. "The concrete truss had developed numerous wide and deep structural cracks jeopardizing the integrity of the bridge. The EOR (engineer on record) should have immediately instructed that the bridge be shored…" (Ayub, 2018, p.109). Due to negligence on the part of the engineers, one employee and 5 motorists were killed, along with another permanently disabled. From what I read, it seems like the structural engineers made multiple errors in designing the bridge and those errors carried through to the contractors, causing a domino effect. It seems like one main proponent for the failing of the bridge was that the selection team at FIGG Bridge Engineers "was swayed by the graphics and rendering of the bridge and did not consider the non-redundancy of the structure" (Ayub, 2018, p.109). Through this incident, ABC amassed heavier scrutiny than ever before, being that this was the first fatal incident that had occurred involving bridges built using ABC methods (Ayub, 2018, p.109).

FIU ended up taking a lot of heat for the collapse, as the families of victims demanded answers. One parent who filed a wrongful death lawsuit last year against Munilla Construction Management, Figg Bridge Engineers and other subcontractors on the project, "expressed frustration with the glacial pace at which the lawsuit is winding its way through the judicial system. They lamented that none of the defendants… had reached out to offer their condolences or accept blame for not shutting off traffic to the Tamiami Trail while construction crews worked on the 174-foot span" (Vassolo, 2019). Serious repercussions were to be had, and rightfully so, but no one group wanted to accept blame. It's easy to neglect consequences, but not as easy to bare them. It was interesting that the families were mainly concerned as to why traffic was not closed off during construction, that being one of the main benefits to accelerated bridge construction. By using ABC methods, we are trying to achieve less disruption in the flow of traffic; yet here in this case, the flow of traffic was disrupted in abrupt fashion. Progress in engineering was made, but at what cost? It is the cost that we must evaluate.

It is in situations like this one where we question our ambition in the world of Engineering. By attempting to be as efficient as possible, the bridge had still been accessible for workers and traffic had remained flowing, as per usual, beneath the bridge. Had a traffic zone been in place to prohibit traffic as per traditional bridge construction, it is likely that there would be fewer casualties on that day. The FIU bridge collapse would be nowhere near as big a deal. Innovation is meant to be taken slowly and gradually, while taking the time to make sure that innovation is worthwhile. We do it in engineering all the time. Products are tested numerous times, with the aim to work out all the kinks before it gets in the hands of consumers. Without the proper knowledge present, innovation is water that should be treaded lightly. The Slow Science Manifesto, a document written by The Slow Science Academy shares the same ideal. "Science needs time to think… slow science was pretty much the only science conceivable for hundreds of years; today, we argue, it deserves revival and needs protection" ("SLOW-SCIENCE.org—Bear with us, while we think.," n.d.).

In no way do I mean to neglect progress made up to this day; we have truly evolved to a point in life where we can afford to implement "slow science" and take our time in most of our technological endeavors. If the goal is to reduce risk in one way, that goal should be reached while taking measures to avoid other major risks in the process, like casualties from a bridge collapse. In my future plans for this project, I plan to gather more data on some of the other bridges constructed using ABC methods. I believe it would also be a good idea to compare and contrast a traditional bridge design to the design used for the FIU bridge. In this, I plan to get a little more detailed as I talk about the different failure mechanisms that ultimately brought it down. By identifying the different groups and parties involved, I'd like to provide further insight and understanding of the liability involved. I also want to become more familiar with the graphics and rendering that caused confusion concerning the redundancy of the bridge and give a better comparison of what discrepancies go into ABC vs traditional bridge design. Using all this data, I will present a case study centered around the collapse that will help me illustrate the issues between acceleration in innovation and the necessity for risk analysis and "slow science".

In the end, if we shy away from innovation, we will never achieve further progress, as we have been doing for so long as the human race. It is human nature to focus on the negative aspects of any situation and decide against it, while it is often difficult to recognize the good and continue to work towards it. Innovation is not the enemy here; it is the speed and haste of innovation that is in question. The ideal that innovation influences society is a valid one, one that I plan to carry out through my thesis. Accelerated bridge construction is just one instance of innovation that carries huge risk with the potential for huge benefits. While technology has continued to change our society, some would say for the worse, it should be understood that "Science develops unsteadily, with jerky moves and unpredictable leaps forward—at the same time, however, it creeps about on a very slow time scale, for which there must be room and to which justice must be done" ("SLOW-SCIENCE.org—Bear with us, while we think.," n.d.). Henry Ford once said "Failure is simply the opportunity to begin again. This time more intelligently" (Ford and Crowther, 1923, p. 19), and innovation can also be viewed in this fashion. In my final iteration, I hope to present a body of work that stresses how imperative it is to assess risk and be patient when making progress in technology.

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