Passive Data Collection on Potholes
(Technical Paper)

How Culture Influences Engineering Practice
(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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Introduction

When trying to learn a new language, it often seem like native speakers of the target language speak far more quickly than is necessary. For some languages, this conception is more true than others. For example, Japanese is a language which is notoriously hard to learn, but according to Christophe Coupe, Yoon Mi Oh, Dan Dediu and Francois Pellegrino, all professors of language at various universities around the globe, Japanese is also a fundamentally inefficient language, in that there is no positive trend between the number of syllables and amount of information conveyed as shown in Figure 1 (Coupe, 2019).

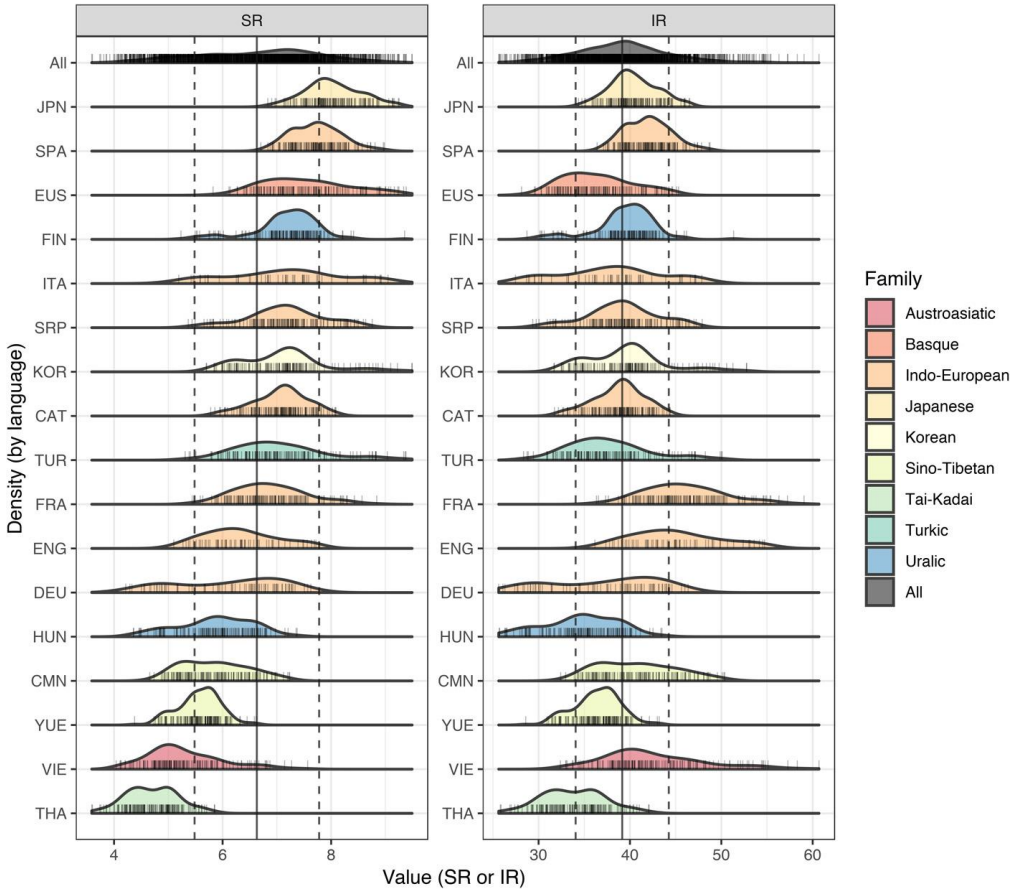

Figure 1: Syllable Rate (SR) vs Information Rate (IR) in Commonly Spoken Languages (Coupe, 2019)

Language has some inherent barriers to understanding, which can make it difficult for people trying to work together, even having studied each others reciprocal language, a case which is already rare to begin with. At the University of Virginia (UVA), engineering students are not required to study a language, which motivates this paper's hope to explore how engineers in particular can surmount cultural boundaries, such as language deficit, in the context of global engineering projects. This paper will pay particular attention to a few case studies of the current state of engineering on a global scale, as well as peer into how engineers around the world are prepared in school to work in a globalizing society. The research presented in this paper is motivated by inevitable diversity present in any workplace; diversity is to be embraced in these areas and this paper plans to show how this goal can be achieved in a workspace where diversity plays a particularly unique role.

An interesting crossroads of culture in contemporary society is the automobile. Technical leaders in the automotive industry have arisen in several places around the globe. The automobiles produced by the companies often reflect the values of the culture they are produced under. In fact, Maria Taljegard of the Chalmers University of Technology points out how Norway, Denmark, Sweden and Germany in particular are currently developing electric vehicles (EV) (2017). Most notably, cultural influence can be seen in the form factor of the car. When it comes to American cars, a popular feature that has risen from factors of modern life in the United States is a device to detect and deal with potholes on the road. In many places around the country, the road infrastructure cannot keep up with the volume of drivers on the road; as a result, to avoid peril by pothole, it is an easier solution at the moment to develop cars that can adapt to road conditions rather than vice versa.

Technical Topic

In America, "repair bills for motorists can range from under $250 to more than $1,000" (Bergal, 2018). While potholes are a direct result of American politics, another American cultural icon, the Ford Motor Company, is developing smart suspension to lessen the impact of potholes. In the newest Ford models, suspension is automatically adjusted upon the detection of a pothole using LIDAR (Thomasen, 2018). Additionally, Google is developing software that tracks general road conditions (Wiggers, 2015). Our team's capstone project aims to combine these ideas in a new way to create a physical smart sensor device that can link to a smart phone application. While outside the scope of the project for this capstone, the hope is that this application's data can eventually be used to direct towns on how to fix these potholes as well as give drivers recommendations about which streets to avoid or use caution on.

The sensor itself consists of an accelerometer, an MSP430 microprocessor, and a Bluetooth Low Energy (BLE) chip. In order to collect more diverse data about any given pothole, these sensors will be combined in a modular format to allow the integration of more than one sensor to the same smartphone. Accelerometer data will be handled through a data transfer bus running inter-integrated chip (I^2C) protocol. I^2C will be coded onto the microprocessor and 'drive the bus.' The bus can be thought of as a literal bus where all the data rides together and goes to all of the stops, whether the data was intended to go to that stop or not. The bus driver is responsible for saying what data actually gets on or off and where. The BLE chip will use a profile, otherwise known as format for communicating, that already exists within iOS devices to easily communicate with any iOS device (in the future the application can be expanded, but for now must be limited by the scope of the project). The deliverables of this project include a physical mountable sensor compatible with any car and powered off of

common AAA batteries with a companion downloadable smartphone application that will produce a visible map of common potholes in the Charlottesville area. Our team consists of two Computer Engineers, Liam Robb and Steve Phan, who are in charge of the software and systems engineering portions of the project which include the mobile application as well as any programming required to run the microprocessor or BLE chip. My job as the Electrical Engineer is to select and interface any hardware components, provide power to the system, and keep the other two informed on what hardware is doing what task so that they know what software will be needed to control each part. The preliminary research for this project was completed to produce a proposal for the project. The remaining research and physical construction of the deliverables is set to be completed at the end of November. The final report will begin to be written post completion of the deliverables.

STS Topic

こんな文を読めますか。O puoi leggere questa frase? It is not likely that either of those sentences mean anything to the average American. In an attempt to mitigate this understanding deficit, high schools, as well as most colleges, enforce a cultural exchange in education, namely through a foreign language requirement as part of a degree (Chance, 2018). However, language practice is not required in all departments of academia. The field of engineering is particularly lacking in this area. “Given the increasing popularity of GSE (global software engineers), it is quite common nowadays to find software

engineering (SE) professionals working in some sort of GSE setting, where the team is distributed across a city, country, or around the globe" (Hoda, 2017). This points out how important it is that projects can be completed across cultural boundaries. Some academics, such as Rustam Shadiev, discuss how, "modern communication technology brings people into close proximity, exposes them to an increasing variety of culturally diverse people, and fosters a range of different relationships" (2019). Which he and his colleagues are trying to bridge with a speech based translation technology. Though language learning is becoming permeated by language processing algorithms like this, as well as artificial intelligence (AI), it is important that even if a language boundary is crossed, engineers can come to a cultural understanding.

The topic will focus on cultural and language barriers as well as bridges within the engineering world. Specifically, the topic will cover the overarching engineering practices and how they differ from and interact with different cultural backgrounds, even down to "research instrumentation...and formats of social organization, as well as by specific conventions of scientific publishing " (Kaltenbrunner, 2018).

Through this paper, I hope to tie in experience from my time spent learning about foreign languages and cultures to bridge cultural divides in an effort to apply my engineering skills globally. An example would like to point out is the English Channel Tunnel project between England and France, which points out the interesting relationship between political goals and

engineering drive, emphasizing how those forces work together, or against each other, to develop the resultant project (Wills, 2015). The tunnel project is an example of success in global engineering despite French and English differences. The second example helps to demonstrate how a difference in culture can have a positive impact on the engineering practices of another culture. The streets of India are densely packed with cars, and replacing these with electric rather than gas powered vehicles presents a positive shift in environment for the people living in the affected areas. In addition to exploring examples of the case studies such as the British Channel tunnel project (Zabusky, 2000) and foreign electric vehicles (Gopinath, 2013) and their effect on the target country, this paper will explore some linguistic (Vandeweerd, 2018) and engineering (Ballatore, 2019) teaching practices to show how different mindsets are produced at the schooling level to prepare STEM majors and humanities or arts majors differently in terms of global scale projects. The last issue is the administrative side of any global project, namely in terms of communication which is perhaps always the first barrier to a wide scale project. To anaylize these concepts, this paper will tie in frameworks such as technological determinism and actor network theory (Cressman, 2009) to show how these methods influence science, technology, society, and the intersection of these three concepts. The historical case studies will be used to shine light on the current role that culture has on the engineering mindset. This analysis includes how it has functioned, failed, and been overcome in past projects to gauge the general effect. The network analysis will aim to see why these case studies resulted in the way they did through analyzing the relationships of the people involved, their cultural background, and engineering experience.

Cultural differences and political interests greatly shape how engineering projects are conducted. It is important to acknowledge these differences in an increasingly global world so that projects do not fall through due to a lapse of mutual cultural understanding.

Research Question and Methods

The question this paper will aim to answer is: how do cultural discrepancies influence engineering practices and the results of intercultural engineering projects. This relationship will specifically be observed through the lenses of cultures I have studied while pursuing my engineering degree to help form a more unique connection to how these various cultural practices affect engineering results. In order to draw out these answers, this paper will explore cultural practices in engineering mainly through the methods of historical case studies and network analysis.

Conclusion

Cultural differences should not be viewed as obstacles to overcome, but rather a unique human trait to be understood in order to better relate to each other. In terms of completing an engineering project, rather than push aside differences for the common good, these differences should be embraced for the overall betterment of the project. In addition to this message, this project will deliver a physical pothole detector, a mobile application, and a technical report outlining the process of how the deliverables came together, all of which invited our team to look into our own lense of culture through the lense of an engineering project. Differences in culture can bring new points of view to a project that would have been overlooked otherwise. The encouragement of embracing these differences starts at the high school level, where those who may end up in a STEM field are first introduced to the idea of studying another culture. This

sentiment is fairly strong is places of long and diverse cultural history like Europe and Asia, but less so in the United States. It is important that a desire to understand other cultures is not forced, but rather gently instilled so that the learning experience may extend through higher education and into the engineering career.

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