Package Deployment Automation

Analyzing Business Influence in Engineering Education

A Thesis Prospectus
In STS 4500
Presented to
The Faculty of the
School of Engineering and Applied Science
University of Virginia
In Partial Fulfillment of the Requirements for the Degree
Bachelor of Science in Your Major

By

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November 1, 2021

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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

For my capstone project, I will be writing about my Summer 2020 internship with SES Satellites. During the internship, my project was to automate SES's package deployment system. This project is important to SES because with an automated deployment system, employees do not have to waste their time individually deploying packages every time a new server is created or every time a new package is needed on a set of existing servers. The objectives of this project were to stand up a server that could house packages, integrate software that could pull packages from the server previously mentioned and deploy them elsewhere, deploy to test environments, and write scripts to distribute the packages to the right servers. Having finished the project, SES is now able to write more scripts to easily deploy specific packages to different groups of servers.

I will be linking my Summer 2020 internship experience to my STS research project by analyzing the imaginaries involved in the education of engineers. These imaginaries are concerned with the material best suited for engineers' learning. The analysis of these imaginaries is important because it affects the job opportunities of recently-graduated engineers. According to the U.S. Census Bureau, 69% of engineers are employed in occupations requiring at least a bachelor's degree and 42% are employed in occupations requiring an advanced degree (like master's, doctoral, or professional degrees) (U.S. Bureau of Labor Statistics, 2020). This implies that while some people are able to become engineers without attending some form of higher education, getting a degree can still be helpful in obtaining an engineering job. Analyzing the imaginaries for engineering education is also important to non-engineers through unknowns: maybe their children will pursue engineering degrees and be affected by this. Moreover, engineers have a large impact on society, having a hand in designing vehicles, buildings, infrastructure and more. Thus, anyone who uses a car, plane, train, or building is affected by how engineers learn. For my STS project, I will be investigating the different approaches to engineering education: whether it is more valuable to focus on teaching problem-solving skills, a holistic education, company-specific skills, or a curriculum tailored more toward a student's needs.

Technical Topic

From June 2020 to August 2020, I worked as a software engineering intern for SES Satellites. My project was a solo effort which aimed to automate SES's package deployment system so that packages could be deployed to the right servers automatically rather than manually. This project was useful to SES because it decreased the time and manual labor

involved in its deployment process. SES is one of many tech companies recognizing the benefits of process automation. A study by Red Gate found that 74% of software companies surveyed in 2021 have adopted some automation practices (referred to in the article as DevOps) and this percentage has steadily increased from 47% in 2017 (Sadalage, Little, Fritchey, Jones, Kellenberger, & Giardina, 2021). Moreover, in a 2017 McKinsey Global Institute report, it was found that automation can enable companies to improve performance by reducing errors and improving quality and speed (Manyika, Bughin, Chui, Miremadi, George, Willmott, & Dewhurst, 2017). Thus, the benefits related to automation expose why SES valued my technical project.

The objectives for my project included setting up a Nexus repository where packages could be stored, leveraging Ansible to deploy packages from Nexus to other servers, using Docker containers to test package deployment, and integrating Nexus and Ansible with Bamboo. Previous to my work, SES stored its packages in Bamboo, which is a continuous integration tool. Bamboo does not have automatic, mass deployment and testing capabilities. However, Ansible is a software that offers such features. The issue with using Ansible is that Ansible cannot pull packages from Bamboo very easily, so a Nexus repository needed to be created to store the packages so Ansible could be integrated into the deployment process. For this purpose, I stood up a Nexus repository on a non-critical server as my first task.

After adding some initial packages to Nexus, I created Ansible playbooks that could pull these packages from Nexus and deploy to test servers. It was important to first deploy to test servers to ensure the protection of data and operations in critical servers. I used Docker's container service to simulate critical-server environments to which I could safely deploy. After completing these tests, I integrated Nexus with Bamboo (the continuous integration tool in which packages were previously stored) so that packages built in Bamboo would automatically be stored in Nexus. I then used an Ansible plugin for Bamboo to leverage Ansible's capabilities with Nexus. Using this plugin, I could trigger the execution of an Ansible playbook after a package was finished being built in Bamboo. I wrote this playbook to pull the pre-built package from Nexus and deploy to the critical servers in which it is needed. At this point, the deployment system had been fully automated and all that was left to be done was to edit the deployment locations provided in the playbook that specified where to deploy the specific packages being built. Tests could now also be written into these playbooks if so desired.

STS Topic

My work for SES Satellites decreased the manual labor and time required to deliver packages to SES's servers. The software involved in this project, like Docker and Ansible, are commonly used among companies. 2019 saw 20% of global organizations run containers and 2021 expects this percentage to rise to 70%, and containers are mostly implemented by Docker and Kubernetes (Hugo & Esposito, 2021). Furthermore, over 16,349 companies started using Ansible in 2021 (Slintel, LLC., 2021). Despite this popularity, these software were unfamiliar to me and created a steep learning curve. This highlighted a potential deficiency in my engineering education and relates to the sociotechnical framework of "imaginaries" by exposing a different perspective of the typical engineering curriculum: maybe (software) engineers should learn software and practices in use by a majority of companies instead of less relevant, fundamental (programming) knowledge. This research will utilize the sociotechnical framework of "imaginaries" by analyzing the various perspectives on engineering education and considering which learning approach to take from now on and in the future. The approaches being considered include stronger focuses on problem-solving skills, a holistic education, company-specific skills, and student-tailored curriculums.

Varying Perspectives of the Engineering Curriculum

One perspective of engineering education advocates for a large focus on problem-solving skills. A literature review written by scholars at Universiti Teknologi Malaysia argues that technology is ever-changing, making it less critical for engineers to learn present-day technology and more critical for engineers to learn skills that will enable them to learn emerging technologies in the future. In this way, engineering students will be more prepared in the long-term when facing new and unforeseen challenges (Subramaniam, Azmi, & Noordin, 2020).

Another perspective argues for a holistic engineering education. Anders Buch, a professor at Aalborg University in Copenhagen, Denmark, asserts that "to solve real problems in substantive practices, [...] narrow engineering skills and knowledge are not sufficient." Thus, some solutions can only be found by considering factors outside of those learned in a non-holistic engineering education (Buch, 2016). Similar to the previous perspective discussed, this approach focuses on engineers' long-term success. However, companies are not always concerned with their employees' long-term performances. Companies like Amazon, Google, and Mosaic employ engineers but have some of the highest recorded employee turnover rates (PayScale, Inc., 2020). Such companies are less

concerned with their workers' long-term capabilities and more concerned with their starting knowledge. This introduces yet another perspective.

This perspective values teaching commonly-used company software and methodologies. Engineers with this knowledge are more useful to companies in the short-term since there is no learning curve. This attracts companies like Google since Google contracts more temporary workers than full-time workers, numbering "121,000 temps and contractors [and] 102,000 full-time employees" (Wakabayashi, 2019). Moreover, learning software like Docker and Ansible will still provide plenty of opportunities in the job market since they are used by many companies. However, not all companies who hire engineers are short-term-goal oriented. Companies like G3 Technologies – a software firm where I was recently employed – focus on their employee retention rates. The Vice President of Engineering at G3, Andrew Park, believes that engineers only improve their technical skills by staying with one company and that the longest-serving G3 employees are his best (Hawes & Park, 2020). Thus, not all companies share the same perspective as those with high employee turnover rates such as Google, Amazon, and Mosaic.

Finally, the last perspective centralizes engineering education around a student's needs. The job-related needs of students vary from person to person and can be influenced by their (and their family's) financial situation. A study conducted for the Journal of Applied Psychology found that students from lower social classes cannot get well-paying jobs as easily as students from higher social classes (DeOrteniis, Van Iddekinge, & Wanberg, 2021). Since students from lower social classes may need to financially support themselves and/or their family, it may be beneficial to focus their education around immediate job preparation rather than around long-term goals like problem-solving skills or getting a holistic education. Moreover, since students must often pay their own tuition, it makes sense to let them tailor their learning to best suit their needs. However, student-tailored curriculums are not limited to students from lower social classes. There are other students (like students who are not pressured to financially support their family) for which learning to problem-solve and getting a holistic education would be more beneficial. In those cases, students can tailor their education around those longer-term goals.

Connection to STS Framework and Technical Internship

In Hess and Sovacool's "Sociotechnical Matters", the authors describe the framework of technoscientific imaginaries (Hess & Sovacool, 2020). This framework involves examining the collective assumptions and representations of sociotechnical order. Here, the sociotechnical order is the education of engineers and the collective assumptions are the

differing views of what engineers should learn in school. According to the Accreditation Board for Engineering and Technology (ABET), engineering higher education generally values teaching long-term skills like the ability to problem-solve and the "ability to acquire and apply new knowledge as needed", among a few other objectives (ABET, 2021). This framework also involves considering representations of sociotechnical futures, which in this context, is equivalent to describing what future engineers should look like. Future engineers are shaped by how they learn and what they are taught in higher education. This will ultimately impact everyone since engineering jobs impact all parts of society.

This research relates to my technical internship because approaching engineering education differently could ameliorate the problems brought to light by my internship. My internship consisted of a steep learning curve since the related software and programs were not taught to me in my higher education courses. Internship and job offers are not always guaranteed for engineers who lack the appropriate knowledge. My STS research examines different strategies for approaching engineering education. Considering these different approaches to education and understanding their affects will allow us to identify the best curriculums for engineering students. After this identification, engineering curriculums can be changed (or maintained) accordingly.

Next Steps

My capstone project is to write a paper about a previous internship experience I had. Next semester, I will take CS 4991 alongside STS 4600 to write this capstone paper. Since my technical topic centers around my previous work, there is no timeline for work that still needs to be completed (since it already finished). The timeline of my technical project was between June 1st and August 7th (10 weeks long). The first half of the internship consisted of standing up the Nexus server. After I completed this, I set up packages and a Docker registry inside of Nexus, with some containers I could use for testing package deployments with Ansible. Then I wrote Ansible playbooks to deploy Nexus packages to the Docker containers. Finally, I downloaded an Ansible plugin for Bamboo and connected all the deployment pieces so that the process was completely automated. At the beginning of working with each new software (Nexus, Docker, Ansible, and Bamboo), I had to research what these software were and how to use them.

I will submit this prospectus by November 3rd and receive feedback from Professor Sean Ferguson soon after. I will then make the necessary edits and submit my revised prospectus sometime in mid-November. Next semester, I will write my full capstone paper.

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