Co-Navigational Aquaculture Vehicle System Design
(Technical project)

Automation and the Potential for Marginalization
(STS project)

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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

As concern grows surrounding the irreversibility of climate change and little being done to stop it within our country, the need for more reliable and sustainable food sources is rapidly increasing. Food demand is expected to increase anywhere from 59% to 98% within the next 30 years (Elferink & Schierhorn, 2016). The Department of Agriculture has come up with one potential solution: offshore aquaculture, or fish farming, which is "forecast[ed] to increase by a further 15% by 2030," (Towards Blue Transformation, 2022). Fish farming provides a source of protein with carbon emissions that are six times lower than that of beef (Petsko, 2021). This is because oftentimes, "marine aquaculture operations have a smaller carbon footprint and require less land and fresh water" (NOAA, 2020). Furthermore, the ability to host its farms hundreds of miles offshore prevents coastal aggravation – in which coastal areas' water becomes polluted by excess nutrients and fecal matter from the greater than usual fish population We are currently ranked as a minor aquaculture producer – 16th as of 2018 (Furukawa, 2022, p. 35), but before aquaculture can become a more reliable food source there are difficulties that must be addressed within this new style of farming. The diving requirements to properly clean and maintain these fish pens are not only inefficient, but pose a safety risk to workers and requires constant transportation to offshore locations. This makes it not only unsustainable, but dangerous. With the rising use of AI and robotics in society, this is the perfect opportunity to exploit such technologies and help promote a safe, environmentally-friendly food sourcing option. Autonomous technologies are seen as, "new methods to improve the quality of life in general, with a better integration into society" (Chakraboty et. al, 2022, p. xiv) and this is a great case study to exploit this idea. Thus, the development of an autonomous robot with the ability to clean

fish pens, while connected to a surface vehicle capable of harvesting wave energy will be a key component to improving current processes.

With the rise in use of automation in different jobs, there are concerns around job displacement, and difficulties in changes of career path. Consider the fact that there was a fourfold rise of industrial robots in the United States and western Europe between 1993 and 2007 (Acemoglu & Restrepo, 2020). Though individuals may be passionate about their work, it may no longer be an option if it is a task that a robot can handle – which is ultimately much less costly, and oftentimes more efficient than a human. Job decisions that are made at an age as young as the teenage years can ultimately guide the rest of one's life, and this is oftentimes driven by attitude towards school (Covacevich, 2021, p.18). If these seemingly small catalysts can lead to the later displacement of work, these individuals will be left in poverty. So, the question that then remains is: How can we ensure they can find a new job? If this issue is not addressed, we will have a society divided by disparate differences in income. Big business owners who can afford to develop or implement these technologies will no longer need their hourly workers, who will lack the skills to fill new roles or find other lower-skilled jobs. Nowadays, at least 65% of jobs require a college education (Georgetown University, 2019), if not more, which is not easily accessible or affordable at all. To address this problem and formulate better career advice and advocacy, the following question must be explored: How do individuals manage career shifts in response to automation?

Technical Topic

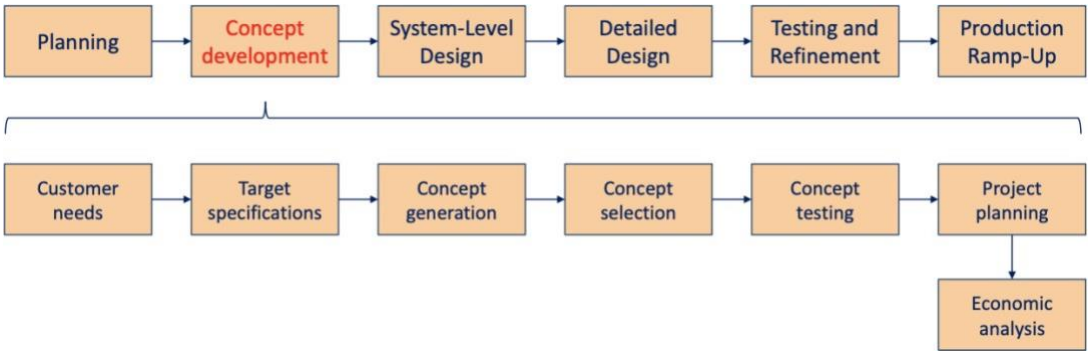
The current system used by offshore aquaculture facilities requires transportation of divers hundreds of miles off the coast – requiring fuel and polluting the ocean. Once there, the

job of fish pen cleaning and maintenance requires high risk safety issues – diving to clean the fish pens is not an easy nor safe task as it requires large depths and unruly fish handling. In terms of the current system, we will be improving a remotely operated vehicle (ROV) to become autonomous and compatible with a surface vehicle developed to harvest wave energy and provide a sustainable source of energy to both vehicles. The BlueROV2 is the ideal ROV to begin with due to its open software design and ability to easily take on modifications (BlueROV2 buyer's guide by options, 2022). Development of these devices will reduce workers' exposure to risk, while also likely reducing costs, especially as given the expectation that aquaculture will become more widespread in response to rising food demand.

In order to automate the devices, ROS, the Robot Operating System, will be used alongside pre-selected sensors to not only properly move along and clean the fish pens, but to also provide tracking information to those using the technology on the farm. Furthermore, the surface vehicle (ASV) and underwater vehicle (AROV) will be connected via a tether to permit the transmission of wave-harvested energy from the ASV to the AROV. The project will be completed by our team of five over the course of the Fall and Spring semesters of the 2022-2023 school year in the ME Design courses, with our client being our professor, Tomonari Furukawa and teaching assistant, Julia Rudy. It will then be further curated by future capstone groups and eventually handed off to the Department of Agriculture.

Further work surrounding these aquaculture projects is being done by Stevens Institute of Technology, MIT, Cornell University, and Virginia Tech. Our project is most closely aligned with Stevens and Virginia Tech, where there are different autonomous devices being designed for various aquacultural jobs. Though these other projects serve as a guide in our work, most of

the focuses of our work were developed through the design process shown on the following page:



Note. Design process utilized by the capstone team, mainly focused on planning and concept development in order to ensure optimization and productivity. From *Customer Needs Presentation*, by T. Furukawa, 2022.

Through interviews with our client and assessment of customer needs, the target specifications and goals of our project were developed, which then drove forward the concepts we have generated and selected for testing.

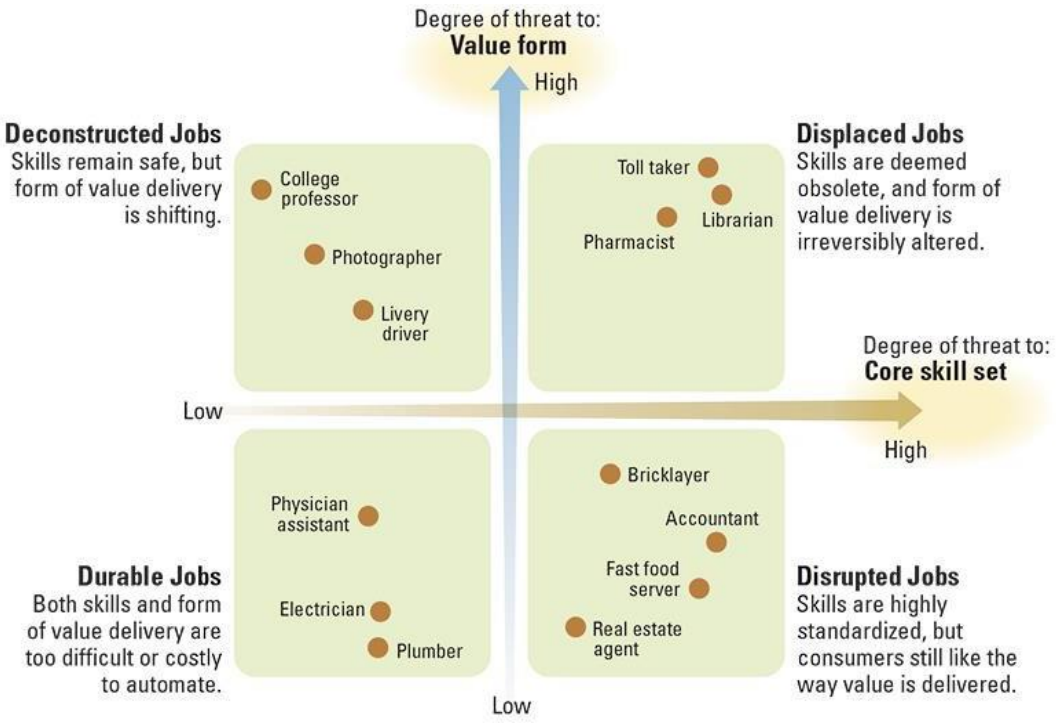
Thus far, our goals have been to refine our requirements and identify the proper corresponding hardware and software necessary to produce a mostly working prototype by the end of the fall semester. In the spring, we hope to refine that prototype, so we have a fully functional and presentable solution to share with other laboratory groups.

STS Topic

As we enter the 'fourth industrial revolution' with the rise in artificial intelligence and technology, more jobs are becoming automated and the remaining jobs are becoming skills-intensive, leading to a rise in demand for skilled workers. Economists such as Acemoglu and Autor note, "the return to skills, for example, has shown a tendency to increase over multiple

decades despite the large secular increase in the relative supply of college educated workers," (Acemoglu & Autor, 2010, pp. 1) illustrating the gap between demand for skilled laborers and the supply. According to a Forbes article, automation will supplant about 85 million jobs by 2025 (Kelly, 2022). Additionally, an IBM survey suggests that more than 120 million workers will be in need of retraining within the next three years due to the impact of AI on jobs (Kelly, 2022). If this is the case, what position does this put the unskilled workers in?

To understand the relationship between the unskilled workers, job displacement, and automation, the following map must be evaluated.



Note. Mapping of automation impacts on different job industries. From *Four ways jobs will respond to automation* by S. L. and B. Humberd, 2018, Sloan Management Review.

Automation is bound to impact all classes of individuals, regardless of whether they are a highly educated, skilled worker or a labor-based unskilled worker. The difference lies within the impact it will have – while it may inconvenience or change the work experience for those with more

education, it can cause complete obsoletion of lower-skilled workers' jobs, such as librarians, pharmacists, and toll takers (as seen in the top right quadrant). Furthermore, this "New Automation" consisting of artificial intelligence in combination with advanced robots is bound to cause more worker displacement and inequality than previous forms of automation (Holzer, 2022). The only groups predicted to benefit from these changes are the business owners, who will reap the benefits of increased productivity and decreased cost, as well as individuals who are able to retrain and as a result, complement the machine rather than be substituted by it.

The task at hand then becomes determining how to help those who are at risk of job displacement with retraining and furthering education. An article from Brookings notes the importance of what is now referred to as 21st century skills: communication, complex analytical skills, and creativity (Holzer, 2022). Reskilling and upskilling can be done either on the job or through private institutions, but oftentimes this can be costly and there is little incentive for companies to aid their employees in doing so. If no action is taken, governments are also going to need to provide stronger safety nets for displaced workers (Holzer, 2022). With fewer working individuals, there will be fewer taxes collected, and fewer government support programs available – if these issues are not addressed, social well-being more broadly could be at risk.

The STS framework that will be used to study the intricacies of automation's societal impact is Bruno Latour's Actor Network Theory (ANT). Actor network theory focuses on the combination of human and nonhuman actors, and how they are enrolled in the construction of technological systems. Latour believes that, "Whatever a scene presupposes from its transcribed actors and authors (this is very much like 'role expectation' in sociology, except that it may be inscribed or encoded in the machine)" (Latour, 1992, p.256). A comparative case analysis will be done, in which two actor-networks will be studied – one with a focus on automation's impact

on higher skilled workers, and one with its impact on lower skilled workers. The two industries being looked at will be farming and finance; two vastly different skill sets that are potentially exposed to the same threats of automation.

Farming is a critical industry being impacted by automation – this is due to the fact that agricultural production will need to increase by at least 70% to serve nutritional trends by 2050 (Ku, 2022). However, it is also a labor-heavy and manual job – if completely replaced by machinery and robots, it would leave 2.6 million people without work (Kassel, 2022). In terms of higher skill work, the finance field is becoming an increasingly interesting point of interest for automation. Jobs such as trading can now be done by algorithms, and only monitored by humans, rather than executed. This sheds light on how automation complements some roles, while completely displacing others, and creates a notable dynamic in terms of worker inequality.

Utilizing actor network theory to perform the comparative case analysis will allow for an understanding of how automation is impacting different classes of people, and whether this impact is similar or not. In doing so, figuring out how to properly create government policies and advocate for these groups will become clearer.

Research Question and Methods

How does automation impact job displacement, and from that, how do individuals manage career shifts in response to automation? In order to gather the data effectively to address this question, my plan involves literary review of a combination of books, online articles, and journal publications. A book focused on mid and late career issues will mainly be used for background and understanding the topic of career shifts more broadly.

The journal publications and articles will be on the following topics: how different skills and tasks impact earnings and employment, robots and their impact on the job markets, retraining and funding of further education by companies, policy related to automation and workplace changes, as well as the AI Revolution. With these sources, I will do a literature review to compile all the information in regards to how automation is impacting the workforce, and what steps are being taken/should be taken to alleviate these impacts.

An example of a useful article is one focused on how truck drivers being displaced by automation find other jobs – this helps to shape the policy surrounding disruptions caused by automation (Van Fossen et. al, 2022). By understanding and closing these knowledge gaps, I can then determine what the proper approach is to utilizing policy to help individuals adapt to this new form of work environment.

The novel chosen is focused on career renewal and the challenges that come along with it on a personal and larger scale. The chapters I will be focusing on look into why people change careers, what is necessary when doing so, and how career theory has evolved. The evolution of career theory is reflective of changes in educational expectations and work-life balance (Wang, 2019), and this is a key concept to understand when determining how the problem of career-change difficulties can be solved.

The main challenges of the proposed question are the lack of data regarding specifics on the exact changes in job requirements – though these can be deduced from various job postings online, as well as articles on the topic. Furthermore, there are a number of complexities that go into such a question – are different groups impacted differently? If so, how can we ensure that each group is properly addressed to be successful in the revolutionizing workplace? Thus, it is

important to hone in on two different classes of jobs, and examine/compare the different manners in which automation is impacting them.

Conclusion

If carried out efficiently and effectively, by the end of the spring semester a completely autonomous version of the BlueROV 2 will be produced and presented to several different research teams for critique and further development. The AROV prototype will rely on acoustic sensors to permit tracking of progress. Via the surface vehicle that self-docks and properly harvests wave energy for both devices, it will receive power through a tether. The improved system will effectively represent a safer, more sustainable aquaculture farm, and future for fish farming.

In terms of the sociotechnical issue being addressed, proper research and analysis will allow for better understanding of the necessary policy changes to ensure that automation does not impair the workforce, and instead, complements it. Additionally, it will allow labor advocacy groups a better insight into what different classes of workers need in order to be successful in the new workplace involving automation.

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