AUTOMATION OF MICRO-MET SYSTEMS
TO EVALUATE CROP EVAPOTRANSPIRATION

My Dang
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EXECUTIVE SUMMARY

The purpose of this project is to contribute to the better management of irrigation and optimization of crop yield in agriculture by deploying cost-effective mobile micro-met stations. Although the need for this new irrigation management technology is increasing, it is yet to be implemented by your average agronomist. In order to address this issue, the primary goal of the project is to automate as much of the system as possible; specifically, the post-processing of data. This goal was achieved by improving the existing programming logic for current and future micro-met stations. Secondary goals included deploying, upgrading, and maintaining instrumentation for new and existing micro-met stations at research sites throughout the central valley. Other tasks included managing files and documentation of weather data and instruments and data collection, analysis and processing. Overall, the outcome of the project was a success and has further contributed to the improvement of this type of technology in agricultural and environmental applications.
PROJECT GOALS & TASKS

Entering this internship, my personal goals for this project were to further my knowledge and experience with respect to agriculture, the environment, and its resources, in order to gain further insight in my graduate studies in Industrial Technology, as well as to better prepare myself for a career path in the USDA or related industry. These aspirations remain unchanged and have led to the beginning of my career in environmental health, specifically, air quality. Although the internship did not lead me to a career path with USDA, it has furthered my involvement in today’s air quality issues and has helped me gain the necessary skill set to make contributions of my own to this industry. Nonetheless, this experience has widened my perspective and role with regard to agriculture and environmental health, and along the way, assisted me in completing my graduate degree in Industrial Technology.

Personal goals aside, the primary goal of the project was to automate the post-processing of data from all micro-met station systems managed by the Center for Irrigation Technology (CIT). Other project objectives that accompanied the primary goal were the management of older and existing systems and the deployment of new ones within the central valley; micro-met stations were maintained and deployed throughout a few locations: California State University Fresno (CSUF), University of California (UC) West Side Research and Extension Center (WSREC), and the Panoche Drainage District.

As originally outlined in the project application, the general tasks required in the internship included micro-met station deployment and maintenance, hardware troubleshooting and programming, and station data collection, processing, and analysis. However, additional responsibilities that were equally beneficial to the project included the management of weather data, documentation, and electronic file management of field computers, as well as the
procurement of system hardware and components; these additional tasks were not only necessary but improved the organization and effectiveness of the original tasks, making them easier.

PROJECT APPROACH

Coming into the internship, there was not a clear and planned approach on how I would go about achieving the goals and tasks of this project. I believed that most of what I already knew or was learning as an Industrial Technology student would prepare me for any obstacles that may lie ahead; or that I would be able to eventually overcome any challenges through hard work. Fortunate for me, I was half right; the other half consisted of a great working environment to learn from. This included mentorship from my project advisor, site supervisor, and collaboration with other interns and staff, which gave me enough direction and confidence to meet the objectives of this project.

In the beginning of the internship, my knowledge and experience of electrical engineering and electronics programming were limited to theories applied in class rather than through practical means; most of my hands-on experience with electrical and electronics systems were gained in a classroom environment; however, that changed as I was challenged by the practical applications of this project. For example, the primary goal of the project was to automate all micro-met stations for the post-processing of data; what this actually meant was writing new logic for micro-met stations to more accurately and reliably measure, calculate, and store data. This was essentially computer programming, in which my experience included working with Ladder Logic and HTML programming; however, CRBasic, the programming language I had to learn, was quite different and was little difficult to adjust to at first. With good direction from my supervisor, self-training and practice, I was able to troubleshoot and improve existing CRBasic programs and wrote the necessary code that automated more of the micro-met
systems and reduced the requirement of post-processing data. I also assisted other interns with developing their CRBasic programs. Ultimately, what made the project goals and tasks easier to complete was that I enjoyed the work and the people I was working with.

Aside from computer programming, the physical construction and deployment of the micro-met stations was another challenge of the project. Although I was able to recall some of my fundamental knowledge on electricity and control systems, it felt like I was learning everything over again; which was good, because this time around, I was able to apply it to a practical application, with a little bit more meaning and a lot more work. On top of that, deploying these systems gave me the opportunity to get out of the office and visit collaborated research sites within the central valley. Though I expected to be out of the office most of the time, towards the end of the internship, I was mostly inside the office; writing code, managing weather data and documentation or conducting data analysis. Overall, my approach did not change throughout the internship; I completed the goals and tasks of the project and overcame its obstacle using the knowledge and skills I already possessed but more importantly using the new skills acquired with the mental and healthy support of my supervisors, interns, and other staff at CIT.

PROJECT OUTCOMES

The primary goal to automate the post-processing of data for micro-met stations was achieved. As previously discussed, this required modifying the existing CRBasic program used for current micro-met stations to include the automation code. The original program took redundant measurements and calculations of numerous sensors and input components connected to the micro-met station and stored it in tables; however, when one of the sensors or input components loses calibration, becomes damaged, or fails—which can happen quite often due to
the harsh climate and unexpected nature these systems are setup in—the data becomes affected. This requires the manual adjustment of data and other post-processing after data collection. The automation code solves this problem by reducing the impact of component failure on data measurements as well as the post-processing workload after data collection. With the new code incorporated into future micro-met system deployments, incorrect component readings or total sensor failures will be eliminated from the internal calculations of the program, retaining data integrity and making post data collection work a much smoother process—especially for the average agronomist.
The construction, maintenance, and deployment of the micro-met station systems were equally important to this project. Over five micro-met stations throughout the central valley, specifically in CSUF, UC West Side, and Panoche Drainage District, were deployed and managed during the internship. Ultimately, these micro-met stations measured, calculated, and controlled the amount of irrigation necessary with minimal effect on optimal crop yield. Generally, each system consisted of a data logger and battery system enclosed in a protective case. The system is powered by a solar panel and is mounted on a foldable tri-pod. The input components differ slightly from each micro-met station configuration; however, can include sensory instrumentation such as thermocouples, soil temperature probes, heat flux plates, radiometer, anemometer, and other sensors.
Existing micro-met stations were also upgraded with better instrumentation for data measurement and irrigation control. These systems were visited frequently for maintenance in order to ensure proper system performance; maintenance included replacing sensor components, entire sensors, wiring, and cleaning the instrumentation as well. Without routine maintenance, crop yield and weather data can also be affected and requiring quality control and further post-processing.

Performing maintenance on a micro-met station in Panoche.

CONCLUSION

In retrospect, I feel that I have come a long way since the beginning of the internship. This opportunity, not only has increased my awareness and skill set in agriculture and the natural environment, but has also increased my involvement in making a difference; specifically in the air quality industry. Though I have accumulated an abundant amount of experience relative to
current environmental and agricultural issues, research, and technology, this internship has given me the opportunity to contribute equally as much to the central valley. From the results of the project, portable micro-met stations and similar systems are becoming more standardized in agronomics and will require much more improvement; improvement in form-factor, structure, and programming will make these systems more efficient and cost-effective. As agriculture and environmental research and technology advances, more and more micro-met stations or similar systems will be deployed for efficient use of irrigation and nutrients while optimizing crop yield.