Successful Internships in Antenna and Electromagnetic Design: From a Host Perspective

Jiang Zhu

There is no need to emphasize how important an internship is for the students who aim to pursue a career in the industry. For those of you who haven't made up your minds yet, the internship provides a unique opportunity to get a taste of a real working environment with an affordable time commitment and discover things you are passionate about as well as things you aren't necessarily interested in, such as technical versus nontechnical areas, research versus development, industry versus academia, and so on. These choices eventually help you make crucial decisions about your career path.

From an employer perspective, companies are more inclined to hire interns for a full-time position once they have invested resources in internship programs. After all, training a fresh graduate to become familiar with the tools and processes and to take on the complexities of antenna and electromagnetic design is a nontrivial effort—it takes months and even years. With an internship, you are given the opportunity to showcase your talents, enthusiasm, and value to a prospective employer, which goes beyond the grade point average, scholarships, and publications information from the resume. At the same time, it is also an opportunity for you to get to know the employer better. The selection is a two-way street!

Digital Object Identifier 10.1109/MAP.2021.3101436
Date of current version: 6 October 2021

EDITOR'S NOTE

CJ Reddy

In this issue of *IEEE Antennas and Propagation Magazine*, we have a very insightful contribution to the column from Dr. Jiang Zhu of Google LLC on internships at companies like Google in the field of antenna and electromagnetic design. After successfully mentoring five interns since 2017, Dr. Zhu provides a road map for managing and executing a successful internship that can be critical for deciding a career path for graduate students.

The IEEE Antennas and Propagation Society (AP-S) Young Professionals Committee is pleased to announce the presence of AP-S Young Professionals on the social media platform LinkedIn. Follow us at https://www.linkedin.com/company/ieee-aps-yp for the latest updates. Also check out the announcement for the Call for Nominations for the AP-S Young Professional Ambassador Program at https://www.ieeeaps.org/committees/ypa. Self-nominations are encouraged. The nomination deadline is 15 November 2021. We have exciting articles planned for this column in future issues. Anyone who would like to contribute to the "Young Professionals" column or has any suggestions on topics of interest, please contact me at cjreddy@ieee.org.

Since 2017, I have been fortunate to mentor five brilliant intern students as their intern host (for four of them) and cohost (for one student) at Google, in the areas of antenna and electromagnetic design. Upon the completion of the internship projects, two students were hired as full-time employees at the headquarters office; one student was offered a full-time position but decided to pursue an academic path, while the other two students returned to school to continue their Ph.D. degree studies. In this article, I would like to share my thoughts and experience about a successful internship in antenna and electromagnetic design from a host perspective with those who are undertaking an internship or seeking future internships. It is also my hope that this article can open up some discussions with my peers from both academia and industry on how to motivate young professionals to devote themselves to careers in the areas that are aligned with our IEEE Antennas and Propagation Society's (AP-S's) field of interest. Let's start with the roles and responsibilities of intern hosts.

THE ROLE OF INTERN HOSTS

The intern hosts are the main contact and are responsible for their individual interns throughout the course of the internship. The intern hosts begin their roles at the internship project design and

application. Once a project is approved with financial support from the company, the host starts the process of hiring the right intern for that project. The host regularly reviews the project progress, provides guidance, and writes the final feedback to be reviewed by the hiring committee. In some cases, an intern cohost (also known as a *supporting host*) is required to work with the host to perform these tasks. When the host is out of the office, the cohost serves as the main point of contact. The host usually selects the cohost for the project.

Even though I encourage all interns to seize every opportunity to have technical discussions with your host and learn their vision, please be mindful of the host's time. The hosts usually only commit a fraction of their time (for example, 20%) to intern projects, and they have their own full portfolio of projects to manage.

INTERN PROJECT DESIGN

The project design is crucial for the success of an internship. I've seen a number of successful internship projects developed at Google and Apple on a variety of topics in the areas of antennas, radio frequencies (RFs), and electromagnetics. The design of an internship project highly depends on the host's expertise and research interests as well as the company's needs and product road map strategies. Typical internship projects can involve the support of new products/product feature development or new technology research. They can be based completely on electromagnetic simulation or require a significant amount of hands-on work in the lab. They can be focused on the module-level design or at the wireless system level.

A well-designed internship project should consider the intern's personal growth. For example, the project should closely mirror the work of a full-time employee's equivalent role to allow the intern to experience a real working environment. It should also provide the intern the opportunity to demonstrate his/her creativity and offer students the flexibility to propose project changes along the way.

From my past experience as an intern host, I find it very helpful to set attainable goals and stretch goals when designing the projects. The attainable goal is an "incremental" goal that has been proven as achievable in the past within a certain time frame. It is the goal that most interns are expected to meet. The stretch goal, however, goes beyond that, and for those who want to stand out, it is highly rewarding. It requires not only hard work but also significant innovative thinking. Sometimes, even the hosts who set the stretch goals may not be sure if they are realistic for the interns to complete in the given time frame. So, don't feel under pressure if the stretch goals can't be completed on time. Table 1 lists the internship projects I hosted from 2017 to 2020 with the highlights of their attainable goals and stretch goals. Each intern project worked out very well, not only in terms of motivating the students to demonstrate their true competence, but also in training them to manage the deliverables when facing tight time constraints—which, in my opinion, is important in industry but often overlooked in the university training.

INTERN PUBLICATION

I have often been asked by internship candidates about publication as an outcome of the internship project. In fact, this is one of the most frequently asked

TABLE 1. LIST OF INTERNSHIP PROJECTS I HOSTED FROM 2017 TO 2020 AND THE HIGHLIGHTS OF THEIR ATTAINABLE AND STRETCH GOALS.

Year | Intern Project	Attainable Goals	Stretch Goals
2017 | Wearable Antennas for Cross-Body Communication and Human Activity Recognition [1]	To design low-profile, miniaturized wearable antennas for robust cross-body and cross-head wireless links	Human activity classification using machine learning
2018 | Size Reduction of Doppler Radar for Human Vital Sign Detection [2]	To design and demonstrate health sensing, i.e., heart rate and respiration rate monitoring, with a conventional Doppler radar approach	To miniaturize the radar antenna array with no tradeoff between range and accuracy performances To demonstrate on real users in real environments, compared to state-of-the-art radar antennas
2019 | RFID-Based Noncontact Human Activity Detection Exploiting Cross Polarization [3]	To demonstrate human activity detection in a noncontact RFID system with a conventional approach	To develop the method to improve range and accuracy Human activity classification using machine learning
2020 | Holography-Based Target Localization and Health Monitoring Technique using UHF Tags Array [4]	To measure respiration rate using the RFID hardware developed from the 2019 internship project	To achieve target localization and health monitoring To extend the application from a single user to multiple user scenarios

UHF: ultrahigh frequency

questions during intern interviews, especially by Ph.D. students. It is understandable. After all, a typical hardware internship takes about 3–6 months to complete, which is a significant commitment for the student. The answer to the question, however, must be taken case by case, and the general practice is as follows:

- *Check the company's publication policy*: Not all the materials from the internship can be published. Many companies have a well-defined publication review and approval process, and the policy varies. Please always refer to those guidelines first. Specific to hardware, if the internship project is closely tied to a product or product road map that hasn't been disclosed, there is a chance that the article will not pass through the internal review process.
- *File a patent application*: If a significant, forward-looking technology is developed through the internship and it has the potential to influence future products of the company road map or benefit the technical society, it is recommended to file a patent application before publication. If the proposed invention is approved for filing as a patent application by the company, a patent attorney from the company is usually assigned to assist you in a typical patent-filing process. In return, a successful filing of a patent application often helps the justification of publication in its review process, particularly in addressing concerns about the protection of the company's intellectual properties.
- *Align with the intern hosts early to get their expectations on publication*: If publication is important to you, this conversation can even happen early in the interview stage. For senior students, you might consider aligning your expertise, i.e., your master's or Ph.D. thesis topic, with the internship project and influence the project with your ideas. It doesn't matter if these ideas are turned down by the hosts; they have to make a comprehensive assessment based on technical factors and beyond, such as time, cost, and business justification, among others.

REMOTE INTERNSHIPS

Because of the travel uncertainties and working-from-home mandates related to COVID-19, and to protect the safety of employees and interns, unfortunately, some companies canceled their internship programs for the time being starting in 2020, while other companies, including Google, offered virtual/remote internships in most regions. This global pandemic has, without a doubt, left its mark on society. As we have already witnessed over the course of the last year, we will need to continue to be ready for and adapt to the disruption [5]. At the time of writing of this article (June 2021), many workplaces in the United States are starting to reopen. While the hybrid working model, combining office and remote work, seems to have become the new norm in Silicon Valley companies, we cannot predict a trend of an internship working model that is most suitable for companies and students in the future—it takes time to iterate and evolve.

Certainly, hosting the first-ever virtual internship in 2020 was a unique and challenging experience. In our case, both host and cohost are located in the San Francisco Bay area, while the intern student is in Atlanta, Georgia. Our day-to-day interaction is through the Google video conferencing system. This is not what we expected as we planned the project one year earlier, and it is certainly not the expectation of the students when they accepted internship offers. We understand their frustration. On one hand, Google as a company has taken many measures to address the challenges of remote internship. On the other hand, we, as the intern host, adjusted the scope of the project to focus on the development of RF-based localization and remote health monitoring of the user's respiration with an application to COVID-19 patients. The motivation is to give the students an opportunity to solve real-world challenges with their knowledge and expertise. To reduce the risk of exposure to the virus, we redesigned the project so that the lab work can be avoided, while the tools and components can be leveraged either from off-the-shelf parts or from previous internship projects I hosted, so the measurements can be made in controlled environments, i.e., at home and in meeting rooms.

Shifting to a virtual format this past summer was a big challenge, but it also presented us with opportunities to be more innovative in solving technical problems that we had never before encountered. For example, because of the restrictions of COVID-19, it was difficult to secure additional users to assist with the measurements in a multiuser scenario. The intern student came up with a synthetic target design made of antennas and electronics to mimic a real user [4]. The introduction of synthetic targets allows us to test and tune the operation of the system in the presence of multiple targets (for instance, one real user and multiple synthetic targets) at different locations and with different spacings without worrying about the social-distancing restrictions on real users.

At the end of the project, we completed the internship with wonderful results: the project led to one patent application, one article published in *IEEE Internet of Things Journal*, and one conference paper submitted to the 2021 IEEE AP-S Symposium. At the company (Google LLC) level, the survey found that 97% of 2020's interns were satisfied with their experiences. This was the same result as obtained in the previous year, when we were all in the office.

INTERN CONVERSION

Many companies offering internship programs provide opportunities for their successful interns to work as full-time employees after graduation. The statistics shows that the intern conversion rate in the United States is very encouraging as compared to the external hiring process. The employer is also motivated by the fact that, according to retention metrics, retention of employees hired from an internal internship program exceeded that of interns hired from external programs and nonintern hires at the one-year and five-year marks.

Regarding the typical conversion process, the intern hosts and cohosts are expected to provide a thorough review of the intern's performances toward the

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EDITOR'S NOTE

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Digital Object Identifier 10.1109/MAP.2021.3103055
Date of current version: 6 October 2021

YOUNG PROFESSIONALS *(continued from page 147)*

end of the internship, which includes the assessment of the intern's general and specialized technical capabilities, communication skills, culture-fitting abilities, and so on. Additional technical interviews might be required and conducted by independent interviewers who do not directly interact with the students throughout the course of the internship. The intern students often find it helpful to conduct mock interviews with their hosts and cohosts before they have the formal interviews with the independent interviewers. The availability of headcount is another factor to be weighed in the hiring process. It is possible that an offer will come from a different hiring manager with a headcount vacancy, rather than the original intern host.

After all of the interview and intern host's review feedback information is collected along with the internship project presentation/report and any publications or patents, the intern conversion package will then be presented to the hiring committee, who makes the final hiring decision. It is worth noting that employers seem more tolerant with the starting date for an intern conversion offer than for offers from external hiring programs, realizing that the interns need to return to school to complete their studies first.

CONCLUSIONS

The wave of 5G and beyond and the shift of the Internet of Things industry toward ambient computing have presented enormous opportunities for young professionals to solve some of the key challenges with their knowledge and experience in antenna and electromagnetic design. If you haven't figured out your interests yet, a successful internship can be your first solid step to help you find a career path about which you would probably be passionate for the life of your entire career.

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