M B A R I MONTEREY BAY AQUARIUM RESEARCH INSTITUTE

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Laughlin Barker worked for me as part of the MBARI summer internship program for 10 weeks during the summer of 2014. In short I would rank Laughlin in the very top tier of his colleagues in his ability to contribute new engineering technology to cutting edge scientific research efforts. He is exceptionally well suited to pursue a challenging graduate degree which will further enhance his ability to contribute to the kind of societally relevant research projects identified by NSF.

During Laughlin's 10 week internship he demonstrated the full range of capabilities I consider important in a candidate for graduate school. More importantly for my particular needs, important in an engineer who can contribute in a significant way to the kind or research projects we do at MBARI which I believe align reasonably closely with NSF's priorities. Laughlin's internship involved dropping into an existing research project developing an oceanographic profiling float being designed to address oceanographic research questions in the coastal zone. Laughlin's specific tasks were to 1) upgrade an early prototype to the current design and 2) extend the current closed loop velocity controller to provide accurate depth control.

The first task required the usual Mechanical Engineering (ME) skills I would expect of any competent recent ME graduate. Laughlin clearly demonstrated these fundamental skills. Laughlin also demonstrated several less usual and highly desirable traits in this phase of the work. First, he was able to perform the ME (his undergraduate degree) tasks as well as the Electrical Engineering and Software Engineering tasks required to upgrade the prototype without any regard for disciplinary boundaries. It has been my observation that in the kind of work we do the engineers best able to make a significant contribution must of course be able to contribute in their specific area of expertise but also need a thorough understanding of, the basic skills and an interest in the other disciplines required to build a robust system. It would have been impossible to tell from his work whether Laughlin's undergraduate degree was in ME, EE or SE. Second, as we all know things don't always go according to plan and not surprisingly several tasks cropped up in the process of upgrading the first prototype that were much more difficult than I'd expected. None of these unforeseen hurdles phased Laughlin in the least. He just kept working on the issue until it was solved, was smart enough to seek help when needed and made reasonable decisions about how to solve issues based on the all too short 10 week period of his internship; all with little supervision on my part.

The second task, extending the closed loop controller, may be more indicative of the kind of work Laughlin will be doing in graduate school. Again, Laughlin demonstrated the highest level of performance in the areas I consider critically important. First he was able to come up to speed very quickly on the literature I provided as background. Second he was able to build on our existing knowledge base with a literature search of his own that resulted in useful articles I

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hadn't found. Most importantly, Laughlin was able to use and extend his undergraduate controls background to improve our understanding of the fundamentals of how our float will actually perform in the ocean. This last point is worth expanding on. Laughlin has the critically important ability that bodes well for his future success in engineering of being able to take his thorough understanding of fundamental engineering mathematics along with a working knowledge of the tools or our trade e.g., Matlab and Simulink, to develop a fundamental, physics based understanding of how our system will actually perform in the real world. Laughlin had the usual single undergraduate course in controls that most ME programs require. With this limited background, it requires an exceptionally capable new engineer to produce anything useful in the few short weeks of a summer internship. Laughlin was able to 1) understand and extend our existing Simulink model to analyze several depth control approaches 2) describe to me the benefits and risks of each approach in a way that allowed us to engineer a decision about which approach to pursue 3) implement the approach on the prototype he built up 4) test and 5) document the results all in a way that was immediately useful to our project moving forward. This was a remarkable achievement in a 10 week internship.

The final point to be made about Laughlin's qualifications for this particular NSF grant is his enthusiastic and abiding interest in science as well as technology. Expanding on a point I made earlier, it has been my observation that the engineers who contribute most significantly to the kind of research we do here at MBARI, which is very similar to the research priorities at NSF, have a real interest in the science that the technology they are developing will support. It is clear from my discussions with Laughlin that he has the rare attitude and interests that will allow him to integrate the engineering skills he currently has and will further develop in his graduate training in a way the best supports the goals of any scientific research project he is involved in.

Sincerely

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