

SHF: Medium: A Pathway for Combining Formal, Static, and Dynamic Analysis of Real-World Embedded Systems: Collaboration Plan

The PIs are all faculty in the School of Informatics, Computing and Cyber Systems at Northern Arizona University. They all work in the same building, which also hosts the SEGA lab (as opposed to the field installations which are located in various places, some near Northern Arizona University, others more remotely). PIs will meet weekly for technical discussion and project status updates, depending on project status (and already do so, in discussions of the preliminary work) to coordinate their efforts, and ensure that tasks in the work plan are proceeding correctly, and to receive feedback on current status of tools. These meetings will alternate between meetings with just PIs, focused on higher level decision-making, and meetings including all involved students, focusing on status of individual work packages. In addition to weekly project meetings, there will be special out-of-band meetings to demonstrate significant new functionalities in tools, or to focus particularly on application of functionalities to specific SEGA components.

The SEGA implementation code and fault(s) form a core concern that helps focus PI interactions, and enables easier communication of technical results between static and dynamic analysis experts and experts in the embedded systems domain. PIs will also set up a project repository, separate from DeepState, Frama-C, or SEGA code repositories (already in existence) and use PR, tagged Issues, and other GitHub-supported collaborative software development best practices to ensure documentation of development, and team awareness of code status for components. Travis CI testing will be used to ensure all project members are aware of build or correctness problems with project code. Graduate students, undergraduate students, and PIs will also share a Project Slack Instance, linked to the code repo, to make discussion of issues arising during the project even easier, outside of scheduled meeting times.

To summarize, collaboration will be coordinated through multiple overlapping methods, to ensure success:

- Weekly project meetings (alternating between PIs and PIs + students)
- Meetings of PIs with involved students
- Demonstration and SEGA-focused meetings
- GitHub repositories for SEGA, DeepState, and Frama-C extensions
- Project GitHub repository
- GitHub PRs and Issues to coordinate development
- Travis CI for code status awareness
- Project Slack linked to GitHub repo and CI, for effective communication

Broadening Participation in Computing – Planned Activities

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The goal of the BPC component of this project is to *increase the number of females who are involved or choose careers in computing, at NAU and in the local community of Flagstaff, Arizona*. Our plan carefully integrates active learning experiences designed for female students at both the undergraduate and middle school/junior high levels.

Undergraduate Education Experience. We have an opportunity to reach female students in three degree programs: Computer Science, Computer Engineering, and Electrical Engineering. In CS, we will target the sophomore-level CS 200 - Introduction to Computer Organization; in EE and CE, we will target EE 410 – Embedded Control, a senior-level elective. While EE 410 has traditionally had a design project, we will integrate a new project in which teams of female (and possibly male, due to the current lack of females in EE, CE, and CS) students imagine and create exciting and meaningful one-day active learning experiences and projects for female student teams in grades 7-9. CS 200 will be reformed to include these projects as well. Students in EE 410 will have had EE 215 – Microprocessors, so will be able to contemplate projects of more complexity. The projects in CS 200 will likely be less complex than those in EE 410. This is an advantage: we will guide the students in the two courses to develop a two-tiered set of active learning experiences that can be designed into two events—and students in grades 7-9 can participate in both in sequence, increasing impact. In both courses, we will bring in expert female speakers to facilitate development of students' understanding how to design these projects so they are marker events in the grade 7-9 students' lives. We will also explicitly address increasing the awareness of the challenges faced by females of all ages in STEM careers, as the undergraduates advance in their programs of study (in CS 100) and begin the transition to professional careers and graduate school (in EE 410).

Outreach to grades 7-9. As noted above, the undergraduate teams will develop active learning and design project “Build Events” for girls in grades 7-9. We will recruit female undergraduates who have taken CS 200 and EE 410 to become mentors in the one-day events for the grade 7-9 students. We will schedule these events as part of the annual Flagstaff Festival of Science, and plan them for Saturdays to avoid conflicts with school schedules, maximizing participation. The Flagstaff Festival of Science (www.scifest.org), now in its 29th year and enjoying wide financial and participatory support in the community, holds over 100 events for all ages over a 10-day period in the Fall, and is an ideal venue in which to participate.

Facilities and Support. By scheduling the grade 7-9 Build Events on Saturdays, we will be able to use the educational laboratories of the School of Informatics, Computing & Cyber Systems (SICCS) for the Flagstaff Festival of Science events. We have requested \$2,000 for each in years 2 and 3 for materials (primarily embedded development boards) to hold the grade 7-9 events. As mentioned earlier, we plan to design two Build Events: the first will probably use Arduino or similar boards and the Arduino IDE,

while the second will use either plug-in shields on these boards, or more powerful boards that include audio/camera peripherals.

Feasibility and Team Expertise. Co-PI Flikkema has considerable experience in developing innovative learning experiences for undergraduates and engineering pedagogy (see Bibliography). He will lead the effort in developing the two integrated BCP programs described above, and seek consultation from NAU's Center for Science Teaching and Learning on helping undergraduates learn how to develop meaningful learning experiences for early-teen females.

Schedule. If this proposal receives a positive merit review, before award we will (1) work with NSF feedback and the CISE program team to develop an informative and efficient assessment plan, and (2) gain a concrete commitment from the Flagstaff Festival of Science to schedule the Build Events for Fall 2020 and 2021. Co-PI Flikkema has participated in these festivals as a speaker and panelist, and knows and will be able to approach Board Members to initiate development of this BCP plan. In Year 1 of the project, the undergraduate students will create projects for the grade 7-9 Build Events in Year 2, and similarly undergraduates in Year 2 will design Build Events for Year 3.

Sustainability. We have specifically designed this effort to continue and possibly grow (e.g., with multiple sessions of the two events) after the three years of NSF project funding. W.L. Gore & Associates is the flagship sponsor of the Flagstaff Festival of Science, and also donated \$10,000 to SICCS this year in support of equipment and supplies for our EE educational laboratories. We plan to approach Gore to provide specific support for the grade 7-9 Build Events on an on-going basis, and support this by continuing to refine the project experiences in CS 200 and EE 410.

Bibliography

P.G. Flikkema, A. Ohta, S. Thomas, J. Frolik, R. Franklin, C. Haden, W. Shiroma, and T. Weller, "ENFUSE: Engaging Fundamentals and Systems Engineering in Introductory Circuits", 2015 ASEE Annual Conference, June 2015.

A. Ohta, S. Thomas, P.G. Flikkema, J. Frolik, R. Franklin, C. Haden, W. Shiroma, and T. Weller, "A Systems-Centric, Foundational Experience in Circuits", 2014 ASEE Annual Conference, June 2014.

P.G. Flikkema, J. Frolik, R. Franklin, C. Haden, W. Shiroma, and T. Weller, "Leveraging Multi-University Collaboration to Develop Portable and Adaptable Online Course Content", *Advances in Engineering Education*, Vol. 3, Issue 4, Winter 2013.

P.G. Flikkema, "Approaching the Design of Complex Engineered Systems: A Model-based Approach Informed by Systems Thinking", PSW American Society for Engineering Education Conference, April 2012.

J. Frolik, T. Weller, P. Flikkema and W. Shiroma, "The Portability of Systems-Centric Content to Existing Sub-Discipline Courses", 2011 ASEE Annual Conference, June 2011.

P.G. Flikkema, J. Frolik, C. Haden, and T. Weller, "Experiential Learning of Complex Engineered Systems in the Context of Wireless Sensor Networks", 2010 ASEE Annual Conference, Louisville, KY, June 2010.

J. Frolik, T. Weller, P.G. Flikkema and C. Haden, "Implementing an Inverted Classroom Using Tablet PCs for Content Development", in *The Impact of Tablet PCs and Pen-Based Technology on Education; Going Mainstream*, Robert H. Reed and Dave A. Berque, eds., Purdue University Press, 2010.

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