StitchFest: Diversifying a College Hackathon to Broaden Participation and Perceptions in Computing

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ABSTRACT
While coding competitions and hackathons have steadily increased in number, few women participate. Because these public events present viable opportunities to broaden participation in computing, we designed the theme to focus on "Wear & Care" and collaborative arrangements in a hardware hackathon, called StitchFest, in which 33 undergraduate and graduate students used the LilyPad Arduino to design wearables. Our analysis focused on the interviews conducted with eight female and seven male college participants to understand how targeted recruitment, thematic framing, space arrangements, kinds of materials and material distribution impacted participation and perception. We discuss what we learned about setting a thematic focus and fostering collaborative learning in coding competitions for broadening participation in computing.

Categories and Subject Descriptors
K.3 [COMPUTERS AND EDUCATION]: Computer and Information Science Education – *computer science education, literacy.*

General Terms
Human Factors.

Keywords
Coding competitions; hackathons; wearable computing; broadening participation; gender

1. INTRODUCTION
One of the most pressing issues in computer science education has been to broaden participation of women and minorities. Many efforts on the college level have focused on purposeful recruitment by reaching out to students, providing stronger mentoring opportunities and redesigning curriculum to speak to socially diverse interests opening the potential for personal application [e.g., 2, 10, 15, 21, 25]. Many of these efforts have resulted not only in bringing in more diverse students but also broadening perceptions around computing participation and potential. There is a growing recognition that not one intervention alone but a network of activities is needed for broader success that reaches far beyond the computer science classrooms.

One activity that has received little attention so far is the increasing popularity of coding competitions or hackathons. Described as "marathon coding competitions" [17], hackathons present both social and professional opportunities to young developers, who are tasked with making a functional prototype to pitch to investors for a prize, working on it for 24 or 48 hours. Hosted within corporate, academic, or community-based settings, by 2011 over 200 hackathons were estimated in the United States alone [17]. Many of these hackathons are organized spontaneously, attracting a hundred or so volunteer participants whereas others, such as the student-organized hackathon, PennApps, which is now in its tenth iteration, attract thousands of college students from all over the world. Leckart [17] argued that "hackathons, with their come-one-come-all ethos, have emerged as the new forum for networking, learning, and beta-testing new apps and ventures." While these hackathons are theoretically open to all, they have been found lacking in diversity unless they are designed as women-only events such as The International Women's Hackathon.

In this paper, we describe the design and implementation of a hardware hackathon, called StitchFest, with the explicit goal to broaden participation by recruiting within affinity networks, promoting new designs with computation, developing new models for collaborative hacking, and impacting perceptions of computing participation. StitchFest took place in February 2014 as part of PennApps, a larger collegiate hackathon. All participants were provided with electronic textiles and computational construction kits to design an application around a theme of "Wear & Care," and 33 participants submitted projects for judging. Analyzing interviews from 15 consenting female and male participants, we addressed the following questions: (1) What motivated participants to join StitchFest? (2) In which ways did coding wearables interest participants? (3) How did the coding space impact involvement and collaboration? and (4) How did perceptions towards computation and hack spaces shift after participating in StitchFest? In the discussion, we address what we learned about the designs of hackathons for broadening participation, projects, and perceptions.

2. BACKGROUND
College CS programs have largely been critiqued for alienating women from participating in computing [18]. Since the early 1980s, there has been a steady decline in the amount of computer science degrees awarded to women [20, 27], and female representation in computer-related careers has significantly declined since the 1990s, according to a census-related report [16]. Research has found that women and girls are less likely than men and boys to be STEM majors at onset or persist in these

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majors throughout their college experience, which is highly influenced by learning environment factors [10]. While most of the efforts have focused on formal CS classes, informal learning opportunities such as small and large-scale coding competitions play a significant role in broadening participation in computing. These coding competitions with names like *Coding Wars*, *CodeChef* and *TopCoder,* to name but a few, have increasingly become popular events to highlight international leaderboards and coding accomplishments. Despite their open nature, female participation in major coding competitions has historically been lacking [e.g., 5, 6, 8, 23], though exact numbers are difficult to come by. It is clear that coding competitions have become popular events and their lack of inclusion limits access to learning and career opportunities, as the technology industry increasingly uses these kinds of competitions to source new recruits and innovative concepts.

The sudden relevance of coding competitions for recruitment and skill building has led the National Center for Women and Information Technology (NCWIT) [19] to release a set of recommendations to address the lack of participation of women and minorities. Among their major recommendations are (1) including promotional materials that feature females and a range of students, (2) actively recruit females, (3) provide ongoing encouragement, (4) allow participants to create projects that appeal to them, (5) encourage mixed teams with experienced and inexperienced members, (6) host a tutorial or how-to event, (7) focus on learning and different ways to win, (8) include female mentors, educators and judges, (9) make sure the space is accessible to all, and (10) educate others involved. These different dimensions highlight the complexities involved in designing coding competitions that are inviting and open to participants of diverse backgrounds.

With StitchFest, we designed a hackathon responsive to these needs. We situated it within PennApps, one of the largest and premier college hackathons in the nation. PennApps, which occurs twice a year, has been successful in bringing together thousands of accomplished college hackers from all over the world. In Spring 2014, over 1,200 undergraduates alone participated in the ninth PennApps. But women only made up only 14.8% of the participants, very much in contrast to the first event in 2009, which attracted 35% women participants. Incidentally, the first PennApps was organized and co-sponsored by Penn's Women in Computer Science (WICS) organization. Since then, the percentage of female participants has been hovering around 15% (based on available attendance records from the last five years). Perhaps not surprisingly, the number of winners is even lower: only 9 of the 93 historical PennApps winners were women.

For the design of StitchFest, we drew on research that suggests materials, themes, and spaces of computing cultures strongly influence participation and retention, as well as changes in perceptions [10]. As a first step, we selected the LilyPad Arduino, a microcontroller that facilitates the integration of engineering and computing with crafting and sewing [3] as our coding platform. This electronic textile construction kit includes a range of electrical components such as microcontrollers, sensors, and actuators that can be stitched together with conductive thread to make circuits that can be attached onto fabric and wearable media. By leveraging material affordances and aesthetics, Buechley and colleagues saw the LilyPad as integrating art and engineering in ways that could productively increase diversity in both the composition of the CS and engineering field and the designs and projects produced. The LilyPad is one effort in increasing female and underrepresented participation in STEM, beyond curriculum changes and mentors:

> …Our work suggests an approach to complement these efforts. In addition to asking 'how can we get girls and women to participate in traditional computer science and support them once they are there?', we should ask: 'how can we integrate computer science with activities and communities that girls and women are already engaged in?' [3]

Second, we developed a design challenge called "Wear & Care" to provide the makers with a common topic that can be addressed differently based on individual interests. The idea here was to frame the open ended experimentations with a function, so that the design would aim to create meaningful experiences in people's lives. What the makers care about obviously varied from entertainment to healthcare and social activism, and the theme also allowed us to observe which topics are more popular among different students that differ in gender, educational background, and so on.

Finally, we paid careful attention to the meeting space (including arrangement of materials), encouraged participants to interact across teams, and tried to engage diverse interests and creativity; research has shown these are instrumental, along with mentors, in getting disadvantaged female youth to design complex electronic textiles [15]. We also focused recruitment through affinity spaces and targeted female undergraduate organizations, which studies show is one key for successfully inclusive programs [25].

The focus of our investigations was to broaden not only participation in computing by reaching larger numbers of female participants but also perceptions of computing through the event composition and theme. Previous research has shown that many college students perceive of computing as too difficult, uninspired, and reserved for smart students [4, 26]. Perceptions are also often gendered, as females are more likely to feel that careers in computing don't apply to their interests and skills [4]. Thus changing perceptions of computing is "a core concern in broadening CS participation… [and] focuses on learners' perceptions of computing, where they see applications for computing, and how they see themselves within the field and future careers" [12].

3. SETTING AND DATA COLLECTION

StitchFest took place in February 2014 as part of PennApps Spring 2014, a larger hackathon,with over 1,200 attendees. We used a design-based approach [24] to investigate the following design features and their relationship to broaden participation, projects and perceptions of computing: (1) intentional recruitment of participants within affinity networks, (2) focus on a theme of "Wear & Care" eliciting a reference to wearables, (3) provision of free hack boxes of computational materials with the same primary components but different sensors and actuators to encourage exchange and interaction amongst teams, and (4) creation of a communal space that situated participants together to encourage collaboration rather than designing in isolation.

3.1 Participants

While 44 students picked up hack boxes, only a total of 33 students (22 men and 11 women) made up 11 final competing

teams with two to four members each. Participants ranged in age from 19-26, with 29 undergraduates and four graduate students from universities in the United States and Canada, and with majors from engineering, computer science, art, and industrial design. For all further analysis, we refer to 15 participants (8 men, 7 women) from ten of the eleven final teams who provided consent for research. Three judges, all women, were recruited for the event. One was an experienced industrial designer specialized in fashion and technology, another was an artist with years of experimental fabric and wearable design expertise, and one (Richard) was an educator with a background in physical computing and tangible design with Arduino.

3.2 Design and Materials

The design of the *StitchFest* theme "Wear & Care" was inspired by quilting circles and promoted collaboration between participants by sharing resources. Teams worked with the *LilyPad Arduino*, and a set of components including a wireless module, MP3 player, various sensors and actuators ready to interface with the kit (see Figure 1). Other materials, such as conductive thread and fabric, along with sewing machines, were provided free at workstations (Figure 2).

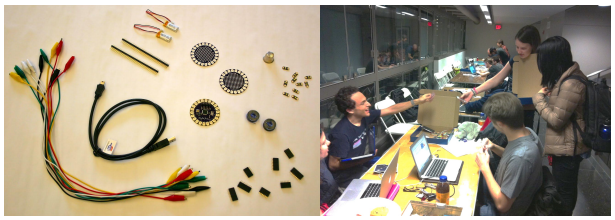

Figure 1: Electronic components (left); Team sharing (right)

Figure 2: Material station (left); Mentor assisting a participant at a material station (right).

3.3 Data Collection and Analysis

Our main data sources were photo documentation of projects designed for the StitchFest judging and debriefing interviews with 15 participants (8 men, 7 women) from ten of the eleven final teams. Interviews were conducted over the phone a few weeks after the event. Questions targeted four principal areas: (1) background and interests, (2) hardware, software, and hackathon experience, (3) StitchFest knowledge, and (4) StitchFest experience. Some questions asked included: Why did you choose to participate in Stitchfest? Did you have previous experience with Arduino / Lilypad Arduino / coding / design? How did you decide on your design? Did you interact with other teams? These interviews were recorded and then transcribed. Two members of the research team coded the interviews using grounded theory [8], with open coding, axial coding and selective coding [23], to identify the themes that are presented in Findings sections in more detail.

4. FINDINGS

StitchFest proved to be a successful event and a productive hackathon experience for our participants. The most visible outcome was that the percentage of female participants in StitchFest was more than double than that in the larger hackathon: while PennApps had 14.8% women among its 1,200 participants, StitchFest counted 33% women among its 33 participants. What did we find out about participants' prior experiences and choices, their final projects, and changes in perceptions?

4.1 Background and Motivations for Joining

In general, female participants were significantly less likely to have hackathon experience than the males we interviewed. Only two women cited being involved in hackathons before, with one having participated PennApps, a software hackathon, and the other stating she had helped organize "small hackathons," which she liked because they were "more hands on." The five females with no previous hackathon experience expressed enjoyment. As one stated, "This is actually my first hackathon ever, and I loved it." In contrast, all of the male participants indicated they had had some form of hackathon experience, whether it be a software-based hackathon or a 48-hour design challenge around "events and spaces rather than programming or hacking." Participants with prior hackathon experience who joined StitchFest expressed: the desire to get "an edge on the competition… [with] a hardware hack"; having a team made up of "programmers and designers"; being able to leverage a hackathon's potential "to learn about [something] in a very accelerated way with a bunch of your friends.."; "...being able to use hardware, which usually has a very steep learning curve…[and is] reserved for electrical engineers"; and being "forced...to be a bit more creative when working with wearables."

Almost all StitchFest participants described having some level of coding experience (2 women expressed limited experience), and most (5 women, 6 men) also had hardware experience (though 2 women and 3 men described their experience as limited). Only one female stated having neither, though described having a design background. She explained that she "thought [StitchFest] was interesting because it could be somewhere a person can be creative, especially since [she] came from a design background." Overall, 6 men and 6 women indicated they had some design experience, though 2 of those men and 2 of those women described their prior experience as limited.

4.2 Diversity in Projects

The final Stitchfest designs included wearable music players, sensory reactive clothing for babies servicing as a parenting aid, responsive purses, wearable games, Twitter pins with changing social justice messages, and a participatory messenger/delivery service to address the needs of students and community-based package delivery (see Figure 3).

The interviews revealed that two particular design dimensions of StitchFest appealed to participants: (1) the design of wearables

and (2) thematic focus on "Wear & Care." Wearables emerged as a salient motivation for many participants, but in different ways. Interest in "designing wearables" was cited exclusively by female participants whereas male participants saw them more as a source of novelty. Many female participants remarked on a variety of reasons for StitchFest's appeal, including "creativity," "combining technology, engineering and design," and "more flexibility and opportunities [than] just doing a pure software hack." Participants with prior hackathon experience (8 men, 2 women) expressed: the desire to get "an edge on the competition… [with] a hardware hack"; having a team made up of "programmers and designers"; being able to leverage a hackathon's potential "to learn about [something] in a very accelerated way with a bunch of your friends.."; "...being able to use hardware, which usually has a very steep learning curve…[and is] reserved for electrical engineers"; and being "forced...to be a bit more creative when working with wearables."

Figure 3: Examples of Final StitchFest designs.

Beyond novelty, social responsibility was a driving force for many designs, as well as a perceived need to the bridge between one's virtual context on social media and face-to-face interaction. One creator explained that her design of the Twitter pin served to "bring your online persona into real life so that you can make connections with people who you otherwise...maybe see on everyday basis but wouldn't know you have these things in common [with] or just a way to create conversation...on the street...and not just online." The creator of a responsive system for baby monitoring explained, "The idea was to create a set of electronics using the LilyPad or Arduino as the mother or the central hub. And then, to connect that to a ... thermal sensor and then have that all be sewable into clothing so that if, presumably your child was experiencing deviations in body temperature, then the LilyPad would be able to … send an SMS and an email to you."

4.3 Space for Collaboration within Competition

Participants also reflected on the design of StitchFest event, in particular the setup of the communal space, the sharing of hardware components and collaboration. Those with prior PennApps experience (3 males, 1 female) noted how the communal space at StitchFest created a greater sense of camaraderie and collaboration than usually found at PennApps. A hackathon-experienced male participant, comparing the two, commented on the diversity of the participants and the differences in the experiences:

> I think it kind of goes back to the camaraderie that you saw with a lot of the different groups because it was not so much a competitive thing even though there were prizes to be won… It was really more about seeing everybody succeed at making... and really having a sense of pride and ownership… I enjoyed interacting with other people a lot. It's a different background than you usually get at PennApps. It's a different type of people it attracts, which is cool.

Another male participant noted how the space and novel materials promoted team collaboration: "We got to see everybody else's projects, and see as they were progressing, especially since a lot of us were having some of the same issues at the same time…[and] figuring out how all the hardware worked… having to do a lot of the same fixes." Working with hardware materials and textiles also prompted a greater sense of division of labor within the team. An experienced female participant explained, "Everyone on my team... were pure computer science… and it was just very appealing to... have access to technology that we wouldn't otherwise have." She went on to discuss how StitchFest differed from software hacks she participated in:

> So previous events, we would just focus on software. It was a lot of fun. But there was really no reason to have... our whole group at the hackathon or to be coding... 24 hours... But doing a hardware hack, It ... made a lot more sense for us all to be there… And... we were able to greatly expand what we could build and what we could work on, to make something a lot cooler.

4.4 Diversifying Perceptions

Most novice and experienced computing and hackathon participants (5 women, 6 men) reflected on how StitchFest broadened their perceptions, with the exception of two individuals who already had experience with "wearables" (1 woman, 1 man), one woman with some hardware design experience, and one male participant who described only having a software background and found that working with hardware was not "beginner friendly." Overall, a common theme most participants shared was how using hardware and electronic textiles provided new ways to think about coding and computation. Crafting and making became skill sets that were necessary and instrumental to the process.

Novices, in particular, reflected on the uniqueness of StitchFest as an entry point and as a way to think about technology and computer science differently. A female participant with the least amount tech experience, reflected on how StitchFest was a good entry point to both the hackathon space and informal computer science learning:

> For me because it was… my first big hackathon experience… I felt like it was a nice entry point. I don't know if I would have participated in PennApps

> if it would have been much different, but StitchFest felt more... like a smaller community-based thing within this huge science event.

Another female participant, who had no prior hackathon experience, but some experience with crafting and technology, provided insights on why she decided to participate in StitchFest:

> … Because it was something new that I haven't seen before, like competitions doing electronic textile type of stuff in person. I've seen online things, but nothing like that… I know how to do all the crafting part, but I'm not really strong on the coding part.

Despite her lack of coding experience, the appeal of combining her interests in crafting and coding influenced her perceptions of how the experience might be accessible to her skillset:

> … the last half hour when we actually did the crafting part…because that's really my strong suit… connecting the components… I enjoyed that. I enjoyed talking with [another participant] …and asking him for help and stuff… I enjoyed… networking with other people, meeting people.

While she did discuss having difficulty with coding and working with some of the more difficult components, she felt her skills were valuable to building the final project, and was able to seek and obtain help from fellow participants, with whom she was able to have positive networking experiences.

For most participants with coding or hackathon experience, working with electronic textiles provided new perspectives on computing. An experienced male participant expressed newfound affordances and application working with the LilyPad and textiles:

> I think that…working with some novel technology… was really interesting… It's fun in a way to struggle adapting to the new stuff and getting your hands dirty with the LilyPad and how it works and getting the connections right and actually sewing together the conductive thread to make something happen. It's really interesting especially for a computer programmer… or even people who've only worked with pins and wire hardware. There's really a lot you can do that previously a lot of the computer science people, speaking for myself, didn't think that that would have that much application, the application space would be that wide.

5. DISCUSSION

Results from Spring 2014 event observations, wearable designs and participant reflections indicate that *StitchFest* was successful in diversifying participation and perceptions. Participants stated they would recommend StitchFest to a range of different kinds of students, from art and design majors, to computer science and engineering majors, commenting on how StitchFest and its activities were applicable to a range of skill sets and interests. In reviewing the StitchFest theme, space and activities we found that the recommendations issued by NCWIT [19] captured the different dimensions of how hackathons can be redesigned to diversify participation and perceptions. However, we learned the the hard way when setting up StitchFest Fall 2014 that a list of recommendations alone is no guarantee for success. While the second iteration of StitchFest benefitted from our experiences in setting up the Spring 2014, having available examples of winning designs, we found that this was not sufficient to bring in larger number of female participants as we did in the Fall. We further discuss design dimensions of StitchFest that led participants to this productive experience, which include the hackathon theme and designing for collaboration within competitions.

In an effort to attract participants to StitchFest, we decided to provide a new, but related thematic focus. In Spring 2014, the theme was "Wear & Care" while in Fall 2014 the theme became "Stitch & Assist". Based on recommendations by the PennApps organizer that previous hackathons with focused themes were not well received, we tried to keep the theme broad enough to appeal to a wide range of interest while still pointing to wearables as an outcome. The diversity of projects designed by participants in either StitchFest provides a case in point that such broad themes can provide a good framing for the hackathon experience. But we also note that there are other hackathons that explicitly focus on an overall theme such as coding for a social good and thus bringing participants together that are motivated to contribute to a cause. What we learned is that providing themes can work in both directions—as a tool for recruitment and as a diversion—because themes can compete with current trends. For instance, in Fall 2014, we found that suddenly designing hacks for drones had become popular theme in light of Amazon's proposal to deliver goods with them, while wearables were definitely the hot trend in the Spring 2014 PennApps, with the arrival of the Pebble and wearable phone devices. Despite the addition of a different health-based subhackathon in Fall 2014 in addition to our own assistive theme, the trend of assistive hacks didn't materialize.

A second factor in the design of StitchFest was the focus on designing a space that fostered collaboration within a competition. While this design feature seems counterintuitive at first, we found that the reasons for participating in a hackathon has multiple attractions, winning only being one of them. The social interactions are in fact a key reason that many decide to spend a full weekend of non-stop hanging out together. Beyond the benefits of socializing, we also wanted to foster interaction and collaboration on a design level by not including some hardware components in all hackboxes. We let them know upfront when they picked up their materials that they could find these sensors or actuators in other team boxes and should ask for them. We realize that this request was possible because, unlike in other subhackathons, we were able to provide all materials free of charge thanks to an industry sponsor. We often observed how this particular request got members from different teams talking with each other and also exchange what they knew about the material component. Equally crucial in this context was the presence of mentors, provided by PennApps or through project members, in helping StitchFest members figure out thorny technical details.

Overall, the goal with StitchFest design was to open up coding competitions to other materials, topics, and participants. We found that this intense and short design experience lived up to its potential by bringing in newcomers and engaging them in designing compelling yet complex applications of electronic texiles in a competitive environment, as well as changing general perceptions, across experience levels, around valuable designs in a hackathon space.

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