MAKEngineering Bags: A library program to engage families in making activities

This Sparks project proposes to design, develop and refine “MAKEngineer” take-home bags that provide learning experiences for youth in grades 3-6 and their families/caregivers in local underserved communities. The Center for Research on Learning and Technology (CRLT) at Indiana University (lead organization), in partnership with local elementary school libraries, WonderLab Museum, and the Boys & Girls Club of Bloomington, is requesting $24,998 to address the following IMLS goals: promote museums and libraries as strong community anchors that enhance civic engagement, cultural opportunities, and economic vitality while promoting the use of emerging technologies (i.e., making, DIY electronics) to facilitate discovery of knowledge. As an additional aim of this study, we expect to examine the logistics of circulation and sustainability of a set of maker bags/kits. We expect this project to have a national impact in that schools and public libraries, as well as museums and community organizations, will be able to adapt and build upon our research-based bags and materials within various contexts. Additionally, although our target sample include youth in grades 3-6 and their families/caregivers, we expect that other family members (e.g., siblings) and peers will engage with and benefit from the MAKEngineering bags as well. We acknowledge that take-home bags, toolboxes, or kits specific to STEM and/or making within school and public libraries are not a new idea; yet, it is our intent to conduct a robust assessment of these materials including the perspective of and engagement with the bags from both youth and their families/caregivers, as well an assessment of the circulation process.

In recent years, there has been an emphasis placed on inclusion of engineering design practices and engineering curriculum within K-12 schooling and/or informal learning experiences such as after-school camps. In this project, school libraries and community organizations will play a key role in the inclusion of caregivers as key participants in this process and extension of STEM learning opportunities beyond schools and libraries and into the home, particularly to under-resourced communities throughout our local community. As such, the proposed study will address current issues that concern the library and museum fields. First, the MAKEngineering bags address STEM content through making-related activities, aligning with the goal to improve learning in STEM as a means for US competitiveness and for empowering people of all ages to become creators. Second, the development of and access to these bags will engage learners of all ages and abilities throughout the community as our partners are dispersed and not centralized to one location in the region. More specifically, we expect these bags to be inclusive in supporting informal learning opportunities, while building an understanding of the learning taking place in home environments. Additionally, the data collected throughout the development, refinement, and implementation of the MAKEngineering bags will strengthen our community partners as community leaders in addressing the needs of our local community, particularly under-resourced families. Families of the community will be situated as experts and research partners in the refinement and implementation of the bags as gathered through family-observation focus groups, surveys, and follow-up interviews regarding their interactions around the bags in their home environments. Additionally, the MAKEngineering bags developed and refined throughout the one-year period will remain with our community partners with the intent to continue utilizing the MAKEngineering bags as a means to address the needs of our community.

Moreover, we expect this project to have a national impact in that school and public libraries, as well as museums and community organizations, will be able to adapt and build upon our research-based bags with a goal of targeting families from under-resourced communities and/or groups underrepresented in STEM. More specifically, we expect to know more about the type of activities that families enjoy, as well as the most appropriate information to include in each MAKEngineering bag so the families engage in a productive manner around the engineering design process and STEM content. In addition, we expect to understand the sustainability and circulation process of the bags within the context of school libraries and other community organizations.

MAKEngineering Bags: A library program to engage families in making activities

This *Sparks* project proposes to design, develop and refine “MAKEngineer” take-home bags that provide learning experiences for youth in grades 3-6 and their families/caregivers in local underserved communities. The Center for Research on Learning and Technology (CRLT) at Indiana University (lead organization), in partnership with local elementary school libraries, WonderLab Museum, and the Boys & Girls Club of Bloomington, is requesting $24,999 to address the following IMLS goals: promote museums and libraries as strong community anchors that enhance civic engagement, cultural opportunities, and economic vitality while promoting the use of emerging technologies (i.e., making, DIY electronics) to facilitate discovery of knowledge. As community partners, we have a shared focus of providing and engaging children and their families/caregivers with science, technology, engineering, and mathematics (STEM)-enriched activities and to support learners and educators through promoting understanding of STEM-related process and content standards. As an additional aim of this study, we expect to examine the logistics of circulation and sustainability of a set of maker bags/kits. While we originally sought to do this through the local community library, in discussions with them it became clear that if we want to really be able to focus on youth from underserved groups, that it would be best to work directly with local school libraries. We expect this project to have a national impact in that schools and public libraries, as well as museums and community organizations, will be able to adapt and build upon our research-based bags and materials within various contexts. Additionally, although our target sample include youth in grades 3-6 and their families/caregivers, we expect that other family members (e.g., siblings) and peers will engage with and benefit from the MAKEngineering bags as well. We acknowledge that take-home bags, toolboxes, or kits specific to STEM and/or making within school and public libraries are not a new idea (e.g., Albemarle County School District (VA), Duxbury Free Library (MA)); yet, it is our intent to conduct a robust assessment of these materials including the perspective of and engagement with the bags from both youth and their families/caregivers, as well an assessment of the circulation process (see Data Sources and Analysis).

As community partners, we serve a population of approximately 80,405 with the majority of the population predominately White (83%); and a smaller percentage of the population being Asian (8%), African American (4.6%) (US Census Bureau, 2016). In addition, as noted the 2011-2015 American Community Survey, 38.3% of the population in Bloomington live below the national poverty level with the median income for households at approximately $30,019. We currently have participation from seven schools across three districts surrounding Bloomington, including Monroe County Community School Corporation (3), Richland Bean Blossom Community Schools (1) and North Lawrence Community Schools (3). These elementary and intermediate schools are all Title 1 school-wide schools and fall within areas defined as small city, town and rural. Collectively they serve approximately 2500 youth with a range from 38% to 89% of these students receiving free or reduced-priced lunch. The Wonderlab Museum provides an after-school program, known as After School EdVentures (ASE), in the three Bloomington schools (~1100 students) participating in this project two times a year for a six-week period, once during the first half of the school year and the other during the second half of the school year. The program is structured so that children in grades K-2 engage in the STEM-enriched activities twice a week, while children in grades 3-6 engage in the activities twice a week. Daily the program runs for 45 minutes. Similarly, the local Boys & Girls Clubs provides after-school, holiday, and summer camps and programs for approximately 350 youth from age 6-18 years old from lower-income families.

Statement of National Need

In recent years, there has been an emphasis placed on inclusion of engineering design practices and engineering curriculum within K-12 schooling (e.g., Engineering is Elementary (EiE); Museum of Science, 2016). While engineering-related programs are spreading across K-12 schooling, they are often available in well-resourced communities or limited to students with strong academic backgrounds (Brophy et al., 2008). Additionally, there are opportunities for youth to engage as engineers in after-school programs and summer camps (e.g., Varney et al., 2012). As research suggests, engineering curricula and after-school programs afford youth opportunities for learning STEM content, problem solving skills, and the ability to communicate ideas and results (Brophy et al., 2008). Even more recently, maker education has been considered a phenomenon with the potential to engage a diverse student body (Barton & Tan, 2016; Peppler et al., 2014; Vossoughi & Bevan, 2014) and transform informal and formal education regarding what and how youth learn (Dougherty, 2013; Martin, 2015). However, we hypothesize that families from under-resourced communities are not always privileged or even aware of making-related activities and/or tools and resources to engage in making. Within this study, making will constitute use of tech-inspired, innovative material and low-cost, easy-to-use tools (Martin & Panjwani, 2016) to facilitate "designing, building, modifying, and/or repurposing material objects, for play or useful ends, oriented toward making a 'product' of some sort that can be used, interacted with, or demonstrated," (Vossoughi & Bevan, 2014, p. 3). Research on making is emerging, but there is evidence to suggest that students may gain an understanding of the iterative design process within various making activities such as robotics, digital art production, and circuitry (Bowler, 2014; Halverson, 2013; Hamner et al., 2008; Sheridan et al., 2014), as well as develop 21st century skills (Buchholz et al., 2014; Gutwill et al., 2015; Peppler et al., 2015) and positive self-concepts and self-images (Barton et al., 2016; Norris, 2014). Libraries are implementing makerspaces (or "playful information-based spaces"; Britton, 2012) and/or making activities for their library patrons, and have noted similar benefits for their patrons – happiness and sense of community (Barron & Barron, 2016; Moorefield-Lang, 2014); creativity and innovation (Barack, 2015; Small, 2014); intrinsic motivation and interest in STEM learning and career goals (Small, 2014); and knowledge of tools and technical skills (Goerner, 2015).

The projected employment rate in STEM occupations is expected to grow 23% in the next decade (US Department of Labor, 2015), yet women and minorities remain severely underrepresented in STEM fields (NSF, 2015). Based on previous research indicating the importance of parents and siblings in the development of STEM interest (Maltese, Melki & Wiebke, 2014), we argue there is a critical need to include families as stakeholders in meeting this demand through implementation of engineering design practices with an emphasis on emerging technologies in the home environment. We are interested in an alternative, and complementary approach to address this national issue – inclusion of parents or caregivers as key participants in this process and extension of STEM learning opportunities beyond schools or libraries and into the home. Parental home-involvement in education has been associated with positive benefits for youth (e.g., Froiland, 2013; Ramini et al., 2015). However, in light of parental involvement, adults' views of engineers and what they do are limited (Marshall et al., 2007; NSF, 2014). This limitation implies there is likely a lack of engineering design practices employed in learning and play in home environments. More specifically, our objective is to address this need through developing, refining, and integrating MAKEngineer take-home bags for library patrons, particularly youth and parents/caregivers in under-resourced communities. As an example, a MAKEngineering bag may contain construction materials (e.g., popsicle sticks, felt, tape), guidance and open-ended questions for making a submarine, and a related book (e.g., *Papa's Mechanical Fish* (Fleming, 2013), *Rosie Revere, Engineer* (Beaty, 2013)). After initial phases of refining the bags and the best practices for circulation, we expect the bags to be delivered to under-served patrons broadly through community organizations (e.g., Boys and Girls Club), school-related outreach programs (e.g., Afterschool Edventures), and school libraries. As an additional aim of this study, we expect to gain an understanding of how the activities are implemented within the home environment as a means to promote STEM content and process skills, as well as encourage exploration and higher-order challenges. It is expected that this data will inform changes in the design and development of the bags and the development and refinement of new bags. This project will address the *Community Anchors* project category in several ways. First, the "MAKEngineer" bags will be a local pilot program that addresses the national need and will have the potential to be scaled and implemented in a variety of local and national settings, including formal and informal learning environments. Our intent is to pursue materials and practices that ensure the sustainability of these bags in settings with limited resources. Second, the bags will provide interdisciplinary learning experiences for youth and their families/caregivers with a focus on underserved communities. Third, progress with the development, refinement, and use of the bags will be shared broadly and in a variety of formats by the research team throughout the one-year grant period.

As our previous research suggests, interest and engagement in a STEM discipline can be triggered at a young age, and parents are considered to be one of the most significant influences in this development (Maltese & Harsh, 2015; Maltese & Tai, 2011). Additional studies imply that family socioeconomic status and parental occupation may influence their children's decision to pursue a STEM major and occupation or not (Hemsley-Brown & Oplatka, 2015; Moakler et al., 2014). Moreover, the benefits of out-of-school learning experiences for youth, specifically as evidenced in science learning, is well documented. Broadly, these benefits include positive dispositions toward science, increase in knowledge and skills, greater likelihood of pursuing a STEM-degree and career, and development of interest and confidence in STEM (After-School Alliance, 2011; Bell et al., 2009; Denson et al., 2015; Dorsen et al., 2006; Eshach, 2007). Within the context of the home environment, Solomon (2003) argued, "no one would deny the influence of home and families on the education of our children" (p. 219). Engaging in teaching and learning of science tend to be spontaneous in everyday conversations such as at the dinner table or sitting outdoors (Bell et al., 2009; Goodwin, 2007; Ochs et al., 1996). On the other hand, structured science activities in the home between parents and children seemed to increase parental confidence in science conceptual knowledge and implant the joy of science in the home culture, indirectly influencing child's self-image and future goals (Solomon, 2003). As such, parents, regardless of their experiences with science, are able to be science educators (Shymansky, 2000; Solomon, 2003). Yet, it is recommended that parents be provided with instructional and scientific guidance, including types of questions to ask their children and becoming familiar with related objects and tools (Eshach, 2007; Jant et al., 2014). Although this literature is grounded in science education, we believe similar results will be documented in engineering and making education (Benjamin et al., 2010; Haden et al., 2014).

In general, take-home bags have been found to be beneficial in increasing parents' understanding and awareness of effective and age-appropriate ways to support children academically in literacy (Barbour, 1998; Grande, 2004), science (Gennaro & Lawrenz, 1992; Gunning et al., 2016; Solomon, 2003; Tzou & Litvak, 2012), and mathematics (Orman, 1993). MAKEngineering bags will be unique in that the goal is to support and engage children and parents in engineering practices, many through inclusion of making-related activities, within home environments. Lastly, youth and families/caregivers will be an active part of the research process through engaging in opportunities to aid in the refinement of and development of new MAKEngineering bags (discussed below).

Project Design

Theory and Practice. As noted above, one purpose of this project is to design, develop and refine "MAKEngineer" take-home bags as a way to provide learning experiences for youth in grades 3-6 and their families/caregivers in local underserved communities. Our proposed study is grounded in Lent and colleagues (1994; 2000; 2008) Social Cognitive Career Theory (SCCT), which focuses on the interplay of various factors by which individuals develop, pursue, and adapt their interests in a career. These factors include one's self-efficacy or belief in one's ability to be successful in a course of action, outcome expectations, choice goals, individual characteristics (e.g., gender identity), context (e.g., parental support), and access to learning experiences. Most relevant to this study are the contextual/social supports and barriers provided to under-resourced children in their home environments by at least one parent/caregiver, which is considered among the most powerful factors in mediating access to learning experience (Lent et al., 2000) and has been shown to indirectly influence one's major choice goal and increase/decrease one's self-efficacy (Ali & Saunders, 2006; Bandura, 2000; Lent et al., 2008; Navarro et al., 2007).

In addition, the proposed study, and the target grade range of 3-6, is grounded in our ongoing research studies. As part of our research on ways youth are engaged in activities similar to STEM professionals in a local after-school program with youth in our target grade range, we began to question how what they are learning and doing in this program transfers to their home environments. It was our sense that for nearly all youth, involvement in STEM activities stopped as they walked out the door. Over a 12-week period in this after-school program, materials were never sent home with participants. Finished projects could be taken home in some cases, but there were no examples of youth being encouraged to extend their explorations at home or to take a "work in progress" home and bring back for discussion or troubleshooting. In instances where youth in this program were picked up early, they often begged their parents to stay and finish the activity, but left with no materials to finish at home. We interpreted situations like this as a major barrier to the development of interest in STEM. However, this is likely not unique to this program. Through discussions with most of our colleagues who run makerspaces or programming for underserved youth, there is minimal opportunity for these students to continue various design activities outside of these spaces. This was particularly concerning to us given that in interviews we conducted with nearly 175 STEM professionals, they regularly cited examples of home engagement in STEM activities with their parents, particularly at an early age, as crucial in triggering their interests in STEM. These STEM-related activities included helping their parents fix things around the house (e.g., clothes dryer) or receiving verbal support and access to material (e.g., computer). This, in turn, has influenced how they raise their own children, as well as how they work with kids in outreach contexts. We also expect that youth in grades 3-6 have developed the fine motor skills and patience that will not hinder them from completing the activities alongside their caregivers as opposed to their caregivers needing to do most of the activity for the youth.

Project Overview. In Table 1, we provide a brief overview of the project. This information will be discussed in depth below.

Table 1. Project Overview

Plans	Research
Phase 1: Goal is to develop and refine MAKEngineering bags	
Gain IRB Approval Development of five MAKEngineering bags, which will include (1) material and packaging, (2) instructions/ideas & additional open-ended ideas, (3) open-ended questions, and (4) STEM and STEM Career information	Panel of "expert" makers to evaluate and provide feedback. Family observation focus group interviews Utilize feedback from experts and families to refine bags throughout iteration
Phase 2: Goal is to implement bags in two school libraries to continue refining bags & to refine the circulation process. Additional and/or new bags will also be developed.	

We will set up a programming exhibit with 2 of our school library partners 2-3 times throughout this phase as way to "advertise" and engage families in the various activities of the bags (e.g. parental STEM nights, library visits). Youth will check-out and return MAKEngineering bags through their school library.	Families will be given a survey to provide feedback. Follow-up, and in-depth interviews, will be conducted with families who volunteer. The library will keep logs regarding this process including circulation patterns, ease of turn-around, what materials are missing, what materials need to be continuously replaced (e.g., batteries), etc. Utilize feedback from data collected from families and library to refine bags and/or develop additional bags. Utilize feedback from data collected from data logs to refine the circulation process of the bags.
Phase 3: Goal is to implement bags among our remaining community partners.	
We will continue to "advertise" and engage families in the various activities of the bags at school and community events such as Makevention (i.e., the local makerfaire), events at local community centers (e.g., Boys and Girls Club), and school events. Youth will check-out and return MAKEngineering bags through various after-school programs and additional school library partners.	Families will be given a survey to provide feedback. Follow-up, and in-depth interviews, will be conducted with families who volunteer. Partner organizations will keep logs regarding this process including circulation patterns, ease of turn-around, what material are missing, what material need to be continuously replaced (e.g., batteries), etc.
Phase 4: Goal is to disseminate findings in multiple forms (see Dissemination Plan below).	

Overview of MAKEngineering Bags. Dr. Maltese and Dr. Simpson expect to develop at least five MAKEengineering bags during Phase 1, each focusing on a different theme. Each bag will vary in STEM-related content and making activities, with an embedded focus on the engineering design process. We will also partner with our school library partners in generating a book list appropriate for each bag. Here we provide a brief description of the five bags. Refer to Supporting Document 1 for an example of a MAKEngineering bag for scribble bots.

1. *Scribble bots*: The purpose of the scribbling machine bag will be to construct a motorized machine that "writes" using low-cost material such as markers, small 1.5V motors, 9V batteries, masking tape, rubber bands, a hot glue stick, clothespins, washers, and pipe cleaners. Families will be challenged to experiment with different material (e.g., popsicle sticks, washers), but also with how the placement of the material on the axle of the motor changes the patterns created by their machine.
2. *"The Kitchen sink"*: The purpose of this bag is to allow more open-ended construction for youth and families using a variety of materials such as wires, batteries, motors, LED lights, play-dough, straws, paper clips, cardboard, conductive tape, felt, ribbon, toothpicks, etc. We will also provide a journal and writing utensil for youth and families/caregivers to sketch out ideas and document outcomes.
3. *LED helicopter*: The purpose of the LED helicopters is to use vellum plastic strips, battery, rubber bands, LED light, and clear tape to construct a helicopter that, when launched, will fly for at least 7 seconds. Youth and caregivers will be challenged to play with the wingspan and wing angle on the flight of the helicopter.
4. *Car Carrier*: The purpose of this bag is to use the least number of ZOOB BuilderZ pieces to build a vehicle that can complete a series of challenges, including following a straight track for a distance of 10 feet, carrying a load of materials such as cans of food or rocks, or achieving top speeds when rolled

down a ramp. This bag ties into local automotive industry and common interests in the state of Indiana, through Indy car racing and the Bloomington Speedway.

5. *Popsicle Prosthetics*: The purpose of the popsicle prosthetic bag is for youth and families/caregivers to construct a hand, arm or leg out of various material such as popsicle sticks, tape, hot glue, rubber bands, cardboard pieces, and scissors, with various goals such as picking up small objects (e.g., paper clips, buttons) and large objects (e.g., bowl). This bag also connects with the local biomedical device industry that employs a sizable workforce locally and throughout Indiana.

Data Sources and Data Analysis. Research collected during this project will include expert feedback from an advisory panel and family observation-interviews via focus groups during Phase 1, surveys including both closed-ended and open-ended reflective questions, as well follow-up interviews during Phases 2 and 3, and data logs during Phases 2 and 3, with each data source being utilized to make informed refinements to the MAKEngineering bags and to how they are circulated through the school library (Phase 2) and eventually through community programs and additional school libraries (Phase 3). Each of these topics is discussed below.

Advisory Panel. Expert feedback regarding the first iteration of the MAKEngineering bags, and development of new MAKEngineering bags following Phase 2, will be sought from five individuals familiar with making within the United States and with whom the research team has established a professional relationship. These advisors are situated within various contexts and implement STEM-related making with a broad age-range: Sean Chambers, a self-identified maker and bio-medical engineer from Bloomington (IN); Diane Harding, a professional development resource teacher in Albemarle County School District (VA), a leading school district in making; Melissa Pardun, owner of Maker's Edge, a makerspace in Waco, TX; Pam Carswell, a librarian and makerspace director of the Minot Public Library (SD); and Abby Cornelius, a school librarian with National Board Certified Teacher credentials from Blue Valley North High School (KS). Each advisor will provide critical feedback regarding various components of the bags such as age-appropriateness of the activity; wording and thoroughness of instructions, ideas, and open-ended questions; STEM-related content potentially overlooked; and the general packaging and organization of the activity, with an eye toward durability and ease of circulation. Each expert maker educator will be asked to evaluate all the MAKEngineering bags. Based on the preference of the advisor, feedback and suggestions will be collected via email and/or video conferencing. As a research team, we will weigh and agree upon needed changes to each bag. This will be completed before testing the activities with families.

Family Observation Focus Groups & Programming Exhibits. Information to guide the second iteration of the MAKEngineering bags will be sought from families of youth enrolled in one of our partner schools. We expect to conduct five family observation-interviews with one bag being the focus of each observation-interview. As a research team (i.e. IU researchers and each community partner, respectively), we will recruit and gain consent from family participants through setting up an exhibit table at various school and community events, as well as send letters home to families/caregivers and conduct demonstrations in school libraries and after-school programs, to showcase the MAKEngineering bags and engage youth and families in the making-related activities. During family observation-interviews, members of the research team from Indiana University will observe families as they engage with the activity, noting the manner in which families engage with the bags and with one another, moments of failures and successes, utilization (or not) of the provided instructions and prompts and STEM content, and even how the bags are re-packaged after use. Additionally, members of the research team will ask questions throughout the process based on in-the-moment observations such as "Tell me about why you are frustrated." "Why did you pose that question?" and "Tell me more about what you are doing." After the observation, we will continue in a focus-group setting, posing questions about their experiences and gathering suggestions for making potential changes. These questions will include “Tell us what you liked/disliked.” “Was the activity age-appropriate? Why or why not?” “Would you check these bags out if they were available in the library? Why or why not?” We expect these family-observation focus groups to last approximately 30-45 minutes and to occur at the families’ local school library or at one of our community partners. To improve accessibility, the family-observation interviews will be held in the evenings or weekends and refreshments will be provided.

Survey. Family members, including at least one parent and one adolescent, will each be asked to complete a survey including both closed-ended items and open-ended reflective questions after checking out and engaging with the bags in their home environment. This will be a set of questions asking what they liked and disliked; what they would change; what they learned; and what they would like included in other MAKEngineering bags. These 5-minute surveys will be paper-based and inserted within each bag, to be returned with the bag itself. These results will be collected from school libraries frequently and examined by IU researchers as a way to inform the design, development and refinement of all bags. For example, in the event that family members claim that an activity was too hard to complete, we will consider several options such as writing the directions to include more detail and images or consider if the activity is age-appropriate. As another instance, if families are continuously suggesting a MAKEngineering bag on sewing, we will develop and refine a bag (Phase 1) to address this request such as challenging families to create and sew anything of their choosing using scrap material, felt, buttons, conductive thread, scissors, rulers, LED lights, and no-thread sewing needles.

Interviews. At the end of the survey, families/caregivers will be asked for contact information if they are open to being interviewed about their experience and opinions regarding their engagement with the MAKEngineering bag. The interview will be conducted by an IU researcher at a time, date, and place convenient to the family member(s). The interview should take approximately 40-45 minutes to complete and will be audio recorded with the consent of the family member(s); otherwise, the researcher will take notes. The intent of the interview is similar to that of the family-observation interviews and will expand upon the information collected in the survey. The interview will begin by asking family member(s) questions regarding the instructions, open-ended questions, STEM-content and STEM careers related to the bag, as well as what they gained from the experience (e.g., content, time with child/caregiver, confidence). Next, the family member(s) will be asked to illustrate their process or be engaged in a similar activity with the researcher noting the manner in which families engage with the bags and with one another. Additionally, family members will be asked questions through the process based on in-situ observations such as “Tell me why you are doing.” or “What do you think will happen when…?”.

Data Logs. Lastly, our community partners in Phase 2 and Phase 3 will maintain logs regarding logistics such as circulation patterns, what material are missing, what material need to be continuously replaced (e.g., batteries), the time it takes to re-package and replace items in the bags upon return, to name a few. This information will be logged by a media and/or technology specialist(s) and maintained in an Excel sheet. This information will be reviewed by all members of the research team (i.e., IU researchers and community partners) on a bi-weekly basis to make informed changes to this process. The intent is to note the majority of strengths and weaknesses, and ways to capitalize on the strengths and remediate the weaknesses in Phase 2. In general, the data collected in both phases will provide the foundation for considering the operational feasibility of curating and circulating these bags. Additionally, the data will allow the research team to evaluate differences based on context and school demographics.

Potential Issues and Alternative Approaches. First, students may not choose to take the bags home. We will “advertise” the existence of the bags through setting up an exhibit table or programming during school and community events over the course of Phase 2 and Phase 3 and ask our school librarian partners to recommend the bags during student visits. Second, the MAKEngineering bags and/or various parts of the bags may not be returned. We have budgeted money to account for this. We also acknowledge that this is part of what we expect to collect through the data logs. Third, there is the potential that youth will renew their access to the bags on a continuous basis and limit the availability of bags for their peers. We will likely limit the bag check-out time frame to 2 weeks with no immediate renewal. While we previously had the concern that we would not be able to get these bags in the homes of the families who are most underserved and underrepresented in STEM, working directly with schools in these specific communities should greatly improve our chances of success on getting materials to these families.

Timetable. The development, refinement, and implementation of the MAKEngineering bags is expected to take one year to complete, June 2017 to May 2018. Major activities within each phase are described in the Schedule of Completion attachment.

	J	J	A	S	O	N	D	J	F	M	A	M
Phase 1	■	■	■									
Phase 2			■	■	■	■	■	■	■	■	■	■
Phase 3						■	■	■	■	■	■	■
Phase 4								■	■	■	■	■

Evaluation Plan. The two main goals of this project are: 1) to create MAKEngineering bags that are interesting, age-appropriate and functional for youth and their families and 2) to get these bags circulated to youth throughout the participating schools. We plan to measure success toward these targets in multiple ways. For Goal 1, we will be collecting data throughout the development and refinement of the bags from a panel of experts, from youth/families and from our community partners. We expect that this formative data from important stakeholders will allow the research team to regularly evaluate whether or not the bags are meeting these objectives. For Goal 2, we will also use multiple forms of data. In this case, we believe that circulation data and feedback from the librarians and from the user surveys included in the MAKEngineering bags will tell us whether or not they are getting use. While we have no true sense of what a reasonable circulation target would be, we intuitively feel that having any of the bags out of the libraries and in homes (not lost) for 30% of the school year, after initial introduction, would be a success. We will be able to use circulation data to judge relative success across the bags and see if there is commonality in these data across schools. As a way to continuously evaluate these goals, Dr. Maltese and/or Dr. Simpson will meet bi-weekly with community partners for the entire length of the grant. At each meeting, we will brief one another on accomplishments and struggles since the previous meeting, including data collection and insights from data analysis, brainstorm ideas, and outline next steps.

National Impact

The proposed study will address current issues that concern the library and museum fields. First, the MAKEngineering bags address STEM content through making-related activities, aligning with the goal to improve learning in STEM as a means for US competitiveness and for empowering people of all ages to become creators. Second, the development of and access to these bags will engage learners of all ages and abilities throughout the community as our partners are dispersed and not centralized to one location in the region. More specifically, we expect these bags to be inclusive in supporting informal learning opportunities, while building an understanding of the learning taking place in home environments. We understand here that a small project like we propose will likely lead to more questions than answers, but we feel this project can provide a strong start and that we can pursue advanced research questions about in-home learning with families in future studies. Additionally, the data collected throughout the development, refinement, and implementation of the MAKEngineering bags will strengthen our community partners as community leaders in addressing the needs of our local community, particularly under-resourced families. Families of the community will be situated as experts and research partners in the refinement and implementation of the bags as gathered through family-observation focus groups, surveys, and follow-up interviews regarding their interactions around the bags in their home environments. This aligns with Peterson's view (2013) that strong relationships and community involvement are key to reaching children and teens, in our case, providing youth with STEM-related making activities with a focus on the engineering design process. Additionally, the MAKEngineering bags developed and refined throughout the one-year period will remain with our community partners with the intent to continue utilizing the MAKEngineering bags as a means to address the needs of our community. Additionally, we expect this project to address the ILMS goal of developing and providing inclusive and accessible learning opportunities among families across our local community.

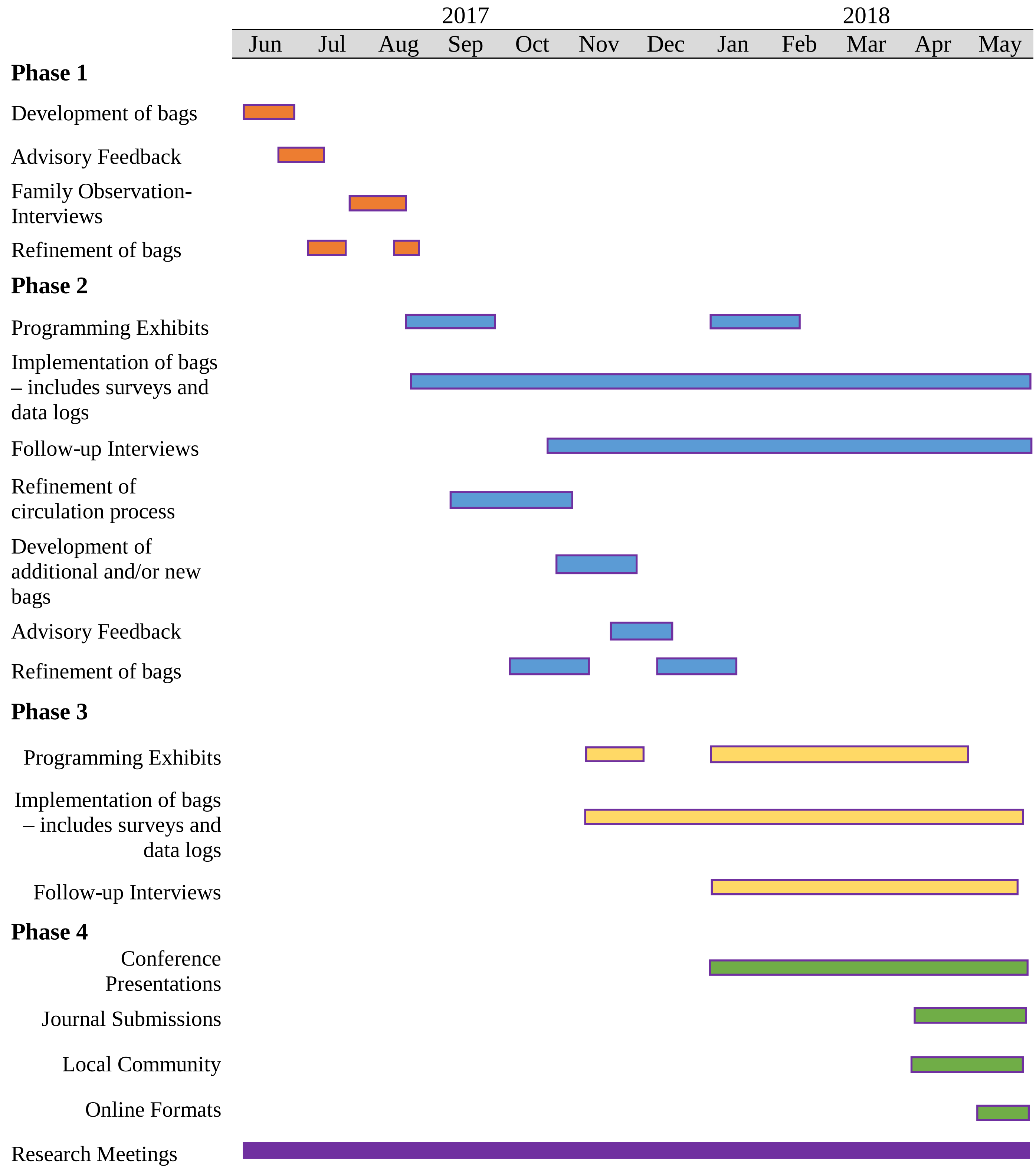
Moreover, we expect this project to have a national impact in that school and public libraries, as well as museums and community organizations, will be able to adapt and build upon our research-based bags with a goal of targeting families from under-resourced communities and/or groups underrepresented in STEM. More specifically, we expect to know more about the type of activities that families enjoy, as well as the most appropriate information to include in each MAKEngineering bag so the families engage in a productive manner around the engineering design process and STEM content. In addition, we expect to understand the sustainability and circulation process of the bags within the context of school libraries and other community organizations.

Dissemination Plan. The results will be disseminated through regional and national conferences for practitioners, administrators, teacher educators, and researchers including, but not limited to the Indiana STEM Education Conference in January 2018, the Public Library Association (PLA) 2018 Conference in Philadelphia, PA, and American Education Research Association (AERA) 2019 in Toronto, ON, Canada. Results will further be published in national and international peer-reviewed journals; examples include *School Library Research, International Journal of Engineering Education,* and *Library & Information Science Research*. Additionally, the research team will post information of the ongoing bag development and research findings on professional IU faculty webpages. Local newspapers and news programs will be contacted near the conclusion of the proposed Sparks grant to disseminate the success of the community-wide MAKEngineering bags. We will hold a webinar at the conclusion of the grant, targeting public libraries and museums regarding the development, refinement, and implementation of the bags. Following from this, we will write a white paper summarizing the study and important findings and share through relevant ALA (e.g., AASL) channels.

Lastly, we will share information on the MAKEngineering bags on Snapguide.com and/or Instructables. This will include the packaging and activity instructions as viewed in the example (refer to Supporting Document 1), pictures, a shopping list with links to various websites to order material, a list of consumables that will need to be replaced and approximately how often, a list of appropriate books to utilize with each of the bags, and direct quotes and anecdotes from family members regarding their engagement with the bags.

MAKEngineering Bags: A library program to engage families in making activities
Schedule of Completion

The following table reflects each major activity over the course of the 1 year grant period, June 2017 – May 2018.



DIGITAL PRODUCT FORM

Introduction
The Institute of Museum and Library Services (IMLS) is committed to expanding public access to federally funded digital products (i.e., digital content, resources, assets, software, and datasets). The products you create with IMLS funding require careful stewardship to protect and enhance their value, and they should be freely and readily available for use and re-use by libraries, archives, museums, and the public. However, applying these principles to the development and management of digital products can be challenging. Because technology is dynamic and because we do not want to inhibit innovation, we do not want to prescribe set standards and practices that could become quickly outdated. Instead, we ask that you answer questions that address specific aspects of creating and managing digital products. Like all components of your IMLS application, your answers will be used by IMLS staff and by expert peer reviewers to evaluate your application, and they will be important in determining whether your project will be funded.

Instructions
You must provide answers to the questions in Part I. In addition, you must also complete at least one of the subsequent sections. If you intend to create or collect digital content, resources, or assets, complete Part II. If you intend to develop software, complete Part III. If you intend to create a dataset, complete Part IV.

PART I: Intellectual Property Rights and Permissions

A.1 What will be the intellectual property status of the digital products (content, resources, assets, software, or datasets) you intend to create? Who will hold the copyright(s)? How will you explain property rights and permissions to potential users (for example, by assigning a non-restrictive license such as BSD, GNU, MIT, or Creative Commons to the product)? Explain and justify your licensing selections.

N/A

A.2 What ownership rights will your organization assert over the new digital products and what conditions will you impose on access and use? Explain and justify any terms of access and conditions of use and detail how you will notify potential users about relevant terms or conditions.

N/A

A.3 If you will create any products that may involve privacy concerns, require obtaining permissions or rights, or raise any cultural sensitivities, describe the issues and how you plan to address them.
N/A

Part II: Projects Creating or Collecting Digital Content, Resources, or Assets

A. Creating or Collecting New Digital Content, Resources, or Assets

A.1 Describe the digital content, resources, or assets you will create or collect, the quantities of each type, and format you will use.
N/A

A.2 List the equipment, software, and supplies that you will use to create the content, resources, or assets, or the name of the service provider that will perform the work.
N/A

A.3 List all the digital file formats (e.g., XML, TIFF, MPEG) you plan to use, along with the relevant information about the appropriate quality standards (e.g., resolution, sampling rate, or pixel dimensions).
N/A

B. Workflow and Asset Maintenance/Preservation

B.1 Describe your quality control plan (i.e., how you will monitor and evaluate your workflow and products).
N/A

B.2 Describe your plan for preserving and maintaining digital assets during and after the award period of performance. Your plan may address storage systems, shared repositories, technical documentation, migration planning, and commitment of organizational funding for these purposes. Please note: You may charge the federal award before closeout for the costs of publication or sharing of research results if the costs are not incurred during the period of performance of the federal award (see 2 C.F.R. § 200.461).

N/A

C. Metadata

C.1 Describe how you will produce any and all technical, descriptive, administrative, or preservation metadata. Specify which standards you will use for the metadata structure (e.g., MARC, Dublin Core, Encoded Archival Description, PBCore, PREMIS) and metadata content (e.g., thesauri).
N/A

C.2 Explain your strategy for preserving and maintaining metadata created or collected during and after the award period of performance.
N/A

C.3 Explain what metadata sharing and/or other strategies you will use to facilitate widespread discovery and use of the digital content, resources, or assets created during your project (e.g., an API [Application Programming Interface], contributions to a digital platform, or other ways you might enable batch queries and retrieval of metadata).
N/A

D. Access and Use

D.1 Describe how you will make the digital content, resources, or assets available to the public. Include details such as the delivery strategy (e.g., openly available online, available to specified audiences) and underlying hardware/software platforms and infrastructure (e.g., specific digital repository software or leased services, accessibility via standard web browsers, requirements for special software tools in order to use the content).
N/A

D.2 Provide the name(s) and URL(s) (Uniform Resource Locator) for any examples of previous digital content, resources, or assets your organization has created.
N/A

Part III. Projects Developing Software

A. General Information

A.1 Describe the software you intend to create, including a summary of the major functions it will perform and the intended primary audience(s) it will serve.
N/A

A.2 List other existing software that wholly or partially performs the same functions, and explain how the software you

intend to create is different, and justify why those differences are significant and necessary.
N/A

B. Technical Information

B.1 List the programming languages, platforms, software, or other applications you will use to create your software and explain why you chose them.
N/A

B.2 Describe how the software you intend to create will extend or interoperate with relevant existing software.
N/A

B.3 Describe any underlying additional software or system dependencies necessary to run the software you intend to create.
N/A

B.4 Describe the processes you will use for development, documentation, and for maintaining and updating documentation for users of the software.
N/A

B.5 Provide the name(s) and URL(s) for examples of any previous software your organization has created.
N/A

C. Access and Use

C.1 We expect applicants seeking federal funds for software to develop and release these products under open-source licenses to maximize access and promote reuse. What ownership rights will your organization assert over the software you intend to create, and what conditions will you impose on its access and use? Identify and explain the license under which you will release source code for the software you develop (e.g., BSD, GNU, or MIT software licenses). Explain and justify any prohibitive terms or conditions of use or access and detail how you will notify potential users about relevant terms and conditions.
N/A

C.2 Describe how you will make the software and source code available to the public and/or its intended users.
N/A

C.3 Identify where you will deposit the source code for the software you intend to develop: N/A

Name of publicly accessible source code repository: N/A

URL: N/A

Part IV: Projects Creating Datasets

A.1 Identify the type of data you plan to collect or generate, and the purpose or intended use to which you expect it to be put. Describe the method(s) you will use and the approximate dates or intervals at which you will collect or generate it.
N/A

A.2 Does the proposed data collection or research activity require approval by any internal review panel or institutional review board (IRB)? If so, has the proposed research activity been approved? If not, what is your plan for securing approval?
N/A

A.3 Will you collect any personally identifiable information (PII), confidential information (e.g., trade secrets), or proprietary information? If so, detail the specific steps you will take to protect such information while you prepare the data files for public release (e.g., data anonymization, data suppression PII, or synthetic data).
N/A

A.4 If you will collect additional documentation, such as consent agreements, along with the data, describe plans for preserving the documentation and ensuring that its relationship to the collected data is maintained.
N/A

A.5 What methods will you use to collect or generate the data? Provide details about any technical requirements or dependencies that would be necessary for understanding, retrieving, displaying, or processing the dataset(s).
N/A

A.6 What documentation (e.g., data documentation, codebooks) will you capture or create along with the dataset(s)? Where will the documentation be stored and in what format(s)? How will you permanently associate and manage the documentation with the dataset(s) it describes?
N/A

A.7 What is your plan for archiving, managing, and disseminating data after the completion of the award-funded project?
N/A

A.8 Identify where you will deposit the dataset(s): N/A

Name of repository: N/A

URL: N/A

A.9 When and how frequently will you review this data management plan? How will the implementation be monitored?
N/A