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Issues

Using Design Interventions to Develop Communication Solutions for Integrated Pest Management

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Abstract

Iowa State University's (ISU) Integrated Pest Management (IPM) program partnered with the ISU College of Design (COD) to use Design Thinking and other practical design methodologies and theories to identify and develop approaches to address IPM extension and communication issues. ISU IPM met with agriculture industry, program colleagues, and ISU COD faculty to discuss IPM-related needs in agriculture and to determine the program's primary challenges. ISU COD faculty developed a two-semester course for undergraduate students, allocating various resources to solve these challenges. Undergraduates in the course, as the primary agents and problem solvers, developed various strategies the IPM program and its colleagues could implement. A model of interdisciplinary collaboration was developed, where design and science may function as equal partners in a design education setting. In our collaboration, the partners bought into a design-led process-based methodology that began with identifying IPM communication needs. This project resulted in unique design interventions to communicate IPM to stakeholders and the public, as well as created a model for interdisciplinary cooperation that can be exported to fields outside of agriculture and IPM.

Key words: IPM, undergraduate education, design thinking, interdisciplinary, crop protection

The Integrated Pest Management (IPM) program at Iowa State University (ISU) provides educational programming to meet the diverse pest control needs of Iowans, with a heavy focus on the two primary agronomic crops grown in the state: corn and soybean. IPM is a set of pest management practices and principles that provide effective and economic pest control while reducing reliance on pesticides. IPM adoption is an important facet of sustainable agriculture, as the process seeks to preserve environmental resources and useful pest management technology through resistance mitigation and by emphasizing sustainable land stewardship.

The ISU IPM program attempts to reach farmers, agribusiness professionals, youth, the general public, and other audiences through many traditional extension methods, including one-on-one meetings, small and large group classroom or field events, publications, videos, and newsletters. The program has also examined nontraditional education methods, such as using social media to track crop disease (Mueller et al. 2018), crop scouting competitions for youth (Freije et al. 2017), and interactive, multimedia online books (Mueller et al. 2017). These traditional and nontraditional communication efforts by the ISU IPM program have been only partially successful, with much left to accomplish (Mueller and Staker, personal observations).

Partial success with IPM programming efforts is an experience likely shared by other IPM educators, as the lack of IPM adoption by end-users has been well documented or reviewed (Wearing 1988, Herbert 1995, Ehler and Bottrell 2000, Sappington 2014, Stetkiewicz et al. 2018), and perceived challenges to IPM adoption have also been extensively reviewed (Stoner et al. 1986, Wearing 1988, Herbert 1995, Trumble 1998, Ehler and Bottrell 2000, Ehler 2006, Parsa et al. 2014).

To increase IPM adoption, the ISU IPM program initiated an interdisciplinary collaboration between the ISU IPM program and the ISU College of Design (COD). The goal of this collaboration was to improve IPM communications through the design process, using non-expert IPM communicators to develop novel methods of IPM communication. This collaboration incorporated design methodologies within an undergraduate studio course. During this course, student design and research processes were facilitated by introducing resources and theory, as well as teaching methods that emphasize a deep analysis of complex issues and articulation of key issues. Through this, particular communication needs associated with IPM education were identified and used as a starting point for student design outcomes. We hypothesized that giving

primary creative responsibility to young designers and artists could lead to unexpected, effective, and innovative design outcomes for promoting or communicating IPM, while providing a unique educational experience for undergraduate students at Iowa State University.

Initiation

ISU IPM staff were made aware of the potential for design outcomes to agricultural issues after viewing ISU COD faculty efforts to address challenges with livestock management using virtual reality. In response, the ISU IPM program approached faculty in the ISU COD to discuss a new, interdisciplinary collaboration. This new collaboration would address IPM-related communication needs by bringing in the unique resources and knowledge of COD faculty and undergraduate students through art and design studio practice, research, ideation, and development.

A focus group consisting of ISU IPM educators and commercial agribusiness employees was formed to identify misconceptions and issues related to IPM adoption. Results from this open discussion informed ISU COD faculty, who proposed a unique curricular experience for undergraduate students in the fields of art and design. To implement this plan, an experimental interdisciplinary course was developed and approved through the ISU COD as a senior-level undergraduate elective: Integrated Studio Arts/Graphic Design 461: Outreach Studio. The first semester included student immersion in IPM and agriculture, formulation of important issues, and development of design interventions to help solve the program's most pressing communication issues. Ideas generated during the first semester were developed further during a second semester by a select number of students.

Course Design

In order to inspire applicable ideas and encourage full involvement in the project, COD faculty gave primary creative responsibility and agency of the project to the interdisciplinary group of undergraduate students participating in the course. It was hypothesized that giving primary ownership and responsibility to young designers and artists could lead to unexpected, effective, and innovative design outcomes while providing a unique educational experience for the students. Experts, having solved similar problem types in the past, store solution templates, and solve the problem directly while novices 'blunder' about in their search for a solution (VanLehn 1988). In many domains, this *blundering about* impacts the quality of the answer and the speed with which it was generated (VanLehn 1988). However, in many design methodologies, blundering about, to some degree, is desirable throughout the process, as many possible solutions are generated in an attempt to produce innovative solutions.

The course was taught as a process-based studio, in which the designed outcomes were not prescribed by the IPM program, but rather determined over the course of the semester through a series of design probes, exercises, and workshops. Students had authorship of the entire design process, from discovering the challenges to IPM education and adoption to creating a framing question for their design interventions and developing and presenting prototypes. While students drove the process, it was supported by the introduction of design tools, methodologies, theories, and resources; and by appropriate, instructor-provided feedback and critique.

Rather than focus the studio around a single design methodology, the pedagogy was designed to mirror the varied tools and methods used in creative practices. Rarely is a singular methodology or tool sufficient to solve a complex problem. Each methodology or tool has its strengths and weaknesses and will produce one or part of one solution. However, when used in combination, different methods can positively reinforce one another and reveal more poignant solutions. The methods and tools listed below are the most prominent that we included in the design process.

Design Thinking

Design Thinking can be defined as a process to obtain innovative outcomes through cross-discipline collaboration and the combination of both creative and analytical methods (Chao 2015). This definition was valuable as the process and intent for the studio course were defined for design students and the IPM program, and it served as a starting point for problem identification and problem-solving processes. The model for Design Thinking utilized at Stanford's d.School was also referenced, which establishes five phases or modes (An Intro to Design Thinking Process Guide):

1. Empathize—Research user needs
2. Define—State users' needs and problems
3. Ideate—Challenge assumptions and create ideas
4. Prototype—Start to create solutions
5. Test—Test solutions

This process offers potential for iteration and can be utilized in either a linear or nonlinear process. During the fall semester studio class, students focused on the first four modes of the Stanford model. A core group of designers working on the next phase of the project, in spring, primarily used the Prototype mode, while also evaluating the process to engage again in the Ideate mode, develop final design solutions, and share with the IPM program.

Thinking Wrong

A Design Thinking methodology developed by John Bielenberg, Thinking Wrong, focuses on teaching designers' unique approaches to problem-solving to yield unexpected, innovative, and successful design outcomes. The big idea for Thinking Wrong is the ability to break out of standard design orthodoxies to generate more effective design solutions (Fell 2012).

Systems Thinking

Systems Thinking is a way of understanding and solving problems in complex systems. Systems Thinking stems from the understanding that all things are interconnected, that the whole is greater than the sum of its parts, and that systems feedback on themselves in positive and negative ways. Within complex systems are Leverage Points, which are smaller areas where minor changes can have a large impact on the entire system (Meadows 2010).

The 5 Whys

The 5 Whys is a simple formulation of Root Cause Analysis (Rooney and Heuvel 2004). The theory is that by asking a series of 'why' questions, by the fifth question, or 'why', the root cause of the problem will be identified (Serrat 2017).

How Might We

Once the students had their outcomes from the '5 Whys' exercise, they undertook another round of sharing, posting, clustering, and distilling of the communication questions they identified. This process resulted in a final set of communication questions, viewed as an

opportunity to derive insights, to ask additional questions, and to investigate topics further.

After using the design methodologies to investigate IPM, students began to develop a final communication question for the project brief. Put another way, this process identified the one big problem that must be addressed by their final proposals. This communication question was framed as a 'How Might We' question, and was based on the research, subject immersion, partner discussions, and Design Thinking exercises (How Might We Worksheet). The students proposed evolving the initial communication question of 'How might we increase adoption of IPM in Iowa' to 'How Might We Create a Culture of IPM in Iowa (and beyond)?' (Fig. 1). This is an Iowa-centric approach, but the potential exists to use the materials created as a model for adoption of IPM in other states, and ultimately, nationally.

Course Experience

The studio participants were organized within one nonhierarchical design team, rather than within small teams or as individual students working in competition. This teamwork strategy resulted in five proposals, each addressing a unique challenge identified through the design process. Proposals were developed using five phases of inquiry: research, immersion, workshops, ideation, and prototyping.

Research

During the first 3 wk of the semester, students self-directed intensive IPM research and compiled findings to present to the class. From these research outcomes, students begin to build a cohesive definition of IPM and highlight some of the communication problems IPM faces. At the start of this process, the students were informally queried as to their previous knowledge of IPM. It is significant to note that not a single student, including those from farming families, had prior knowledge of IPM.

Immersion

The immersion phase required students to interact directly with stakeholders and to investigate the subject matter (IPM). This was directly related to phase one of the Design Thinking process, known as the Empathize mode, as defined by the d.School at Stanford. The ISU IPM program has many stakeholders, including researchers, farmers, farm cooperatives, seed companies, chemical corporations, and others. In order to help students understand these stakeholders and their needs, two site visits and a studio presentation were included as part of the course. Each of these immersive experiences left a strong impression on the students and allowed them to see varied and distinct perspectives on the value of the IPM process from the unique perspective of farmer, farm supplier, and researcher. These experiences also fit traditional models for IPM education, which include hands-on workshops, lectures, and meetings with farmers.

The first site visit was to the Field Extension Education Laboratory (FEEL), a demonstration farm operated by ISU and the IPM researchers. At FEEL, the students were able to have first-hand experience with the practice of IPM and hear from scientists why IPM is critical for sustainable agriculture. The research

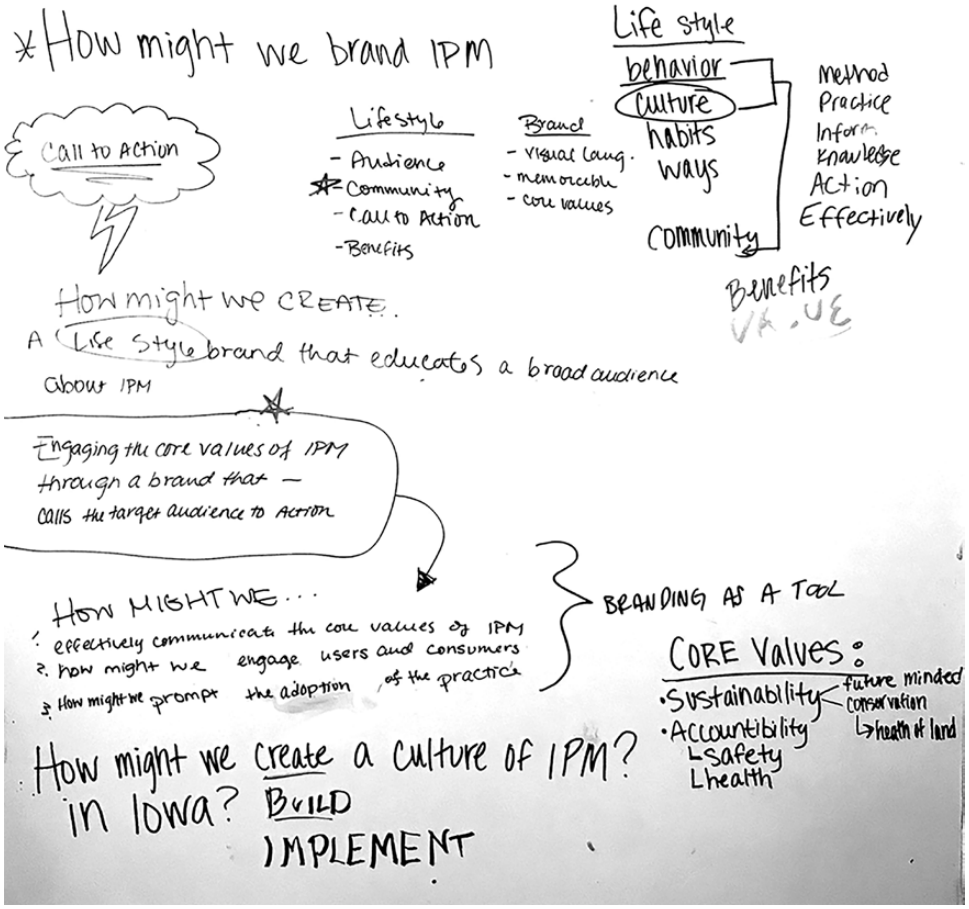

Fig. 1. 'How might we...' ideation of early IPM communication needs and strategy.

and extension scientists at FEEL led the students in a hands-on field day outing, which focused on the process of scouting crops for pests and disease (Fig. 2). Students were able make the connections to the values of targeted scouting and pesticide application through this experience more so than by simply reading about it in a textbook.

The second site visit was to a family farm that implements IPM practices. Also present were representatives from the local agricultural cooperative that supplied seed and agricultural products (pesticides, fertilizers, etc.) to the farmers (Fig. 3). Students learned about the benefits and challenges of IPM for farmers, engaged in a deep discussion about the economics of farming, and learned about the importance of the cooperative in helping farmers practice IPM.

A third experience was a studio visit from a soil scientist, who gave a detailed presentation about the role and impact of soil in the IPM process. The soil scientist taught the students about the complex ecology that is soil, the importance of healthy soil to farming, and the damage done to soil through the over-application of agricultural chemicals and tilling.

Workshops

One workshop experience was held during the fall semester. Barkley Design invited students to their Moonshot Lab in Kansas City to participate in a workshop on Design Thinking with an emphasis on user empathy. This experience was scheduled for the period of transition from research and immersion to ideation—the rapid and unfettered generation of potential solutions. Barkley stressed that, in their experience, including designers and design methodologies like Design Thinking early in a project led to greater success for their projects.

Ideation

After weeks of research and immersion, capped off by a Design Thinking workshop, the students were anxious and ready to synthesize information. To start the process of ideation, multiple in-class sessions focused on design and problem-solving methodologies such as Thinking Wrong and the 5 Whys, as well as other brainstorming techniques, to identify effective points of intervention and potential vehicles for information dissemination. At this phase, students focused on generating as many potential ideas as possible. Students compiled what they had learned through research and immersion experiences. They then presented *IPM Challenges* to the ISU IPM program, identified objectives for the studio, and identified pertinent messages about IPM that should be included.

Prototyping

The final step in the process was to create prototypes based on their research to present to our partners and IPM stakeholders. For this step, students worked in teams of two, self-selected a challenge, and developed prototypes.

Studio Outcomes

IPM Challenges

As students synthesized outcomes of research, immersion, and meetings, they were encouraged to identify potential barriers to widespread adoption of IPM practices. These barriers or challenges would serve as a conceptual launch point as students developed proposals and strategies for addressing the communication divide between educators and their intended audiences. Students initially tackled this task individually, focusing on creating lists that included as many potential challenges as possible. Students then met as a group and transferred lists to paper sticky notes with each challenge written on its own note. Findings were then shared by posting these notes in the classroom, creating top-level categories, clustering similar findings, and then distilling these down to a carefully chosen final list that represented the most relevant potential challenges to address in final design outcomes. Before being finalized, this proposed list of project challenges was evaluated through discussion with project partners and stakeholders.

Fig. 2. Design students scouting for pests and crop disease at an extension learning and demonstration farm as part of the course immersion process.

Fig. 3. Design students learn about IPM at an Iowa farm as part of the course immersion process.

From this process, one of the primary challenges students identified was a lack of a clear, understandable definition for IPM. There is not a wide public understanding of what IPM is, as the name and acronym are difficult to parse, and although composed of three recognizable words, the name itself does not offer insight into what the topic or approach actually means. This became an opportunity to explore potential naming and renaming strategies, which could culminate in an overall rebranding of IPM. This also provides the opportunity to explore alternative ways to position IPM that clearly articulate what the subject matter is to a wide range of potential audiences, future adopters, and stakeholders.

The final IPM Challenges identified were:

1. *Lack of awareness of IPM*. The acronym 'IPM' is unclear, and the actual terms do not describe what IPM is to a wide audience.
2. *Lack of unified IPM identity*. There is no existing or well-known 'brand' for IPM.
3. *IPM information is complex and unattractive*. It is hard to understand the process and value of IPM without expert guidance and assistance. There is a profound lack of materials that clearly articulate this information.
4. *IPM information not easily accessible*. The information is complex, there is no easily accessible hub or database of information for current or potential adopters to access.
5. *Upfront costs of IPM are intimidating*. There is an initial investment required, a fear of failure, and the beneficial financial results are often not immediate.
6. *General public believes organic is the solution*. Organic farming is a well-known approach with high acceptance and demand, it is well-branded, messaged, and supported. IPM (within the context of conventional agriculture) may use targeted synthetic pesticide use, and so cannot be classified as organic.

The stakeholder focus group identified the same or similar challenges as the students and this parity between both groups, specialists and non-specialists, confirmed that the studio process was effective at quickly getting students up to speed.

Key Messages

As the students developed their final proposals, they identified a number of Key Messages, or attributes, that the proposals should address and reinforce for a successful outcome. Key Messages are based on identified challenges and act as starting points to reference as campaign proposals are developed:

1. IPM is the holistic future of farming.
2. IPM is not a 'one size fits all' process
3. IPM is a mindset
4. IPM is a process, not a product
5. IPM is sustainable
6. IPM is an investment
7. IPM is profitable

Proposals

To create a culture of IPM in Iowa, the students presented five main proposals. Each proposal reflected the Key Messages identified and addressed a specific audience. Three of these proposals were chosen as primary focus areas to continue during the spring semester.

Approach 1: Moonshot

This proposal is an aspirational call to action to create an IPM movement within the state of Iowa with the goal of having 75% of farms practicing IPM by 2025. It includes a branding system (Figs. 4 and 5), an inspirational statewide campaign, and a short film that used the poem 'Pioneers! Oh Pioneers!' by Walt Whitman as an analogy to the space race of the 1960s to position rural America as the next great frontier.

The moonshot campaign is designed to invigorate public interest and curiosity, galvanize a sense of pride toward IPM, and to derive the same amount of astonishment as former president

Fig. 4. Moonshot proposal Ground Control identity specifications.

Fig. 5. Moonshot 75x25 proposal billboard application.

John F. Kennedy's moonshot campaign of the 1960s in the United States. It intends to use IPM for a better tomorrow, starting with the soil.

Audience: Farmers, landowners, consumers, and agricultural corporations

Proposed Components:

- 'Ground Control' identity system
- Mission patches for participants
- Pioneers! O Pioneers! Walt Whitman short film—a call to action
- 75x25 Ad Campaign
- Local and State government initiatives and competitions

Approach 2: Pest Patrol

Pest Patrol focuses on providing experiential learning for children that allows them to engage with the principles of IPM in a fun, community-building way. It is designed to spark an interest in IPM among youth and educate about IPM practices in a creative way: activities undertaken result in the earning of merit badges or other rewards while youth learn about IPM and improve the neighborhoods in which they live (Figs. 6–8). This approach also creates a community of elementary students who will be more aware of food origins and needs related to food security.

Audience: K-6, 4H, Future Farmers of America, and Extension and Outreach

Proposed Components:

- Pest Patrol identity system
- Pest Patrol achievement badge system and award ceremonies
- Pest Patrol merit badge handbooks
- Pest Patrol day camps, workshops, and immersive IPM scouting experiences

Approach 3: Future Farms

The Future Farms proposal directly addresses the next generation of farmers and creates an immediate and recognizable visual system that clearly identifies IPM adopters (Figs. 9–11). This identity system would be similar to the Century Farm signage at farming operations that celebrates family ownership of a farm for 100 or more years. Future Farms signage would celebrate farms and farmers that use IPM practices. It also is an educational and promotion vehicle for IPM.

Audience: The next generation of farmers, elementary and high school students

Proposed Components:

- Future Farms identity system
- Future Farms signage and identifiers for adoptees increasing visibility and awareness IPM practice

Fig. 6. Pest Patrol identity (left); Pest Patrol merit badge application (right).

Fig. 7. Pest Patrol merit badges.

Fig. 8. Pest Patrol activity book.

- Future Mini-Farms for immersive field trips and field day experiences
- Mobile Future Farms IPM Lab allowing Extension and Outreach to take their IPM message on the road to schools, camps, and communities

See Supplementary Materials (Supp Figs. S1–S7 [online only]) for additional proposals and other supporting project materials developed as part of the studio course by undergraduate design students.

Fig. 9. Future Farms identity.

Conclusions

Some of the most important outcomes of this project include the non-specialist identification of six IPM Challenges and the development of seven Key Messages for IPM communication efforts. Focusing on Key Messages in future IPM communication projects may serve as a way to more successfully impact intended stakeholders and increase IPM adoption.

A primary conclusion drawn by ISU COD students participating in this project was that IPM may benefit from a rebranding or renaming, as it is difficult for potential consumers and users to understand and identify. Similarly, Dara (2019) suggests updating the concept of IPM for a modern appeal. Dara (2019) also suggests that extension should focus not only on educating farmers about IPM, but also on consumers who drive demand and thus influence the production of food. Likewise, several of the design interventions proposed in this project by non-scientist design students are directed at consumer and public education for just this reason. It is interesting to note that both 'novices' (ISU COD students) and experts (authors of this manuscript, Dara 2019) have identified a unified need for a better public understanding of IPM, coming to similar conclusions about what is necessary to move IPM forward. Furthermore, partnering with design faculty and students, who specialize in visual communication to stakeholders, is an example of focusing on the 'human aspect' needed to increase IPM adoption, as outlined by Gott and Coyle (2019). This is especially apparent in design outcomes such as the Moonshot campaign and Future Farms identity system, which are designed

Fig. 10. Future Farms billboard application.

Fig. 11. Future Farms identity signage on a variety of platforms, including educational field signs and participating farm labeling.

to galvanize a sense of pride toward IPM and the celebration of farms using IPM, respectively.

This work has shown that it is possible to create a culture of innovation in an interdisciplinary design studio utilizing a collaborative model in which educators, students, and subject matter professionals work as equal partners, collaborators, and investigators. Giving primary creative responsibility to students led to unique design outcomes and provided a unique educational experience for the students. It required engaged student designers and artists who saw the value of a nontraditional studio experience in which they were given the responsibility of synthesizing, defining, and developing strategic approaches to complex real-world projects such as IPM.

We did not conduct a formal survey of students before or after the process. However, at the beginning of the course, we informally questioned students about existing IPM knowledge. Even those whose parents were farmers had no previous knowledge of IPM. By the end of the course, they understood the concept of IPM and its importance to a sustainable future, and they were excited to create work that advocates for the practice.

Stepping outside the boundaries of the traditional design-for-hire client model and committing resources to an unfamiliar process-based methodology focused on a communication problem rather than the final design products was crucial to the project and learning outcomes for the students. Due to positive studio outcomes and student feedback, a similar curricular and studio experience would be well received. This model could be applied to research teams and programs across university systems through the creation of an ongoing interdisciplinary program or center based on this initial collaboration.

The results of this project show that there exists great potential for interdisciplinary partnerships to help inform the best ways to communicate important IPM information to stakeholders and the public. The next step in this process may be to implement student-devised design outcomes as part of IPM communication strategies.

Supplementary Data

Supplementary data are available at *Journal of Integrated Pest Management* online.

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