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PROBLEM FRAMING IN THE AGE OF DATA ANALYTICS

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ABSTRACT
This paper provides a way to bring together qualitative and quantitative methods to investigate how data analytics could offer an additional perspective to framing social innovation design problems in the classroom. Using data analytics to complement current design research methods could be useful to identify, frame, and address complex societal design challenges more effectively. This methodology can also support design educators who are interested in social issues to frame projects for their students considering real implications and potential impact in an objective way. This paper describes a social innovation studio project sponsored by the Episcopal Farmworker Ministry in North Carolina, in which students applied human centred research to address hydration needs of tobacco seasonal migrant workers in the field, who come to the U.S. from Mexico. The results of this analysis suggest that qualitative methods could benefit from data analytics to develop framing design problems from a comprehensive perspective.

Keywords: Problem framing, problem framing in the classroom, data analytics, social innovation.

1 INTRODUCTION

Designers are increasingly called upon "tackling open, complex, dynamic and networked problems because expert designers deal with the new types of problems in the professional field without too much trouble" [1]. Businesses and business schools are looking at "design thinking methods" as alternative approaches for innovation in the context of complex problems. One of the methods at the core of "design thinking" is the human centred approach to problem solving. The goal of placing the user at the centre of the inquiry is for the designer or team to develop empathy and a deep understanding of the unmet needs (physical and emotional). This is accomplished by a variety of methods borrowed from psychology and the social sciences. The objective of this approach is to challenge the development team to consider multiple perspectives that go beyond their own understanding of the problem and their idea of what is needed or desired. These methods have proven compelling in the context of physical products. In the context of complex social, cultural and political challenges, the human centred approach along with other design thinking methods while inspirational, have yet to prove effectiveness in practice [1]. Early user research can inform and inspire design directions but the results of ethnographic research alone in some cases does not provide sufficient information to generalize outcomes due to its limitations on sample sizes, reproducibility and potential subjectivity. One additional challenge is the limited training designers possess in the social sciences. According to Norman (2010), *"designers have become applied behavioural scientists, but are woefully undereducated for the task. Designers often fail to understand the complexity of the issues and the depth of knowledge already known"* [2]. This is especially problematic when addressing social innovation projects specifically in the classroom.

Over the past decade, there has been a significant increase in student and institutional interest in social innovation and social entrepreneurship educational programs. This trend centres on the influence of Millennials, who as a generation, are considered universally more engaged in social activism than any other generation in the history of U.S. [3]. It's possible the increased globalization of the campuses has contributed to the interest in social innovation as well but there are still many unanswered questions about the ethics and sustainability of these type of programs as they exist today. Are our students prepared to address a range of issues, including hunger, homelessness, poverty, illness, and violence?

Design and the use of design thinking methods in the context of social innovation has also been trend that is seen in new academic programs from MBAs to MFAs around many universities in the U.S. This is a great opportunity for designers to make positive impact in society but there is a need to acknowledge the limitations of the design thinking methods not only in the professional field, but also in the classroom. Students express enthusiasm in participating in projects that "do good." They want their efforts to make a difference in someone's life but that enthusiasm should be met by design educators with a clear "framing" and structure for how to appropriately and responsibly approach the design challenge. It's important that the design faculty fully understand the issues involved and that they are able to formulate the assignment within the scope of what the students can accomplish while acknowledging the limitations and constraints. According to David Scobey, Executive Dean at The New School for Public Engagement (N.Y.), "*students should learn about all sides of an issue in historical terms, understand the communities and people involved that are already working on the issue, and have an objective understanding of existing solutions already at play. Without this "homework" the context and complexity of an issue will be lost and the potential for long-term damage is high."* To this end, the use of ethnographic methods in design assignments can support the students in engaging with the community and the people they are trying to serve, but in the context of an academic environment, the length of the project, the access to the users and the limitations of the ethnographic research in terms of reliability, make an objective understanding extremely difficult. In the context of social innovation, the assumptions made by stakeholders, faculty and students can be detrimental to the groups they are attempting to serve.

The need for objectivity is critical; one way of achieving a balance is by tapping into knowledge that already exists. Data analytics offers new opportunities to cross reference, complement, question or validate conclusions generated by human centred research. Incorporating "big data" in framing complex design challenges by stakeholders, teachers and advanced design students can lead to identifying alternative strategies that incorporate multiple perspectives to minimize confirmation bias and other subjectivities related to the designer's background. In this context, data analytics techniques could be considered as a complement to better understand the wider context in which the problem at hand is developing [4]. The objective of big data analysis is to understand patterns associated with an important segment of a population [5]; to achieve this, this type of analysis relies on the exploration of five different characteristics linked to big data: volume, velocity, variety, veracity and value [6]. By bringing this conceptualization to design thinking, use of publicly available datasets and some statistical parameters can improve the framing of the project, which ultimately could deliver appropriate class assignments and more comprehensive project results.

2 PROBLEM AND PROJECT FRAMING

With the complexity that characterizes nearly every social innovation problem, a limited understanding of the problem can result in different stakeholders having different perceptions of what the problem is. It is also possible that in an attempt to manage the complexity, the problem can be defined too narrowly by addressing a sub-problem and not the issue that may have the most impact. In the case of a social innovation project in a classroom, the stakeholders often include a sponsor (non-profit organization), the community being served, the government (policies), the instructor, the university (curriculum) and the students. These stakeholders may have different perspectives so the framing of the problem becomes a major challenge for the faculty member. Problem framing is in fact one activity/method within the design thinking toolkit. Experienced designers have always been known for creating new solutions where others see none, and finding new opportunities where others see only problems [1]. One of their biggest assets is the way in which they tackle complex or wicked problems by creating frames that allow novel ways of defining the problem. Experienced design faculty are also proficient in the art of problem/project framing but we argue that the research needed to frame and solve a physical product challenge differs from the research needed to frame a social innovation problem in the classroom. The reason is that expert designers as well as expert design instructors frame design challenges by relying on their own unique experience and intuition that derives from knowledge about the materials, processes and methods they use to gather, visualize, devise and implement solutions. Designing class assignments involves a clear understanding of the students' capabilities and needs, acknowledgement of limited resources in terms of access to users, time constraints, ethical considerations and feasibility of deliverables. In the context of social innovation assignments, the complexity of the problem increases, the stakeholders multiply and the

people and the community being served are often far removed from the faculty's sphere of knowledge. This is especially true when the project involves underserved domestic and international contexts.

3 A SOCIAL INNOVATION ASSIGNMENT

This project resided within the second year, first semester of the Industrial Design undergraduate program at North Carolina State University. The studio also included a group of graduate students and involved a teaching collaboration between two senior faculty members and a visiting scholar. The project was sponsored by the Episcopal Farmworker Ministry in North Carolina. The ministry's concern was to enable farmworkers to maintain adequate hydration during the work day. The nature of the farm work in tobacco fields is largely manual. As such, it is extremely physically demanding, requiring endurance, dexterity, and physical strength. Additionally, the majority of the work takes place during the seasons of extreme heat and humidity in North Carolina, with long workdays. The Ministry framed the problem based on their own observations of people at work. They believed that hydration in the field is the primary way to maintain the worker's safety, so the task they defined for the students was to develop a product that would allow workers to carry a water bottle with them at all times. At a glance, the design and development of an artefact that meets the physical requirements needed to hold a water bottle while at work is not a very complex challenge if removed from the context. In that sense, it represented a good vehicle to meet the goals of a second-year industrial design studio. This activity seemed to support the several course goals: introduction to the design process including human centred research, where the students were able to observe, interview and receive feedback on their ideas and prototypes from users. Serving the real needs of a specific population was also a good motivator for the students.

This project seemed like a beneficial collaboration for all stakeholders but for the faculty assigned to frame the problem and structure the course activities and deliverables, the complexity of the context was a major driver to reframe the problem. To that end, the instructors needed to research the context to understand factors such as farm workers' social characteristics, health risks, environmental conditions, policy and access to water and sanitation. This information was necessary to determine the appropriate level of content and complexity in the assignment. In this case, the second year students did not have prior experience with the design process or with basic design research. The primary challenge was to establish a good balance between the design of an artefact that met specific physical requirements and designing an artefact that met the needs of people considered part of a population at risk. The instructors didn't have access to the users prior to the beginning of the semesters so many of those questions could only be partially answered through simple web searches such as census documents, injury prevention programs, the National Institute for Occupational Safety and Health, etc.

After initial research, the primary findings indicated that in the fields, heat related illnesses are a significant cause of death or injury; while hydration is a preventative measure it is not the only one. Health education and acclimation (to gradually increase exposure to warm climates and higher exertion levels with rest periods) are the two major factors in preventing injuries as well as medical and environmental monitoring systems [7]. The scope of the project was then expanded from designing a product to carry a water bottle to designing solutions to prevent heat–related illnesses. The instructors believe that the new challenge allowed the students to explore alternatives that could potentially have more impact.

4 FIELD RESEARCH

After the introduction of the project and preliminary research, the instructors, with the assistance of the ministry, organized two visits to a tobacco farm. The first visit was intended for students to experience the environmental conditions, observe the task of collecting tobacco leaves, the equipment, the water supply and the farm's hydration practices. Interviews were also set up to answer questions about current practices and perceived needs. An on-site observation was not available due to scheduling problems but the farm owner organized a simulated activity with eight farm workers. The students were able to interview the eight participants and observe the process, the methods, the work pace, equipment and actions necessary to collect tobacco leaves. They also observed the methods and artefacts related to hydration and heat illness prevention. The second visit allowed the students to bring preliminary prototypes for user feedback. The same eight workers were available to answer students' questions and to test some of their concepts. The final presentation was given to representatives of the ministry and included concepts that ranged from first aid kits, water bottles,

wearable water pouches, cooling garments and temperature/activity monitoring devices (analogue and digital).

4.1 Conclusions from the field

The students gathered information and arrived at conclusions in the areas of: personal background, hydration practices at one farm, hydration practices by these workers, perception of health and health needs and heat illness literacy. Additionally, the students were able to reach conclusions about the interactions between workers and supervisors.

The farmers interviewed were eight men between ages of 26 and 60. All of them came from Mexico for the tobacco season with special working permits to work in the U.S. In terms of hydration practices at the farm, water was readily available to the workers during the work day. Workers did not express the need for a different system that the one in place. They described themselves as healthy with one of them suffering from diabetes. There was also limited knowledge in regards to Exertional Heat Illness symptoms and prevention. Most of the workers drank water according to the pace set by the tractor that holds the tobacco and not based on their own needs. The role of the supervisor in providing proper breaks is critical but there is no policy to enforce or facilitate this process. There was also no monitoring system for temperature and water intake. The workers rely on each other and themselves to address their needs and not the supervisors or employees. There is a level of mistrust and fear of job loss so the participants were not comfortable during the interviews. In general, students gathered information that was relevant to a few workers from that specific farm and were not able to validate the applicability of their results to other farms or farmworkers. In this particular sample, the problem as defined by the ministry was not as relevant to the participants. The need for a product that could carry a water bottle was not expressed as a priority by this particular group of workers.

5 RELATED LARGE DATA ANALYSIS

After the project was over, the instructors were interested in exploring alternative ways of framing the project to increase the validity of the research and the relevance of the final designs. While the faculty did not intend for the students to produce highly refined solutions, the process raised the expectations of the workers and gave the students the perception that their work could have a direct impact in the life of these workers. The initial research conducted by the instructors gave insights to the problem beyond the water bottle concept but the scope remained limited because of the lack of access to users. In order to have a holistic understanding of farm workers' social characteristics, health risks, environmental conditions, and access to water, the authors decided to include data analytics to see if the results could have better informed the project and/or validate the user research conducted by the students. For this purpose, the National Agricultural Workers Survey dataset—produced by the U.S. Department of Labour—was used. This survey has been conducted every year since 1989, but questions related to the health of farm workers started in 1999 and the latest available information was published in 2012. In this sense, the dataset ranges from 1999 to 2012 and includes answers by 34,456 individuals who at the time of each survey were working as farm workers in the United States. In addition, a general dataset (1992-2006) from the Centre for Disease and Control Prevention (CDC) was obtained to include information related to heat-related fatalities of farmers across the U.S. and specifically in North Carolina, where the target population of this study was based.

5.1 Procedures

Given that the Department of Labour's survey includes questions on a variety of topics that are not related to this study, it was necessary to manually assess and select the variables that can inform about the farm workers social characteristics and the potential health risks they are exposed to. For that reason, the following variables were identified: Personal background (gender, foreign born, indigenous origin, migrants, family income, age, country of permanent residence, legal status in the U.S., race, English proficiency, access to social security benefits, how many years since their first farm work, years doing farm work in the U.S., average days per year working as farmers, and geographic area of origin), water (the employer provides clean water and cups every day and access to toilets) health (does the employer provide insurance, do the workers still get paid if they get sick, asthma rate, diabetes rate, high blood pressure rate, tuberculosis rate, heart condition rate, urinary tract infections rate, use of health services in the past two years, or if the workers have been injured at work) and temperature (average monthly temperatures of the four most common places of origin of the farm

workers, and the temperatures of the farm place in North Carolina).

5.2 Method

The data analysis required the use of statistical measures. The software SPSS was employed to obtain the descriptive statistics that provided a general perspective of the farmers, and logistic regression was also conducted to better understand the possible relationships between the different variables. Thus, with logistic regression it was possible to explore if any of the personal background and water-related variables could predict any health issues among the farm workers.

5.3 Analysis and Conclusions

The data provided by the CDC shows that in the period between 1992 and 2006, 423 individuals died from heat stroke in the U.S.; of that total, 68 persons were farm workers. The heat stroke death rate for the general population is 0.02 per 100,000 people every year, but the rate significantly increased if you only consider farm workers (0.39 per 100,000 crop workers). The latter figure places farm workers as one of the most vulnerable populations in terms of heat related issues. Those farm workers who died by heat stroke were primarily male between 20 and 54 years old. Their country of origin was unknown for 46% of the cases, but in the specific period of 2003-2006 71% of the deceased were from Mexico, Central America, and South America. According to the CDC data, it is more likely for heat-related fatalities to happen in the month of July. Furthermore, of all 21 states in the U.S. that had a death of this type, North Carolina had the highest incidence of heat stroke fatalities.

The analysis of the National Agricultural Workers Survey shows that 79% of farm workers who participated in the study from 1999 to 2012 were born outside the U.S., 20% were international seasonal migrant workers and 22.8% lived below the poverty level. In terms of their status, 51% were unauthorized workers, 23% had a Green Card, and 1% had temporary work permits. 15.9% of all the workers were from Mexico and the main states of origin were Sinaloa, Puebla, San Luis Potosi, and Tlaxcala. In relation to their ability to communicate, 39% of them stated that they don't speak any English, 30% speak a little, 7.7% replied somewhat, and 23% speak English well.

For the health-related variables, of the 34,456 surveys, 74% said that they are provided with insurance and 11% said that their employer does not provide insurance. 55% of the workers still get paid if they get sick, 21% don't get paid, and 23% did not know. Among all the surveys, 3.5% of the population said they have been diagnosed with asthma, 7.4% have high blood pressure, 1.4% have had a urinary tract infection, 1% have been diagnosed with a heart condition. Also, 13.5% of the workers have needed health services related to their job as farm workers and most of them have paid those health services out of their own pocket. In terms of access to water, 6.7% of the farm workers said their employer does not provide water and cups for them, 9.6% have access to water but no cups, and 83% said they do have access to both water and cups.

The logistic regression analysis explored the connection between the health-related variables and the personal background and access to water categories. In this sense, the results suggest that migrants had higher rates of asthma and migrants and foreign born workers were more likely to have diabetes. In addition, those farm workers living below the poverty level were also more likely to have diabetes and those with social security benefits were less likely to have been diagnosed with this disease. It was also statistically significant that foreign born workers were more likely to have a heart condition. Additionally, the analysis of the temperatures where the farm is located in North Carolina and the four main places of origin of migrant workers offered an insight in terms of acclimation. Except for the state of Sinaloa, the average temperature in Dunn, North Carolina, during the harvest season is higher than the temperatures of the rest of the places where most of the migrant workers come from.

6 DISCUSSION

The analysis of the available databases related to this study suggests that farm workers are one of the most vulnerable groups to die from heat related issues. A significant number of workers (13.5%) in the survey have needed health services related to their job as farm workers, but there is no definitive information to conclude that lack of hydration is the main cause but it could be a contributing factor. The biggest problem is not likely to be lack of access to water given that the majority of the employers (93%) offer hydration solutions to the workers. It is possible that the hydration system in place is not supportive of the activities in the field and/or that employers are not offering enough guidelines in terms of water consumption.

In addition, it is relevant that among farm workers those who are migrants and foreign born are more likely to have been diagnosed with one of the health conditions listed in the survey. Another key element that might be increasing the risk of farm workers is related to the temperature of the work place and where most migrant workers come from. In this study, it was established during the qualitative research that the farm workers were originally from Mexico, and using large datasets it was determined that most of the workers from Mexico are originally form the states of Sinaloa, San Luis Potosi, Puebla, and Tlaxcala. In this sense, an important element of this study is that except for the state of Sinaloa, the workplace in North Carolina had higher temperatures than the places where most of the U.S. farm workers coming from Mexico originate.

The study suggests that beyond designing a device for the workers to have water at all times with them, there could be also a need to develop acclimating programs to gradually increase workers' exposure to the extreme climate and higher exertion levels. Along those lines, migrant and foreign born workers are more likely to have a heart condition and suffer asthma and diabetes. These conditions increase the risk for heat related illness so health literacy and additional monitoring systems for those at risk could have significant impact. Finally, the data analysis suggested that almost 40% of the farm workers in the U.S. do not speak or understand English, which could be another variable affecting the hydration patterns of crop workers, therefore providing information and training in their native language could also make a difference.

7 CONCLUSION

In terms of the class project framing, the new data suggest that product based solutions (portable water devices) offer limited impact in terms of heat related illness in the larger community, especially if they are not connected to a system that includes factors such as health literacy, monitoring systems and acclimation. If the objective is to improve the conditions for the farmers served by the ministry, all these factors need to be taken into account. Advanced design students are more prepared to address some of these complexities but this type of project could benefit from a multidisciplinary approach. If the objective shifts to giving entry level design students experience in conducting user centred research, then developing a low-tech solution for this particular farm could be a more honest direction.

The use of data analytics by faculty members to frame a social innovation projects in the classroom has the potential to make significant impact in the design and development of appropriate solutions for the communities by the students interested in outreach. In the case of this particular project, we only analyzed data related to farm workers and did not include other populations that are at risk for exertional heat illness such athletes or military personnel. Data analytics opens up a wide range of possibilities for designers and for design education. Developing courses where students can learn how to apply and combine user centred methods with data analysis may be the next challenge for design education.

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