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Academia-industry collaboration as an emerging model of design research: An examination of the Steelcase – Mayo Clinic case

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ABSTRACT

Although the field of design research could potentially gain from collaboration between academia and industry this approach to research has not received much experimentation or scholarly attention. Design outcomes research, the primary objective of which is to examine the outcomes of designed artifacts when implemented, is one of many potential foci of design research that could benefit from such collaboration. However few models of successful collaboration exist and there is little knowledge about how such collaboration can work, what could go wrong and what safeguards might be implemented to increase the chances of success. This is a case study of a design outcomes research collaboration between an academic unit, the Mayo Clinic, and a corporation, Steelcase Inc. The study traces the evolution and describes important details of the collaboration process.

keywords: academia-industry collaboration, design outcomes research

1. INTRODUCTION

The resurgence of design research offers some new opportunities for academia and industry. Nigel Cross (1999) offered three categories of design research: 1) design epistemology: the study of the designerly ways of knowing), 2) design praxiology: the study of the practices and processes of design, and 3) design phenomenology: the study of the form and configuration of artifacts. An additional category includes the examination of the effects of human interaction both with and mediated by designed artifacts. Several scholars have pointed to the importance of design research that addresses both the artifacts in use and the user (Friedman 2000, Roth 1999). For lack of a standard phrase for this type of research we refer to it as "design outcomes research."
The goal of design outcomes research is not necessarily to impose scientific values on design but rather to use academic research methodology to uncover effects and mechanisms involved in human activity mediated by designed artifacts. Several models of such research are available in environmental design research, such as post occupancy evaluation (POE), where investigators study the effects of buildings once completed and occupied (Preiser et al 1988; Zimring & Reizenstein 1980; Seidel 1979). However, in this approach a building must be designed, constructed, and occupied. This is both time intensive and expensive and the results, though potentially useful for future projects, have minor impact on the existing building.

Design outcomes research is a potential source for research collaboration between academia and industry because it requires interdisciplinary teams in which the participants have a pertinent expertise. Design practitioners, mostly in industry, have expertise in the design and realization of products. Researchers, mostly in academia, have methodological expertise to investigate the social, cultural and/or behavioral effects of these designed products or systems. There are examples of this type of collaboration in the fields of science and technology (Nelkin, Nelson and Kiernan 1987), but few in design research.

Mayo Clinic and Steelcase Inc. have collaborated on a design outcomes research study, called the SIT Trial, to investigate the extent to which the design of the clinical exam room affects patient-physician interaction. This paper describes this case of industry-academia collaboration on a design outcomes research project (Fig. 1) tracing the process and negotiation involved in this collaboration.

Figure 1. The domain and context of this case study

Because there is little knowledge about academic industry collaborations in design research the primary aim of this case it to describe process of the collaboration. This focus revealed what worked well and what went wrong. Further, the case offers a potential model for design research based on a critical analysis of both the successes and challenges of this collaboration.

2. ORGANIZATIONS INVOLVED IN THE COLLABORATION

The two main parties in this collaboration are Mayo Clinic and Steelcase. Both of these organizations are large and have strong missions, values, and cultures. They are composed of smaller departments and units with their own goals that serve the institutional mission. This is important because the negotiation of this collaboration occurred on a number of levels including the institutional level (legal, ethical) and research groups level (intellectual, logistical, physical).

2.1 MAYO CLINIC

Mayo Clinic, located in Rochester, Minnesota, is one of the largest healthcare facilities in the world. It is not a traditional university, but an academic medical center with both a medical school and graduate school. It is a non-profit institution with three main objectives: health care, research, and education. Their mission statement is as follows:

> "Mayo Clinic will provide the best care to every patient every day through integrated clinical practice, education and research" (Mayo Clinic Web Site, 2007).

The majority of the research pursuits at Mayo are academic in nature. The academic studies that reach the public realm through publication are all subject to IRB (Institutional Review Board) approval and peer review. Government, nonprofit, and industry (mostly pharmaceutical and device manufacturing companies) funding support biomedical research at Mayo Clinic.

Mayo Clinic has institutional policies to protect the integrity of the research and of the participating parties in industry-funded research. The Office of Medical-Industry Relations interprets and applies federal guidelines as well as Mayo Clinic policy and guidelines to professional relationships involving intellectual property where Mayo staff interact through a contractual basis with corporate sponsors or commercial firms. The Medical-Industry Relations Committee independently reviews all industry-funded research studies seeking to protect the privacy of research participants (including patients), and to examine and manage potential conflicts of interest.

The Knowledge and Encounter Research (KER) Unit is a laboratory at Mayo Clinic. The KER Unit's mission is to translate

> "the best available research evidence into clinical practice through evidence synthesis and through enhancements in the patient-clinician encounter, to contribute to evidence based medicine and to better understand the clinical encounter and especially the shared decision making process between patient and physician" (Montori Lab Web Site 2007).

The KER Unit is a multidisciplinary laboratory with open membership that values collaboration. Participants include physicians and nurses, patients, social workers, research personnel, anthropologists, librarians, statisticians, and designers (from SPARC, see below). The atmosphere in this laboratory is entrepreneurial, iconoclastic, and curious. Their work has been published in top medical journals. Their interest in improving the outcomes of the patient-clinician interaction and their expertise in the design of quantitative and qualitative studies of this interaction, including experimental designs, made them key participants in this collaboration.

The SPARC Innovation Program at Mayo Clinic opened in 2004. SPARC is an important institutional component in this case. SPARC employs designers and business professionals. Both these groups work together to achieve SPARC's goal to realize new insights in healthcare delivery at Mayo Clinic. The focus of their work is to innovate the service experience, environment, work

process, and systems using design thinking, design research and strategy. The director of operations and design at SPARC has developed a strong relationship with leaders at Steelcase and played a central role in the initiation of this collaboration. The director of research at SPARC also initiated the KER Unit and SPARC designers are frequently involved in KER Unit projects, thus affiliating the two laboratories. Another important aspect of SPARC is its physical infrastructure. The SPARC space includes clinical exam rooms and is located in a corridor of the Division of General Internal Medicine. This location assures access to real clinical encounters between patients and clinicians in these exam rooms. These rooms can be easily repurposed and redesigned and include video cameras to observe in real time and to record the nature of the visits. The inclusion of a live clinical environment makes SPARC a very unique program that enables design research.

2.2 STEELCASE INC

Steelcase Inc is the world's largest office furniture manufacturer. Founded in 1912, Steelcase began innovating in the office environment by manufacturing metal wastebaskets as an alternative to the typical straw wastebaskets that posed a fire hazard. In the years since, Steelcase has grown its portfolio to include furniture, interior architectural elements, and technology. Steelcase's mission is "to provide a better work experience" through their vision of "Focusing externally... understanding the needs of users, facility managers, architects and designers and dealers better than anyone else" (Steelcase Inc. Web Site, 2007). To this end, Steelcase has a group called WorkSpace Futures (WSF) that conducts research on work, workers, and workspaces. The Explorations team within WSF is composed of design researchers who are dedicated to understanding different vertical markets, such as higher education, professional services, and healthcare.

Designers with the Explorations team conduct user-centered design research using a six-step process: Understand, Observe, Synthesize, Realize, Prototype, and Measure. The Understand phase includes secondary research to develop an intellectual frame of reference so the researchers are familiarized with their subject before they conduct primary research in the Observe phase. Designers employ design ethnography to identify the tacit and latent needs of the users. Data is recorded through interviews, still photography, video, and field notes. Participatory design sessions are also conducted with users to learn more about their aspirations and preferences. They use analytical frameworks to synthesize the findings into key insights and design principles. These frameworks guide ideation in the Realize phase. Ideas from this phase can then be prototyped and tested in subsequent phases. Levels of prototyping and testing vary from rough foam core models used to elicit preliminary user feedback to full-scale mockups that use formal research methodology.

This process is both scalable and iterative. It can be used to understand a large systemic work environment, such as a hospital, or a smaller environment, such as a private office. It is iterative in that the information that is uncovered during the six steps both add to the understanding of the problem and raises more questions for further exploration.

In 2006, Steelcase launched a new company called "Nurture by Steelcase". Its origins go back to work done by WSF four years earlier that helped to build a business case for Steelcase to pursue clinical areas; previously, Steelcase had only outfitted administrative (on-carpet) areas in healthcare. An internal Steelcase document stated that Nurture's vision is to

> "shape and improve the future of healthcare delivery. Nurture concentrates on space and environments and how products within those environments can help make them more comfortable, more efficient and more conducive to the healing process"

Nurture's foundation occurred in the context of Evidence-Based Design (EBD) within healthcare. Practitioners of EBD apply the best findings from research and project evaluations to design healthcare facilities with the goal of improving outcomes. These outcomes can include patient health, efficiency, and satisfaction, among others.

3. THE PEOPLE

Each team involved a senior and a junior member. The Steelcase team included the director of WorkSpace Futures Explorations and a design researcher and the Mayo team consisted of a physician (director of research at SPARC and principal investigator of the KER Unit) and a research assistant. These team members incorporated, as needed, the expertise of other members of their respective teams in the design and conduct of the research. These key players in the collaboration will be referred to in the negotiation process and in the planning of the study.

4. EVOLUTION OF THE COLLABORATION

In 2002, two Mayo Clinic physician leaders began to question why there were research and development labs for clinical science but not for the delivery of care. They initiated the planning and development of care delivery "R & D capabilities." Early on, design research was considered a core capability. They conceptualized the mission for a new program (SPARC) and contracted IDEO (a

Steelcase subsidiary) and Steelcase to design its facilities. This initial project formed the foundation for future collaborations between SPARC and Steelcase.

In summer 2005, WSF began a research project on outpatient care delivery. In an unpublished document they stated that their initial goal was to

> "advance practices in Outpatient Care through process, space, and product design, thereby enhancing the physician, staff, and patient experience."

The scope also stated

> "Solutions developed will improve the typical outpatient care service floor of large, general, integrated facilities that offer multiple services. Applications of solutions will be scaleable to serve more specialized practices."

A team of five researchers sought to gain access to healthcare facilities around the country to conduct observations. Because of Steelcase's preexisting relationship with SPARC, Mayo authorities granted them access to its facilities.

At the same time, Mayo's SPARC was beginning its own research effort called the "Plummer Project". In an unpublished document they state that their goal was to

> "optimize support for the physician in delivering high quality care by identifying opportunities and implementing a stream of integrated innovations in the areas of efficiency, teamwork, technology and communication."

Through conversations, SPARC and WorkSpace Futures decided that the two projects could and should be conducted in parallel, with the teams meeting at the end of each phase of the six-step design research process to share their findings. In August 2005, the teams met for a charrette at Mayo. A number of groups from Mayo including, physicians, patients and administrators, were asked to give feedback on concepts for the design of an outpatient clinic that could improve workflow and patient experience. A full-scale foam core model of an outpatient clinic featuring product and service concepts was built in unoccupied and unfinished space within a new clinic building. Design researchers at Steelcase used this month-long initial user evaluation to make decisions regarding which products to select for further development. SPARC designers gained important insights towards the formulation of new internal work flow processes. This exploration created the opportunity for the lead researchers of Steelcase's WSF, SPARC, and the KER Unit to work together.

The conceptual redesign of the exam room environment, specifically the work surface used by the doctor for reviewing patient charts, attracted the team's attention. In their observations, the

Steelcase researchers discovered that the way in which patients and clinicians sat often impeded the physicians from sharing information with the patient. In some observations, researchers saw doctors offer their own seat at the desk to the patient to allow them to view their records, and at other times, patients crowded around the doctor or craned their necks to try to see the computer monitor.

A half-round table was designed to better support patient-clinician-computer interactions, to enable equal access to information, and potentially decrease the hierarchical nature of the interaction. It was designed to become an element of an innovative free-standing furniture system Steelcase named "Opus". The Steelcase research team was interested in further pursuing research on this environment for several reasons: (1) to test whether their design visions would prove accurate; (2) to enrich their research with new methods learned through collaboration with medical researchers; and (3) to contribute a robust and reliable process to the growing body of evidence-based design.

Meanwhile, the KER Unit had been working on projects to understand the patient-physician interaction. While analyzing videos from a study measuring the effect of a graphical aid to help patients and clinicians make a key preventive decision, one of the research assistants noticed a difference in eye contact in rooms equipped with a mobile table (rather than a fixed desk). The KER unit members approached SPARC's director of operations expressing interest in a collaborative study to understand the effects of the environment on the patient-physician encounter. The SPARC director was aware of the interest that Steelcase researchers had in partnering with an academic institution to research the extent to which their new designs affect the interaction between the patient and the physician, and connected both parties. During a series of conference calls, it became evident that the KER Unit and WSF's agenda and research interests were aligned and the process the Mayo Clinic-Steelcase design research collaboration began.

5. INSTITUTIONAL AND GROUP NEGOTIATION

5.1 FACTORS IN THE NEGOTIATION PROCESS

During the negotiation process it became apparent that this project was different from Mayo's previous academia-industry collaborations such as pharmaceutical research and R & D projects. Resolving intellectual, financial, ethical, and spatial matters took several months.

5.1.1 INTELLECTUAL

Intellectual and educational pursuits were the primary focus of this collaboration. Both groups were fundamentally interested in improving the clinical encounter (especially for the patient), to do high quality research, and to contribute to the academic literature. The Steelcase team, from the beginning, was highly motivated to learn about this type of research method and to conduct the research study. Each group was also very interested in learning from the other. Thus, strong interest in intellectual exchange and sharing was and remained the central goal in this project.

Pharmaceutical research collaboration is typical in the academic medical setting. In those collaborations the pharmaceutical company initiates the study, solicits an institution or researcher, and provides funding and equipment. The researcher then carries out the study under the supervision of the pharmaceutical company and reports to them. That collaboration is more akin to sponsorship and involves little intellectual exchange (in the past and rarely now, industry-academic projects involved true scientific partnership and collaboration). Increasingly, pharmaceutical and device companies have control over study data and their analyses limiting the ability of academic scientists to disseminate in an opportune fashion the findings, particularly if these are unfavorable to the sponsor. The model of collaboration between Mayo researchers and Steelcase described here resembles more traditional academic-pharmaceutical partnerships in which researchers from industry and academia share similar questions and partner intellectually to find and disseminate the answers.

5.1.2 FINANCIAL / ETHICAL

Several financial and ethical issues needed attention and agreement. Resources were necessary to conduct the study and applying for grant funding would have delayed the process. Steelcase was willing to fund the research. They were clear that they wanted to make not just a financial investment in this study but also an intellectual one. Nevertheless, this funding arrangement necessitated decisions about the integrity of the research. Potential and perceived conflicts of interest needed to be addressed. The study would also have to be approved by Mayo's Institutional Review Board (IRB). Agreement was required for public dissemination of research findings, whether favorable or unfavorable to the parties. Mayo had a strict policy regarding use of their name especially related to potential in advertising or sales. The main point of contention was the way Mayo perceived Steelcase might use their name when publicly discussing the research and its findings. While Steelcase wanted to disseminate information about the research project, Mayo had

concerns that this would be perceived as Mayo Clinic's endorsement of the product. Ultimately, the parties reached an agreement where the academic dissemination of the findings was prioritized; Mayo Clinic had control of the data, analyses, and dissemination while allowing Steelcase to discuss the work publicly.

5.1.3 SPATIAL

The decision to select The Mayo Clinic as the spatial location of the study was easier. Mayo had access to a large population of potential study participants, both patients and physicians. The Clinic also has the appropriate ethics infrastructure to ensure academic standards and research integrity. Further, SPARC has up to seven rooms that could be used for research experimentation and projects. SPARC was able to release two clinical exam rooms for redesign and use in the study.

Geographical distance was a major spatial challenge. Mayo is located in Rochester, Minnesota, and Steelcase in Grand Rapids, Michigan. The team had to determine how to meet, make decisions, when to work separately, and when to work together. An additional challenge occurred later when the junior KER Unit researcher moved to Southern California. This created a greater strain on the already existing difficulties related to geographical distance and time constraints. Even negotiating meeting times became a challenge across three time zones. Email, which became the primary mode of communication, and phone calls between junior members of each group kept the planning efforts on track.

5.2 NEGOTIATIONS ON THE RESEARCH PROTOCOL

The topic and formulation of the study required extensive negotiation. Three initial research interests were: (1) a positivist method to measure the extent to which the design of the exam room would affect the long-term health outcomes of the patients; (2) to see if the use of a decision aid and the physical environment would improve patient's adherence to medication more than a decision aid alone or the room alone; and (3) a qualitative method involving interviews and observation (video analysis) to examine how the room was used, how the patients and physicians worked in the space and how it affected the conversation, eye contact, etc. There was discussion about methods, scope of the research, about complexities in studying decision-making and behavioral aspects of medication adherence, physician-patient interaction, the influence of design, and what was reasonable to include in the study. The team decided on a mixed method approach

focused on the effect of the room on the patient-clinician interaction. In this way all, common interests, goals and research preferences were addressed in this plan.

During the negotiation process the senior members were the initiating force while the junior members were the glue that held the study together. The junior members assured that the daily needs of the project were attended to and communicated on a regular basis. The senior members provided institutional knowledge, vision, and safeguarded the interests of their respective institutions. The combination of good communication and mutual trust and respect between senior and junior members within the groups facilitated realization of the study.

5.3 CHALLENGES IN THE NEGOTIATION PROCESS

Several major challenges emerged during the negotiation process for this relatively uncharted collaborative project. Mayo's prior experience with the pharmaceutical and device industry had produced a model, but it did not address all concerns thus not constituting a good fit. Legal and proprietary issues had to be negotiated at the institutional level. This separation, though necessary, was a vexing experience for the team trying to facilitate and commence the collaborative venture. The most difficult negotiation was regarding the ownership and use of data. Trust within the group related to how the data would be used was high. However, Federal, State, and Mayo's institutional level policies concerning patient privacy required confidentiality and de-identification if data were to be shared with others outside of Mayo. This would have been nearly impossible to accomplish with the video recordings. It was finally decided, as a result of the privacy issues, that Mayo would own the data and Steelcase would have access to it within the Mayo campus.

5.4 OTHER CHALLENGES

Several practical factors slowed the collaboration. There was a long delay in obtaining the statistical analysis plan. Because the survey created by the group had not been previously validated it was necessary to conduct a small pilot study and to calculate the sample size.

Time allocation by team members was an issue. No team member was assigned 100% to this project. As a result, commitment to this had to compete with that to other projects. This coupled with the geographic distance, made time and coordination a great challenge. Had there been

dedicated personnel at both partnering organizations, the project may have moved much more quickly.

6. THE SIT STUDY

6.1 SIT STUDY DESIGN

The Space and Interaction Trial (SIT) is a study to research the question: to what extent does the design of the clinical consultation room affect the interaction between the patient and physician? The attempt is to measure, using a randomized controlled experimental trial, the extent to which a newly designed clinical room, compared to a usual room, affects the patient-physician interaction.

This outcome will be judged by: (a) videotaping encounters; and (b) conducting post-visit surveys with both physicians and patients using both qualitative and quantitative tools. Patients will be recruited from Mayo's Division of General Internal Medicine. On signing consent forms they will be randomly assigned to either room for their consultation. Post-visit data will be collected and later analyzed.

This is an innovative study because it is difficult to control the designed elements of a space to the extent that the difference can be measured. The purpose and function of the rooms are specific and the scale of the study is such that measurement is possible. However, one issue raised by both groups is whether the patient and physician spend enough time in the clinical exam room for the effect of the design to be noticeable. The exam room is an important locus for patient-physician interaction and it was decided that the length of time was not as important as the nature of the interaction.

6.2 THE ROOMS

Two room design configurations are used. Steelcase had researched usual exam room designs across various medical institutions and what might be typical arrangement of furniture and placement of the computer monitor. The most common arrangement wherein the physician and patient sit laterally and the computer monitor is placed in front of the physician is referred to as the "typical room" by the team (Fig. 2). In this layout the patient may also be sitting on the exam table during the visit.

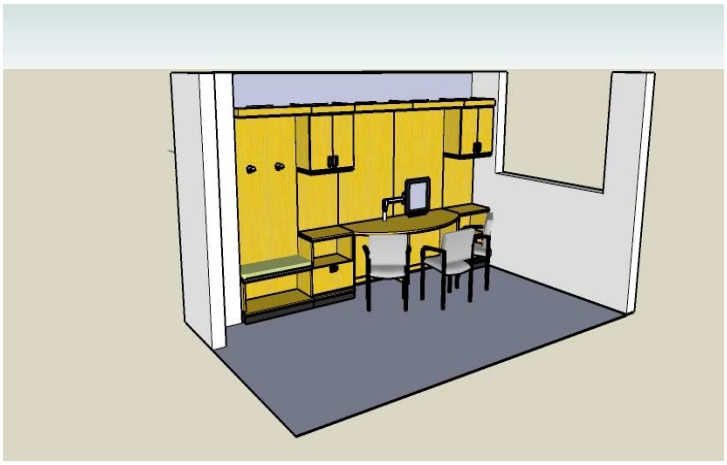

Figure 2. The experimental room

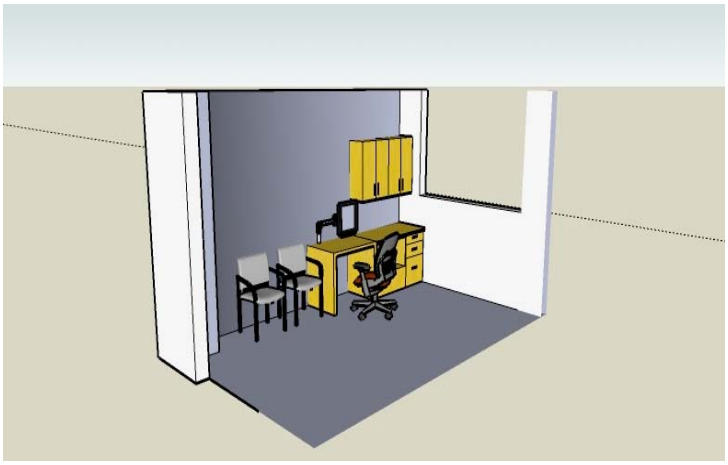

Figure 3. The typical room

The newly designed room has a half-round table design, a significant change from the traditional rectangular desk (Fig. 3). Several anticipated advantages to this design include the following. First, it is not clear which seat "belongs" to the patient or physician. Ideally, the patient would choose a seat first and the physician would then adapt his/her choice. Second, the half round table facilitates a choice between a shoulder-to-shoulder or semi face-to-face seating arrangement. The chairs can be moved to accommodate the preference of the patient and physician. This design resulted from observing many interactions in which the patient and physician would work around built-in furniture to create an arc around the computer. Third, this design also allows more open access to the computer screen through use of the adjustable arm monitor (pivoting at the axis of the semicircular

table) and wireless keyboard and mouse. Fourth, and most importantly, this seating arrangement aims to diminish the divide between patient and physician space. Lack of clear demarcation of "sides of a table" makes it accessible to both users.

7. DISCUSSION

What lessons can be drawn from an experience? Analysis of this case leads to learnings on two levels we discuss below: a) those specific to the Steelcase-Mayo case; and b) those related to academia-industry collaboration on design outcomes research.

7.1 CASE-SPECIFIC LEARNINGS

For the SIT study, collaboration was the best option because neither group, on its own, was equipped to answer the research questions. The KER Unit personnel lacked the experience to design, build, and equip the clinical rooms. Steelcase did not have access to the patient-physician population, and was ill equipped to conduct sophisticated research design and analyses. Additionally, in-house research may not have the rigor and apparent and real protection against bias that an independent research partner can provide.

Several aspects of this case worked well. Prior history of mutual interests and a long and positive research relationship between Mayo (SPARC) and Steelcase helped this collaboration. For two institutions, driven by non-identical missions to collaborate, the individual, social, and organizational relationships become crucial. Some of the key players in this collaboration had strong relationships built on trust and respect. Importantly, the organizations provided time and resources to enable key relationships to evolve and grow over time.

The personnel contributed significantly to the collaboration working well. The people involved were familiar with each other and had worked together. The somewhat long term connection and familiarity between members of both parties aided communication, mutual valuation and respect, and perhaps even trust. Their guarded optimism led to search for solutions to the problems rather than abandonment of the potential project. Also helping were strong commitments from those in charge on both sides, and hard work by the team. Thus, the core team was well matched and worked well together.

The groups shared fundamental goals. The Mayo team aimed at conducting important, valid, and rigorous research focused on studying the impact of interventions on the patient-physician experience. The Steelcase WSF team was interested in testing their new products using reliable research. With this as a base, negotiations could occur on numerous differences and challenges. These included thorny issues related to conduct of the research, data ownership, and publication of results, among others. Additional concerns were Mayo's interest in numerous safeguards for human subjects (addressed by their IRB), for legal and ethical issues in dealing with industry (domain of the Medical Industrial Relations Committee), and those generated due to Steelcase funding the research and Mayo being the site of research. However, these presented opportunities for thorough reflection and development of safeguards. Many problems thus became opportunities and the deep-seated cultural values on both sides could be respected and implemented.

Organizationally, their approach seemed to have worked well. They did not conceive of this collaboration between an organization from academia and one from industry with the sole focus being this study. It became clear that this project was a new approach to industry-academia collaboration. The KER Unit and WSF are organizational units carrying the cultures of their host organizations but were nonetheless explicitly interested in collaboration and on working out the issues related to ethics, human subjects research, research quality, funding, publications (public domain knowledge), and potential use of knowledge produced by such collaboration for private gain. Another critical organizational component of this collaboration was the central role of SPARC, the design innovation program at Mayo Clinic. SPARC balances and negotiates a variety of different relationships; they are located in an academic institution and they are able to maintain strong ties with industry. The director of SPARC was a broker to the initial collaboration and played a central role in facilitating this collaboration. Additionally, SPARC facilities served as the optimal site for the research.

7.2 DESIGN OUTCOMES RESEARCH RELATED ACADEMIA-INDUSTRY COLLABORATION

From a singular case, it is not sensible to generalize, but it is reasonable to offer considered propositions that might be transferable to other similar instances. This study reveals that it is important to carefully consider a number of factors.

Research issues: The methodological quality of the research and the resulting validity of the results are not only crucial, failure in these can render the research unreliable and useless and the effort, time, and resources wasted. Care of research participants, ethical concerns, ownership of data or results, possibility of publishing results in the public domain, need agreement. Possible use of the research, whether in product promotion or advertising, needs to be to be clarified with attention to the societal value of the research ensuring its publication regardless of the results, and with attention to the brand identities of the participating organizations.

Organizational arrangements: When collaboration is needed it is probably common for two vastly different organizations to simply join together with the sole focus of completing that project. This model of direct collaboration (Fig. 4) does not give sufficient thought to how the collaboration could happen, and most importantly, little thought might be given to the various considerations described here. The likelihood of encountering many problems that would be difficult to resolve leading to breakdown would be high. It might be easy to conclude that such collaboration is fraught with problems and ought to be avoided. But the problems might not inhere with the idea of collaboration as to the inability to work through problems.

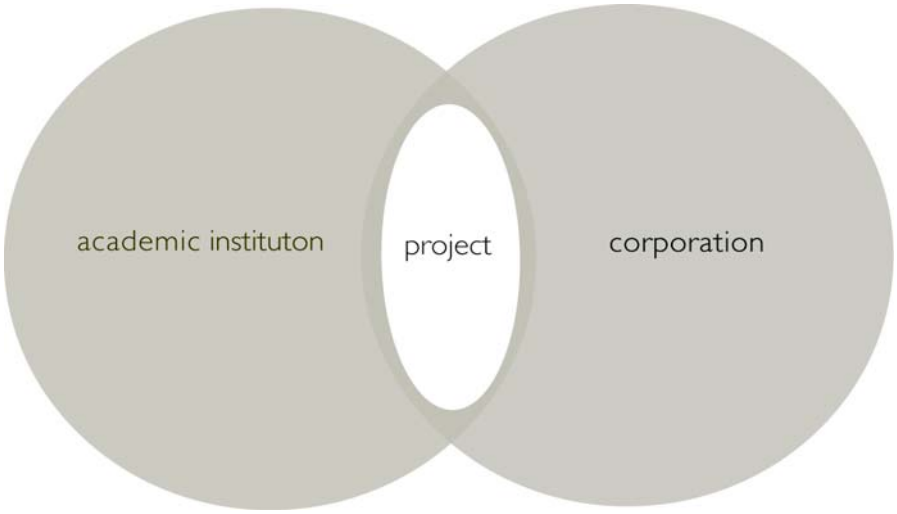

Figure 4. Direct project focused collaboration

Creation of one or more organizational or sub-organizational units that could mediate this collaboration (Fig. 5) entails explicit thought and attention to negotiating and devising organizational mechanisms to help the project succeed. Among these are embedding the primary and core values of the organization, installing procedures, checks, and safeguards, selecting personnel to ensure that the important concerns are addressed on an ongoing basis (with one or more persons responsible for those), and assigning roles, responsibilities, and tasks to individual positions to maintain energy, finding creative solutions to differences and problems, and bringing synergy for the creation of new and good research. Discussions, difficult though these might be, on concerns of each organization can be scheduled so that they are not forgotten.

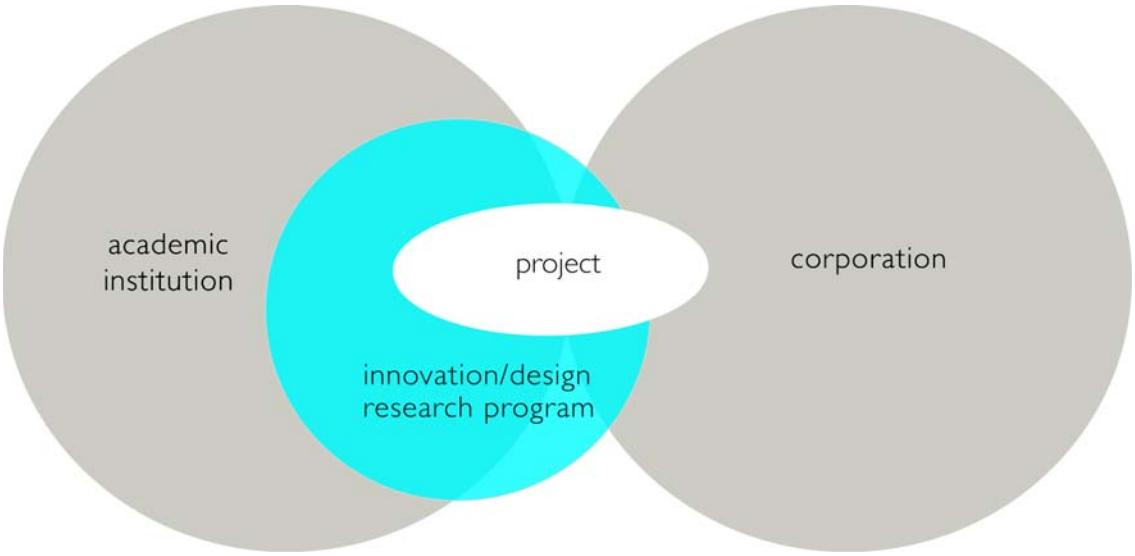

Figure 5. New organizational mechanisms for collaboration

Personnel: It is easy to overlook this component and believe that if good researchers are employed everything will work out. Well-trained researchers with energy and commitment to not only conduct quality research but also to work through difficult non-research but related problems can help the collaboration be successful. In the direct collaboration model, the potential for breakdown of collaboration due to frictions and difficulties is high. Time for developing familiarity, work styles, and enculturation into values is needed. A history of working together can be a useful resource for the personnel.

Physical arrangements: Availability of proper space, equipment, resources, and support ought to be considered. Locating the research facility where strict academic controls for research can be implemented is helpful. It facilitates following the requirements of ethical research, e.g. the Human

Subjects by IRB, the Medical Industrial Relations Committee, as well as the research procedures and protocols that would ensure valid results that will withstand the peer-review process of journal, scientific, and scholarly publications and research end-users (i.e., key decision makers).

8. CONCLUSION

Although many organizations in industry have their own in-house research, it is useful and advantageous for them to collaborate with academic researchers as it provides them with access to state-of-the-art methodology, to critiques (sometimes from anonymous expert reviewers), and to contribute to the development of the field. Academic researchers gain from such collaborative research with industry by tackling questions that have direct relevance to application and to affecting the world around them, of bringing latest developments to bear on these questions, and funding.

Such collaboration however is fraught with problems and pitfalls that range from its possibility to violate canons, to compromise the quality of the research, to maintenance of bias-free research, ethical issues, to the mechanics of collaboration. In the past, these concerns have prevented academia-industry collaborative research as it was felt that it was better to avoid even the perception of impropriety (Abelson, 1982, Midwest Center 1988, Prager and Omenn, 1980). However, this might have been too hasty a conclusion. Examination from a more neutral stance of whether collaboration must immediately be treated with suspicion and avoided or if it is possible to conduct research of the highest caliber and quality even while collaborating with those who might be less concerned with questions of research bias, research ethics, and neutrality is useful.

Just as human subjects research is not abandoned because of the potential for harm but painstakingly scrutinized to enable good research to flourish, academia-industry collaborative research also can carefully install safeguards to enable good and ethical research to be conducted. Attention to several features and actions, checks and safeguards might lead to a successful collaboration, something that may not be possible with sponsorship-type models. Our case study helps identify possible safeguards that may lead to the successes and failures in this particular endeavor. It also demonstrates that there is potential for academia-industry collaboration and for it to make important contributions.

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