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Future Trends Research Methods for New Material Applications: Common Goals in Curriculum and Industry

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Abstract

Bayer Material Science and Carnegie Mellon University's Industrial Design Program joined together to forecast new material technology applications in specific markets. Though industry and educational collaboration is not unique, it is the problem set of appropriate design ideation for particular material technology and the innovative design process that provides a rare combination of results. This is a case study in which macro future trends research and smaller-scale qualitative participatory design research proved to be effective methods for building new conceptual ideas for next-step supplier applications.

Introduction

Bayer Material Science, one of one of the world's largest producers of polymers and high-performance plastics, has a core business that is innovation-driven and technology-intensive. The ability to forecast material and product applications is extremely challenging. This particular research is longitudinally time demanding, with delayed results and feedback from the immediate work. Carnegie Mellon University (CMU) School of Design's philosophy is to improve current human conditions by understanding people through traditional and action research methods. The similarities are that both institutions are innovation-driven and technology-intensive. There are slightly different reasons and rationales, but the commonality allows synergy. The other similarity is the need for and constant investigation of users, user groups, and particular populations and business sectors. Bayer Material Science commits tremendous resources to stay up to date on a range of particular segments of industry and society in hopes of being the leader in material development and service. Brian Long, Innovation Manager of Bayer, presented the challenge and project to CMU's junior level Industrial Design Studio course.

The project's overall purpose is to provide insight into material-related opportunities through design. The results or outcomes would be forecasts of markets that have significant relationship and relevance to Bayer's core business of material supply and development. The plan is to use current research of future trends to identify where user needs or opportunities exist in a five-to-ten year projection. Tying technology and trends together through design is a natural progression to balance both the push and pull aspects of being a material supplier. Buyers and users of polymers, polyurethanes, and new innovative materials require vision and leadership to extend their offerings.

Bayer mega-trends concentrated on these areas: Future Logistics, Future Security, and Aging. Additionally, two caveats were to determine if polyurethane material technology and/or the application of robotics

would be part of the future forecasting. With this background framework, CMU's Industrial Design Advanced Studio and Professor Wayne Chung brought design research processes, visualization methods, and unique connections and access to various robot designs, innovative material applications, and other specialty disciplines to the work. The collaborative charge was to develop and deliver several future scenarios with product systems as part of the forecast.

The following content is a case study of a participatory research method that enables innovative solutions for a highly complex problem set. The paper uses one of six teams' processes to demonstrate appropriate research tools to attain relevant results to provide tangible design guidance.

Unique Problem Set

The challenge included the time frame of fifteen weeks to synthesize broad mega-trend research to a product system that satisfies future human needs. This is no small task for fourteen undergraduate, junior-level industrial design students. However, our program stresses creativity in problem solving; and problem solving is not limited to products. Development of an appropriate design process and application of research methods is invaluable in connecting all of these wide-ranging issues. Knowing the people and users is paramount in innovation. The layers of collaboration, though complex at the outset, become the essential ingredients in building relevant end solutions. And the essential ingredients still require user-centered methods. The initial difficulty was that there were no highly defined target user groups, just large mega-trend areas. In this instance, at the front end of the design process, the designers' role shifts to building research methods that allow people to express themselves through props, prompts, and tools. It is notable that we are treating the participants as people and not as users; because we do not have a specific task per se that is being qualified, tested, or evaluated.

An additional internal challenge was that this course was one of the first that integrated and emphasized behavioral research. Students were all educated about the requirement of confidentiality, anonymity, and the basics of Internal Review Board (IRB) standards. They were required to go through the NIH subject approval test as part of the course. Showing and demonstrating respect for the participants was especially paramount for all the groups. The earlier students are exposed to this level of ethics and rigor, the less the research results are prone to bias and misinformation. Most importantly, the students understand the significant responsibility they must uphold when entering into a person's personal space, whether physical or mental.

Participatory Research Method

This social science and design thinking approach may seem unfamiliar to those who have not been exposed to this type of research technique. However, this methodology is commonly used by large corporations to elicit the latent wants and aspirations of target segments. The methodology is considered "action research" in terms of behavioral research methods. In the design field, it is called participatory research. The term "participatory" comes from the fact that the research participant dictates and is seen as part of the research process. They are provided tools and props that enable them to help define or design the proposed solution. This method augments but does not replace traditional behavioral research methods of questionnaires, interviewing, and ethnography. Using multiple converging methods provides a method for understanding people's unmet needs. These methods can be grouped into three categories: what people Say, what people Do, and what people Make by using projective tools. When you use all the methods and then merge the findings, you can gain a very deep understanding of people, their needs, and their

aspirations.

Figure 1. The "Say-Do-Make" Research Framework

Participatory research methods come in many forms. They can be collage exercises, self-documentation photo diaries, visual cognitive mapping, or lifestyle scenarios. However, the real value of these tools is they are just vehicles for allowing everyday people to express their latent needs and wants through visual aids. Having conducted projects with Whirlpool Corporation, Texas Instruments, Rubbermaid, Procter & Gamble, and many other large to small corporations, we have found that, regardless of the problem and actual product/service, this shift in research methodology has allowed us to gain invaluable insights that enhance our creativity.

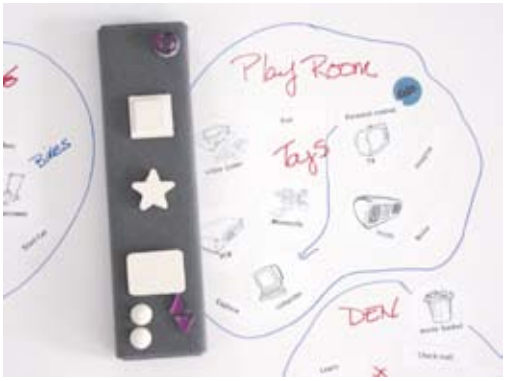


Figure 2. Velcro Modeling and Collaging Examples. Courtesy of Sonicrim.

Our overall research process has several intents. From an educational standpoint, it is important to have students understand the targeted audience and not just design from their own experiences. Second, the primary research we conduct will help confirm and validate the mega-trends presented to us by Bayer. If they do not directly confirm particular findings, they are not necessarily false, but a possible tangent or unique area that may be of interest. Any trend is subject to various filters and summarizations that sterilize, group, and attempt to describe a collective movement through identification of patterns. What can be lost are the personal details, stories, and experiences that fortify the trend and allow a more direct connection or relationship indicating why a product, system, or service may serve them best. Therefore, this primary or first-person research is essential for understanding the people and validating the mega-trends provided.

The participatory research process typically cannot be developed with the aid of traditional research methods. After a brainstorming session and determination of areas that showed the most promise and allowed students access to participants, the class concentrated on: Aging in the Home, Aging and Driving, Aging in Retirement Centers, Security of Personal Valuables While in Transit, Security of Personal Items in Automobiles, and Product Shipping Logistics. These themes aligned with the grand scope of Bayer's trends research. After identification of initial participants, traditional methods of questionnaires, interviews, and observations were conducted. The Aging in the Retirement Centers group contacted and interviewed

two separate centers. The Security for Personal Items in Automobiles group contacted multiple parking structures, security responsible for the establishments, and owners. The Product Shipping Logistics group interviewed FedEx Ground and digital fabrication labs. Every team was responsible for identifying the core target people and experts in the respective field. The Aging and Driving group had the fortune of garnering tremendous knowledge from the leaders in elders and driving behaviors.

Learning by Using the Design Research Process

The traditional research method results allowed the students to gain a firm understanding of their specific subject matter. It also ensured that the area identified (Aging in the Home, Aging and Driving, Aging in Retirement Centers, Security of Personal Valuables While in Transit, Security of Personal Items in Automobiles, and Product Shipping Logistics) was part of the trends that were relevant and identified by Bayer. Most importantly, it provided the springboard to developing appropriate participatory methods to elicit uncovered wants and needs. In the case of Security of Personal Valuables While in Transit, the development of a collage elements (keywords, images, emoticons) were all derived from the interviews and questionnaire analysis results. The Security of Personal Valuables (Appendix Figures A-H) portrays how a team's approach would start broad and narrow to more specific problem areas. These traditional research methods, analysis, and results inform the critical stage of participatory research. From the analysis, particular concepts surface from the respondents. These concepts confirm previous hypotheses or scenarios depicted from Bayer. More significantly, the analysis and results allow the design team to project the aspiration and, in the case of Security of Personal Valuables, the desired cognitive state of a traveler. Almost all the participants wanted a calm and peaceful mindset so they would not be in the position of stress, forgetfulness, and worry. They wanted to know that their possessions were not simply attached to them, but when out of their possession were accounted for and secure, or worthless if taken.

The team selected the participatory collage technique to elicit the manner in which they wish they could travel in relative security and sense that their belongings had a level of protection. The collage technique is most effective when the participants have been part of the previous traditional research methods or have been briefed about the subject matter beforehand. This allows them to project and express ideas and issues in relation to their undesired current state of travel. Appendix Figures B-G show the previous research methods that the participatory research subjects were given to prepare them for the collage exercise. In some instances, the conversations are transcribed. And frequently used vocabulary and terminology can become elements of the participatory research tools. For example, in relation to the Security of Personal Valuables, the images and words are selected because of high frequency of use, contradictory meanings amongst the participants, and relation to the projected scenario. Figure 3 shows the sticker examples of the images, text, and pictures provided in the collage exercise. These images and text are gathered in direct relation to the vocabulary and stories told earlier in the research process.

The participatory method allows the subject to use the images and texts to react to the relatively simple prompt. For example, a poster board may be separated exactly in half horizontally by a line. Each of the participants is asked to create a collage showing the "Current State of Traveling" on the bottom half, and on the top half, to express "How You Wish You Could Travel." The simplicity of the collage tool is designed to allow the participant to build his or her own ideas. Collage creation is a springboard for them to verbally explain their thoughts and decisions regarding why they chose certain elements and their connections. What provides an even richer and more dynamic dialogue is the fact that the collage exercise is held with two to four participants. Usually, each participant engages in the discussion empathizing with similar or disparate ideas, and they start building onto each others' aspirations and ideas. Frequently we have participants using images or text that is not the same as other participants. The result is further explanation and clarification for both the researcher and participants. This sometimes leads to more in-depth

discussion, debate, and inquiry, but essentially makes the discovery and informing stage deeper in terms of understanding the person's beliefs and experiences. The visual results are rich in information and content, but coupled with the verbal explanation and dialogue, provide a wealth of qualitative information.

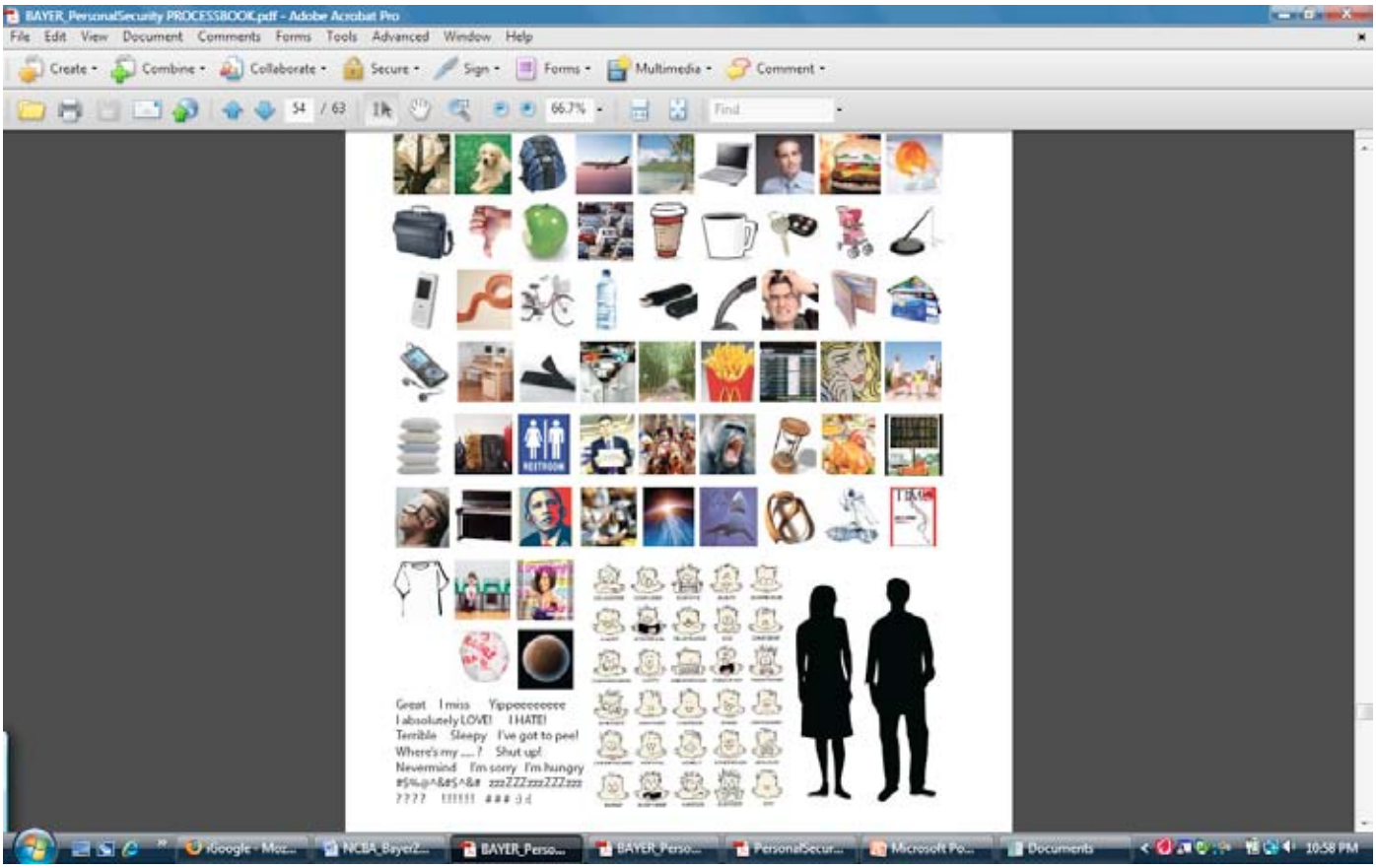
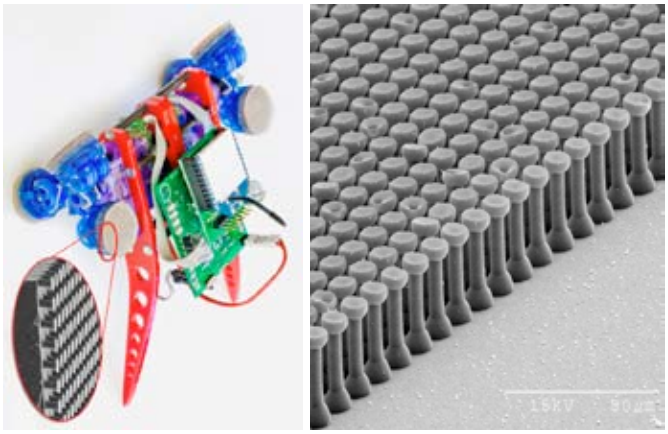


Figure 3. Security of Personal Valuables While In Transit: Collage Sticker Selections

Being true to their initial charge of applying material technology to product system solutions, the team identified with the polyurethane Gecko technology. Figures 4 and 5 illustrate NanoRobotics Gecko Material Technology. This material is developed at Carnegie Mellon University's NanoRobotics Laboratory, headed by Dr. Metin Setti. The Gecko material has similar qualities of Velcro without having to match a male and female surfaces; it simply clings to a raw surface. Although there are physical limitations, its effectiveness is due to the multi-faceted design of the Gecko hair shapes and the inherent material qualities of specially developed polyurethanes. In addition to these incredible properties, adding an electrical current can change the material structure to either flex or change shape—an On or Off state. This premise allows for many of the future concepts created by the Security of Personal Valuables team. The concepts deal with future mobile computing, communication, and personal objects. Minimizing and reduction of product footprint is assumed, but security still remains a paramount issue. People will still work in public places such as coffee shops, airports, and restaurants. The different types of situations identified through the research shows that various securing modes are necessary to accomplish the longer-range perspective of "calm and peaceful mindset" established by the team. By the results and analysis of the research, the team can identify Product Opportunity Gaps of: Built-in Security, Add-In Security, and Secondary Security. (See Figure 6.) This stage enables the team to target particular problems that can be addressed.



http://nanolab.me.cmu.edu/projects/geckohair/
http://nanolab.me.cmu.edu/projects/waalbots/tri-leg.shtml

Figures 4 and 5. NanoRobotics Gecko Material Technology

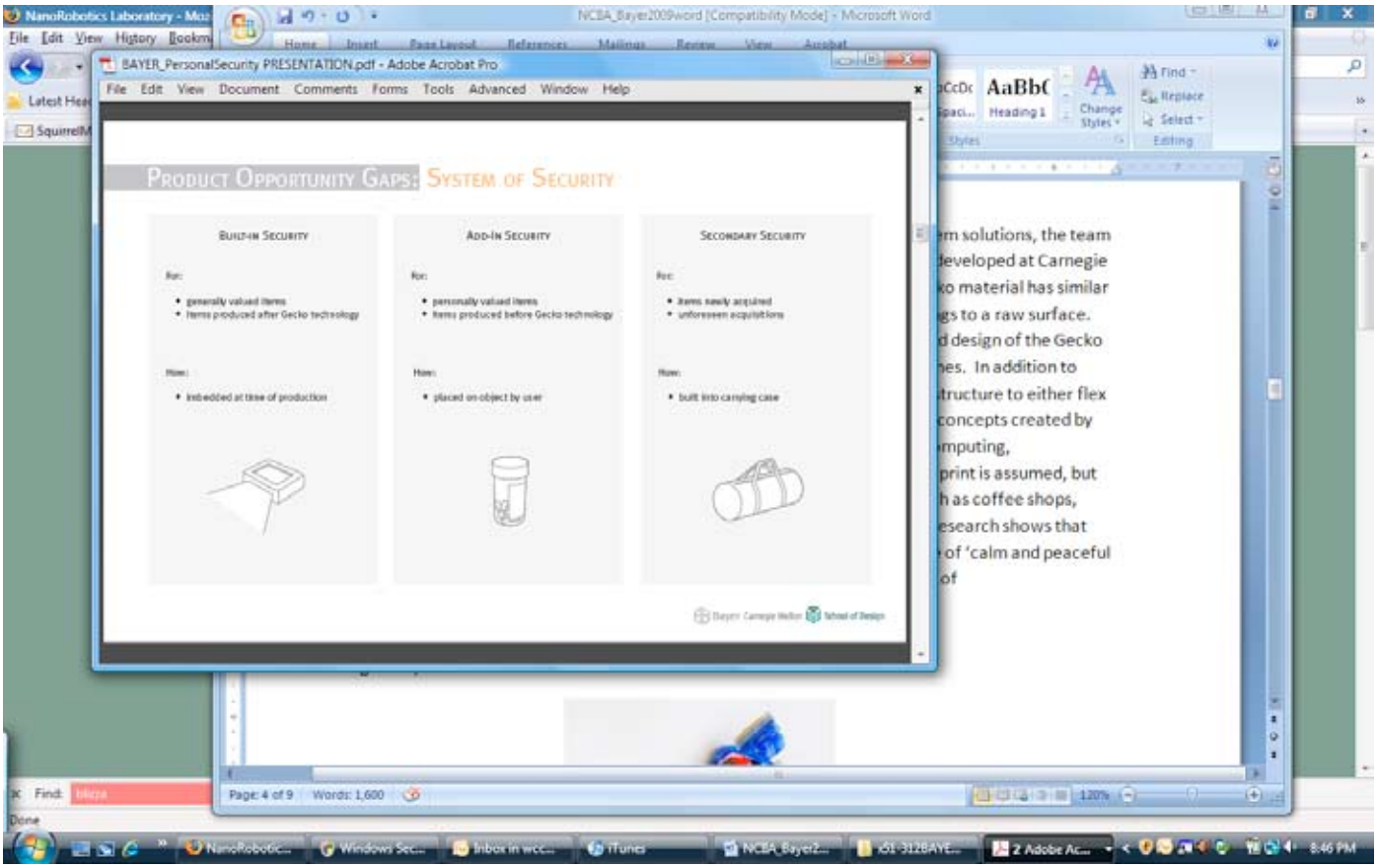


Figure 6. Product Opportunity Gaps: System of Security and Premise for Solutions

Benefits of Participatory Research

The first direct benefit of using a multi-method research approach is in the research document and information garnered; the second direct benefit is the results. The corporate clients are enthralled with the rich and in-depth information discovered by using a range of techniques. The participatory method delivers a rare glimpse of how future trends can be envisioned by the forward thinking of individual research subjects. With the use of broadly defined areas, people, and conversion to personas or profiles that have limited specificity, there is less key or significant information with which to explicitly direct design decisions. It must be reiterated that the purpose of participatory research methods is to guide design development and decisions and not necessarily inspire grand shifts or corporate judgments. The design research process and range of research methods educate students in the person and environment in which

they are relatively unfamiliar. The results force discussion, debate, inquiry, analysis, and synthesis or a range of information. And in most cases, it just makes students want to ask more informative and relevant questions, and/or develop better research techniques.

Also notable is that the research results allow for rational design decisions. Justifying the form, color, texture and a range of visual to tactile designs to highly experienced professionals requires more than just undergraduate academic credentials. One of the main reasons why corporate clients come to a university is to obtain unique and new methods so that the results are not predictable and safe. The use of multi-method research, particularly the participatory method, allows the student teams to bolster their design concept positions by using their research results. Their belief and conviction lies in the broad and deep self-conducted research work and analysis. Figures 7-9 show the results of the Security of Personal Valuables While in Transit team. The class entailed six teams that stepped through the similar research and design process to build relevant solutions to future trend material technologies.

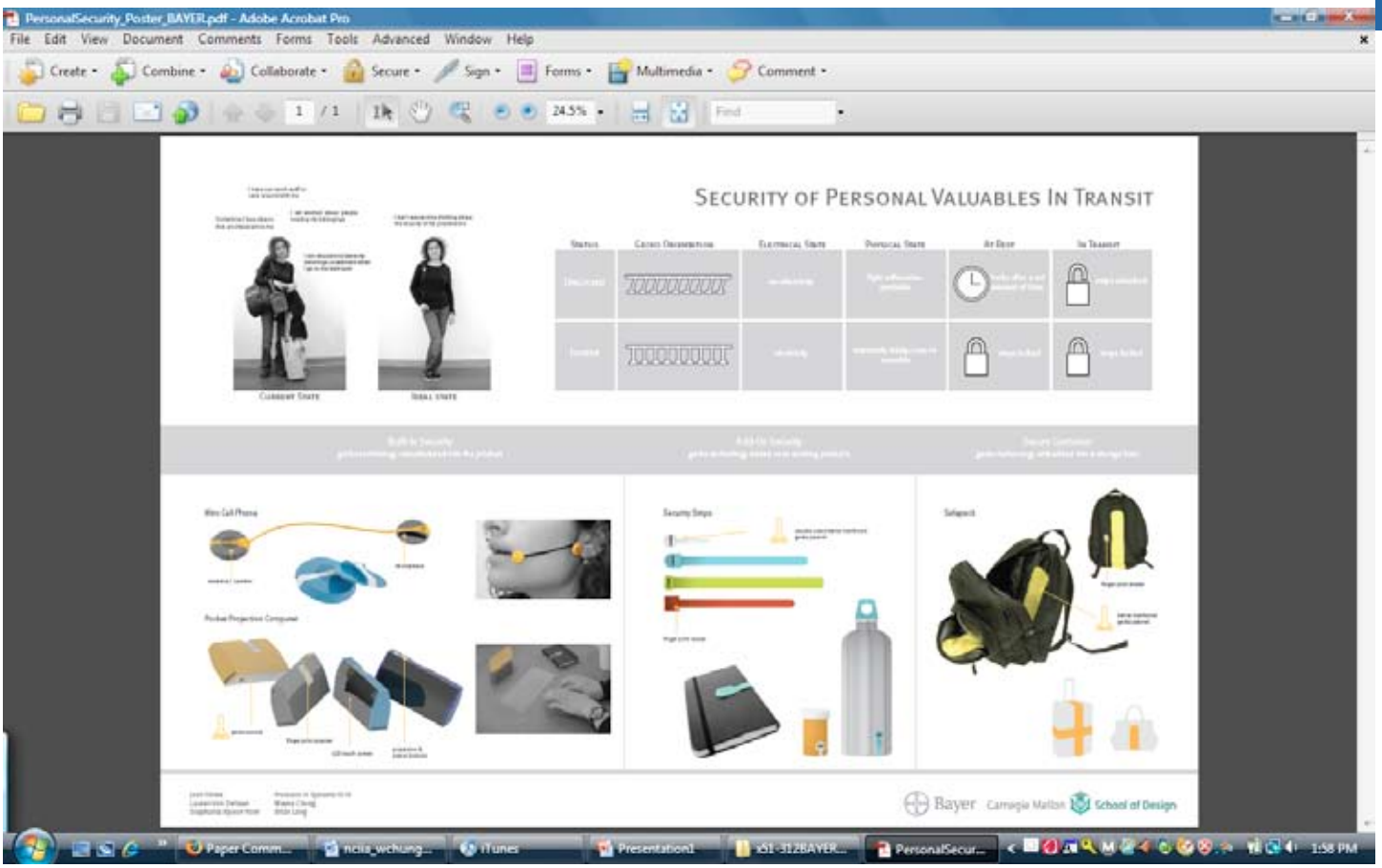


Figure 7. Functional Description of Electrically Controlled Gecko Security Material

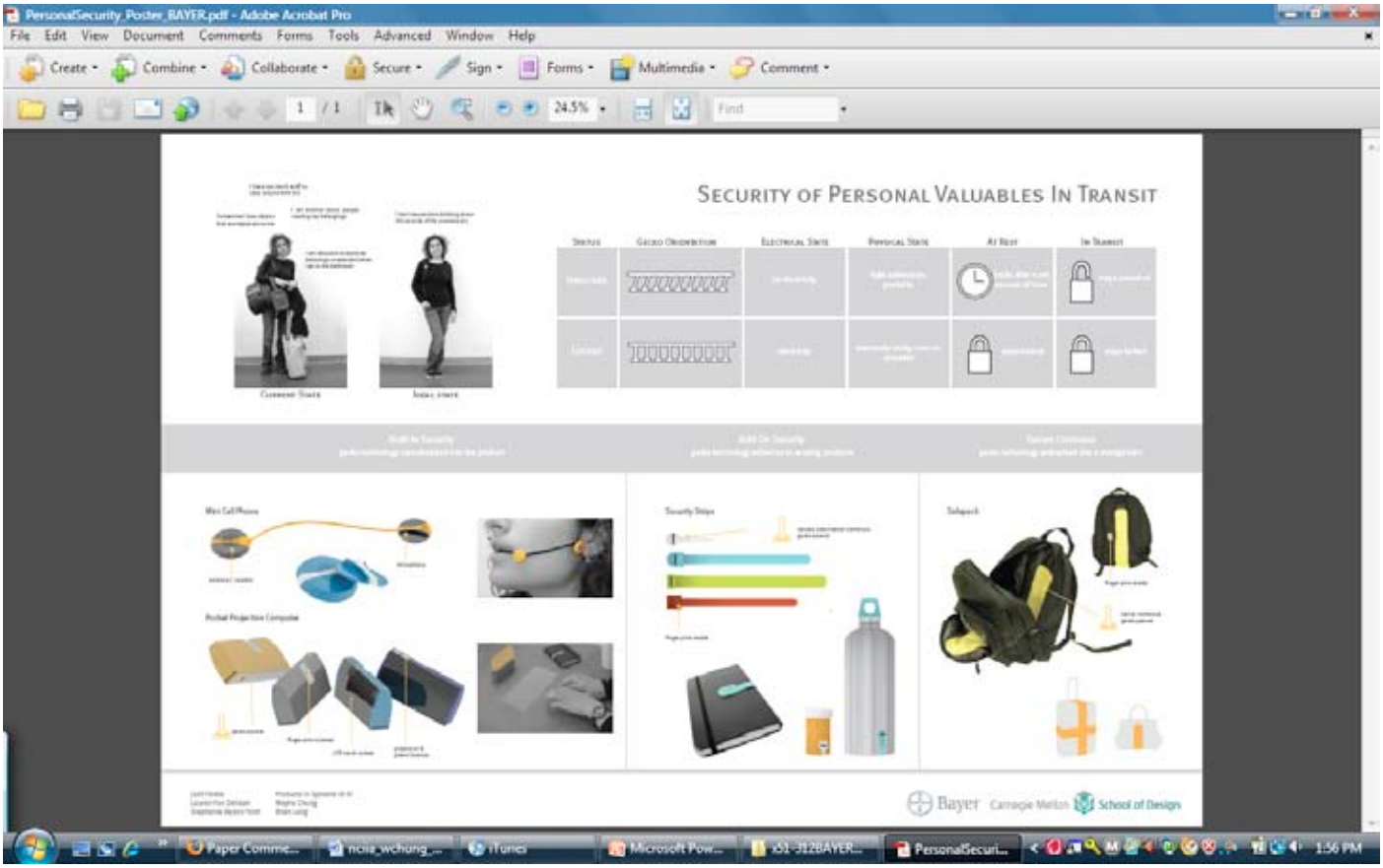


Figure 8. Built-In Security for Mobile Communication and Computing

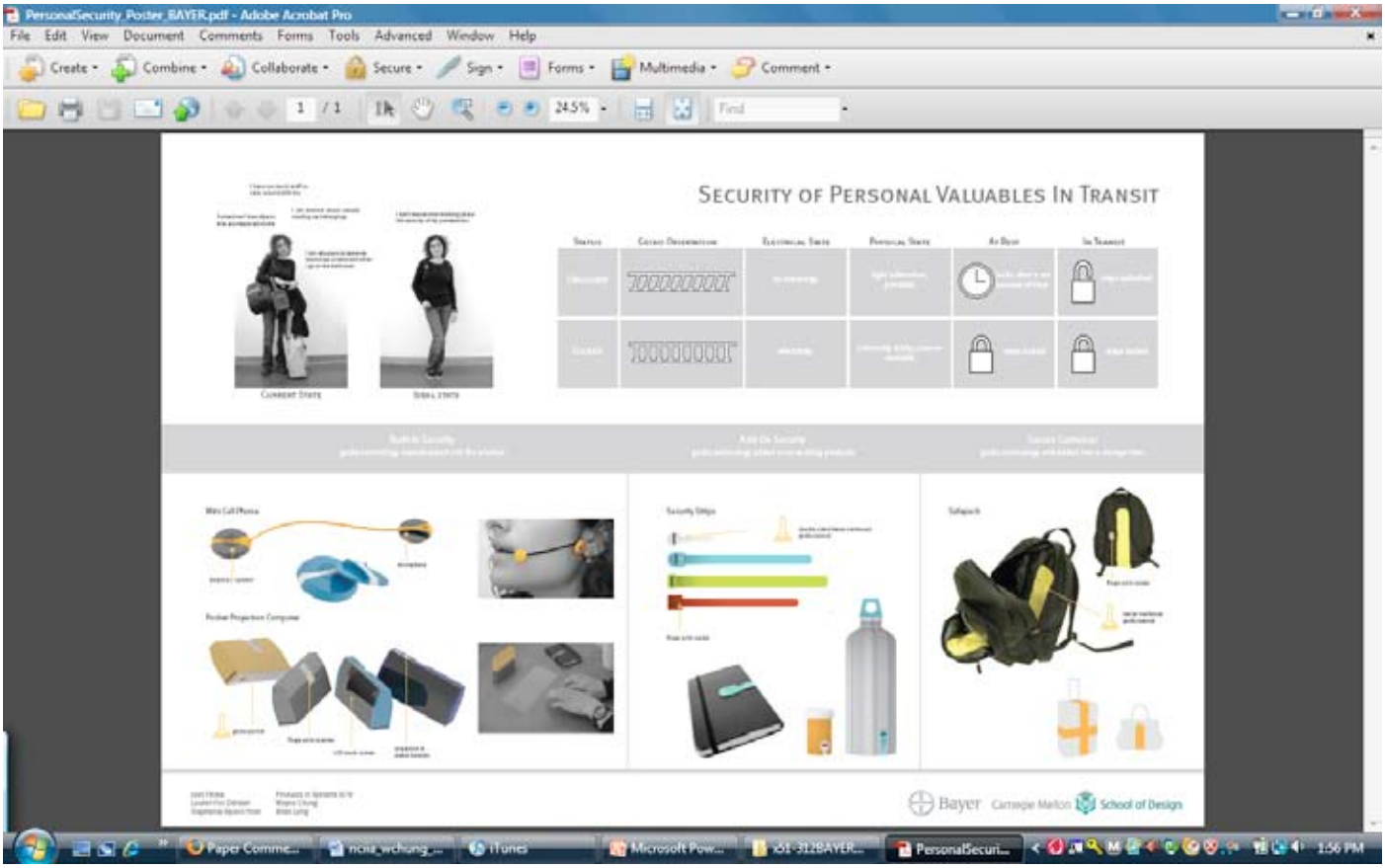


Figure 9. Add-On Security for non-OEM Gecko Security Manufacturer Items

One of the main students' challenges came in the form of moving out of their comfort zone of campus and studio. The necessity of going into the environment and meeting people in the contextual settings proved

to be incredibly valuable as a designer who needs to be user-centered. The other major challenge was that the traditional sense of form and function design was not the emphasis, instead focusing on creating a process to elicit stories and responses. This new level of problem solving and new cognitive approach initiates new and more complex thinking. But once the students saw how the research was integral to the end goal of visualizing an applied design concept, they knew this experience would be useful in their future projects.

The field of industrial design is about building objects. But building an appropriate or innovative object with proper interaction and relevance requires insight. The only manner to gain insight, beyond your own experiences, is to elicit them through methods, mediums, and stories of other people. We have repeatedly found participatory research methods as one of the most successful tools that match client goals to people-centered needs and desires.

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APPENDIX:

Team: Security of Personal Valuables While in Transit

Josh Finkle
Lauren Von Dehsen
Stephanie Kiyeon Yoon

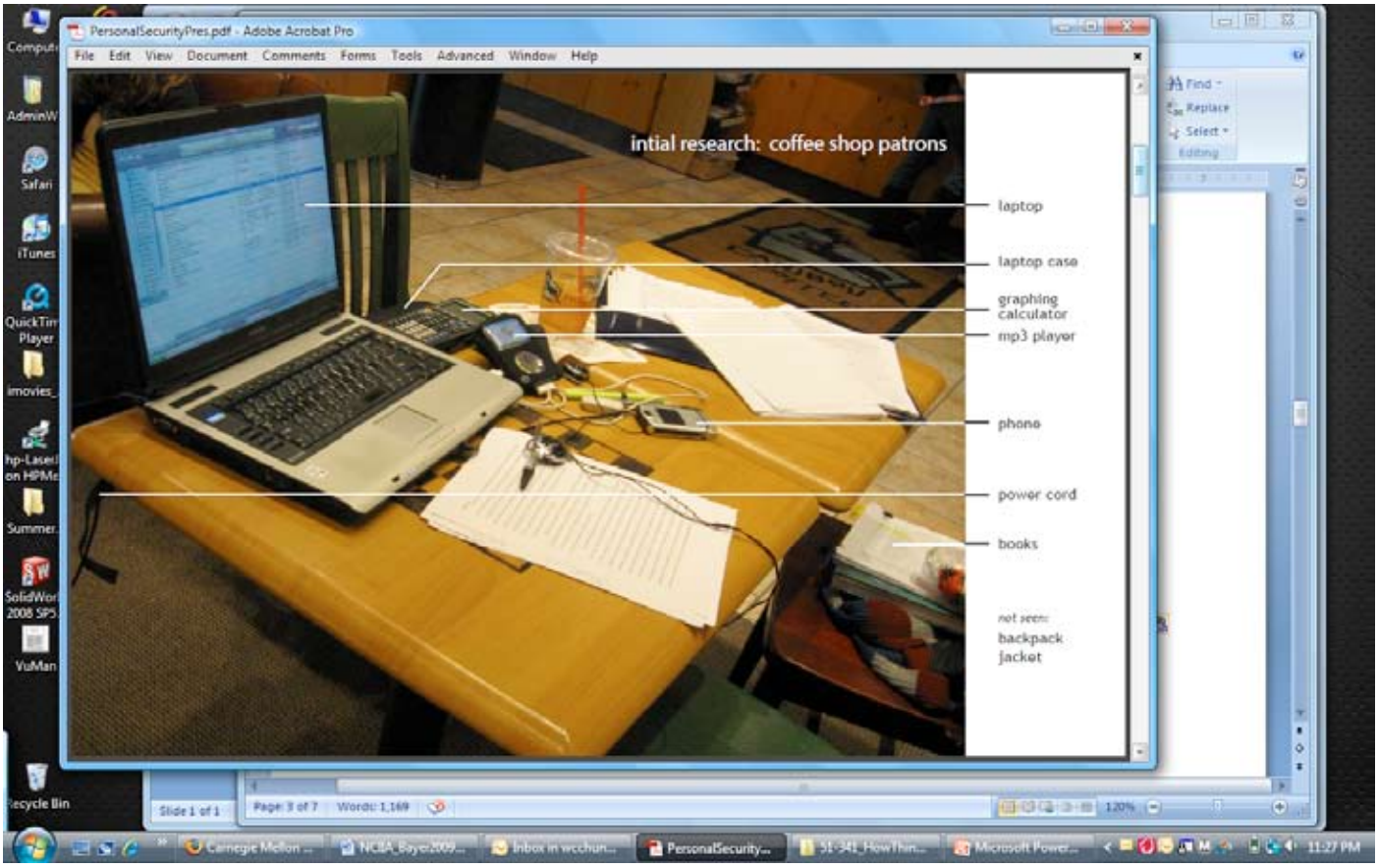

Figure A. Traditional Research Method/Observation in Coffee Shop Patrons

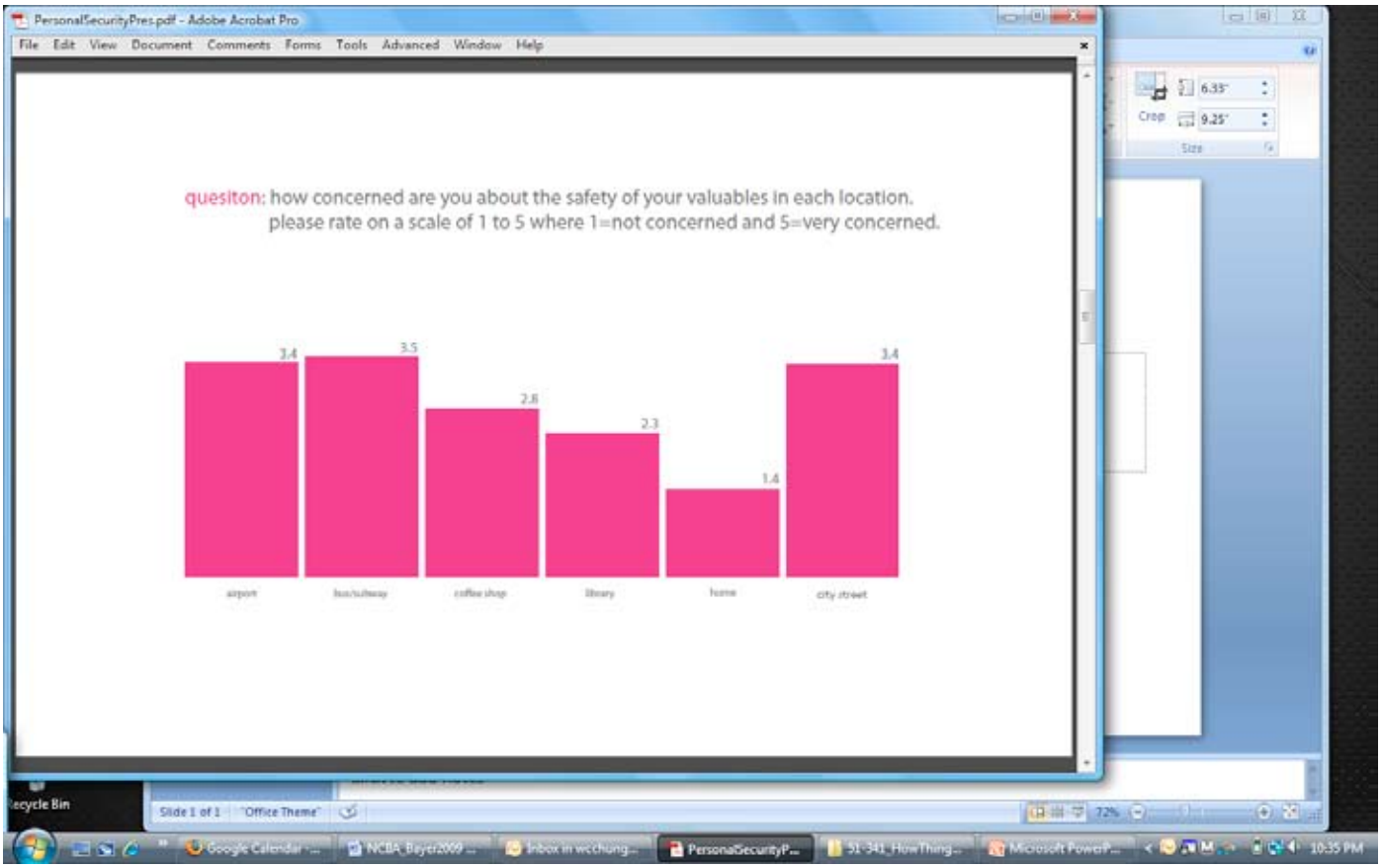

Figure B. Traditional Research Method/Questionnaire

Q: How concerned are you about the safety of your valuables in each location? 1 = not concerned, 5 = very concerned

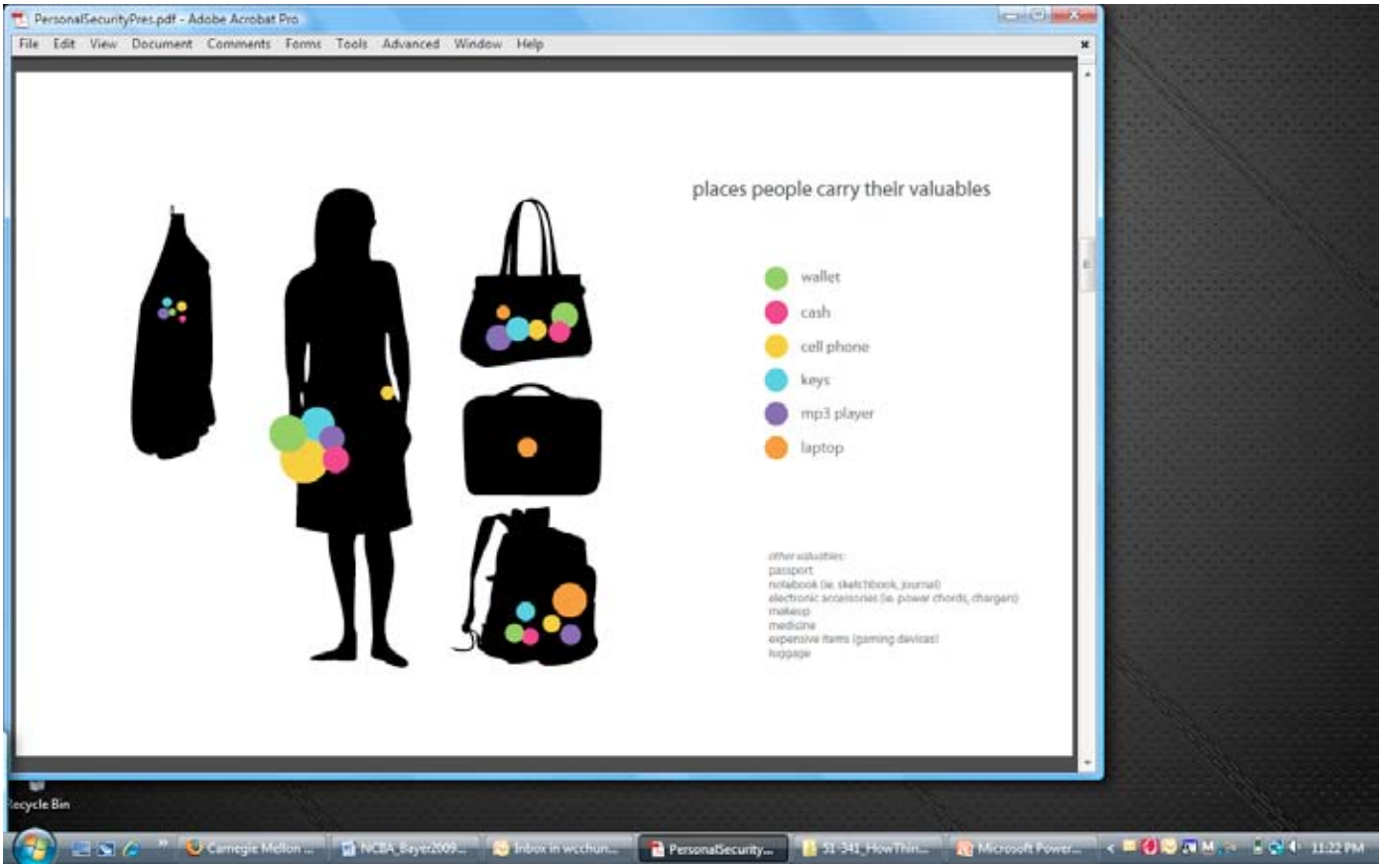

Figure C. Traditional Research Method/Questionnaire

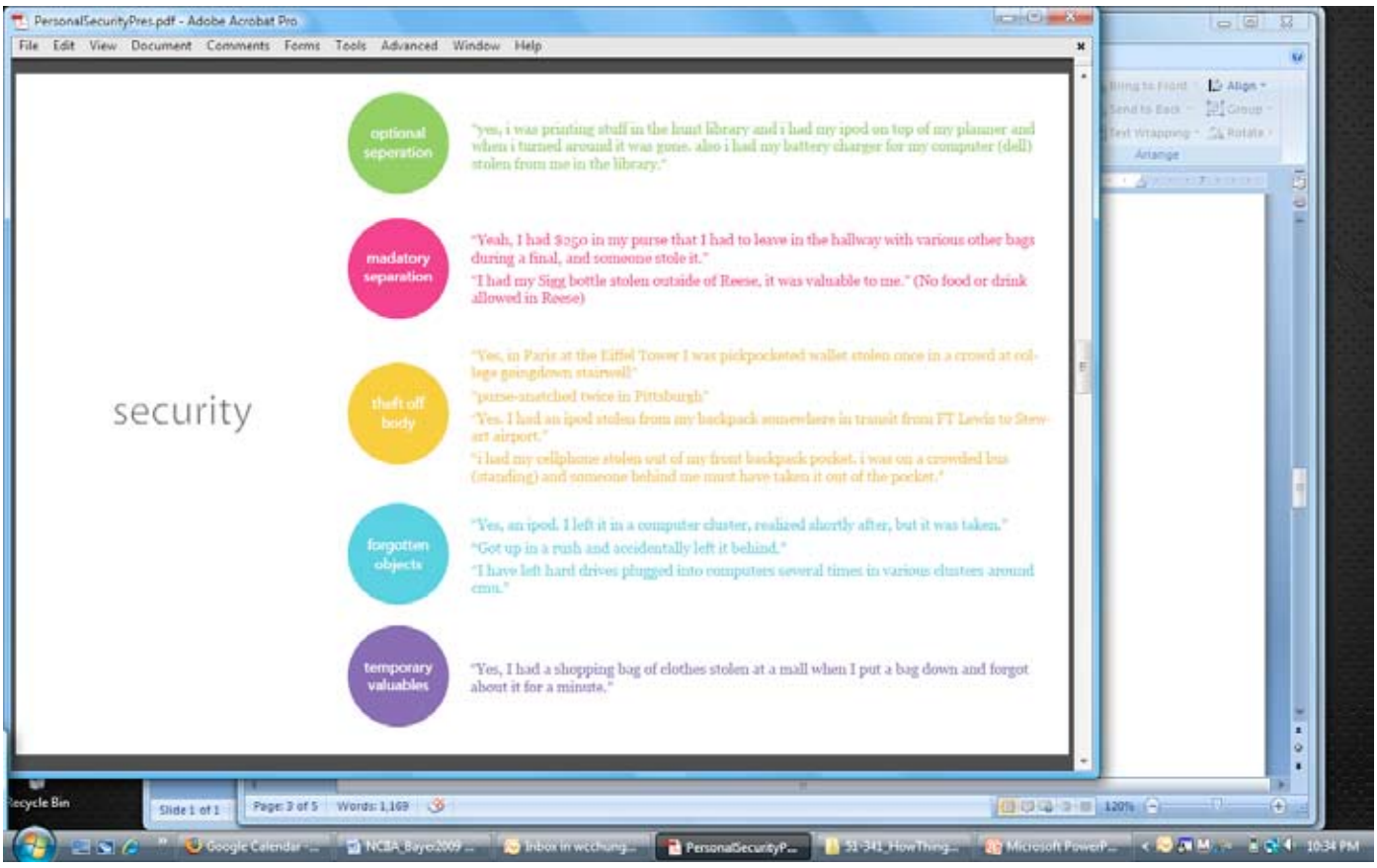

Figure D. Traditional Research Method/Interview Results and Analysis Categories

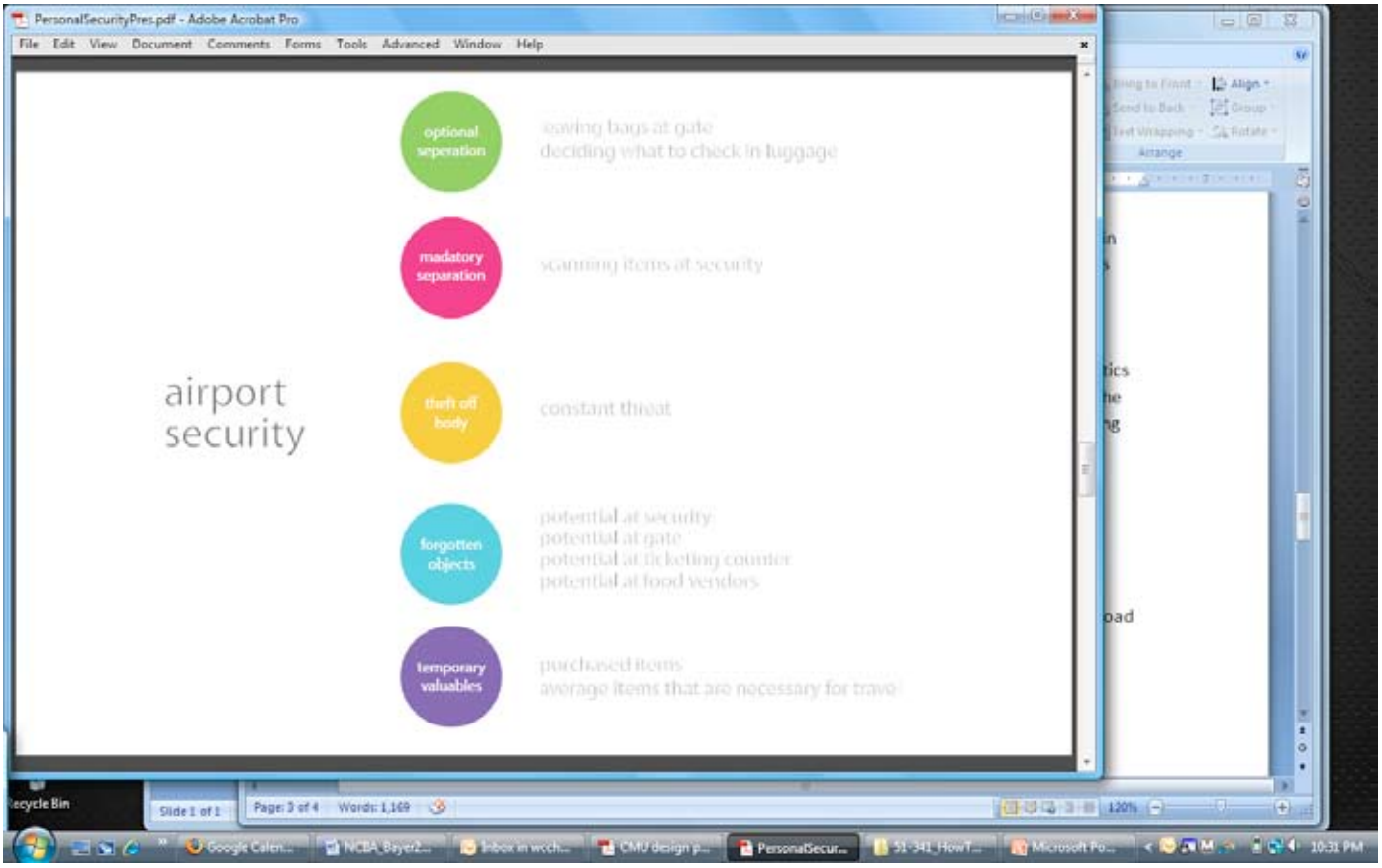

Figure E. Traditional Research Method/Interview Analysis Results and Categorization

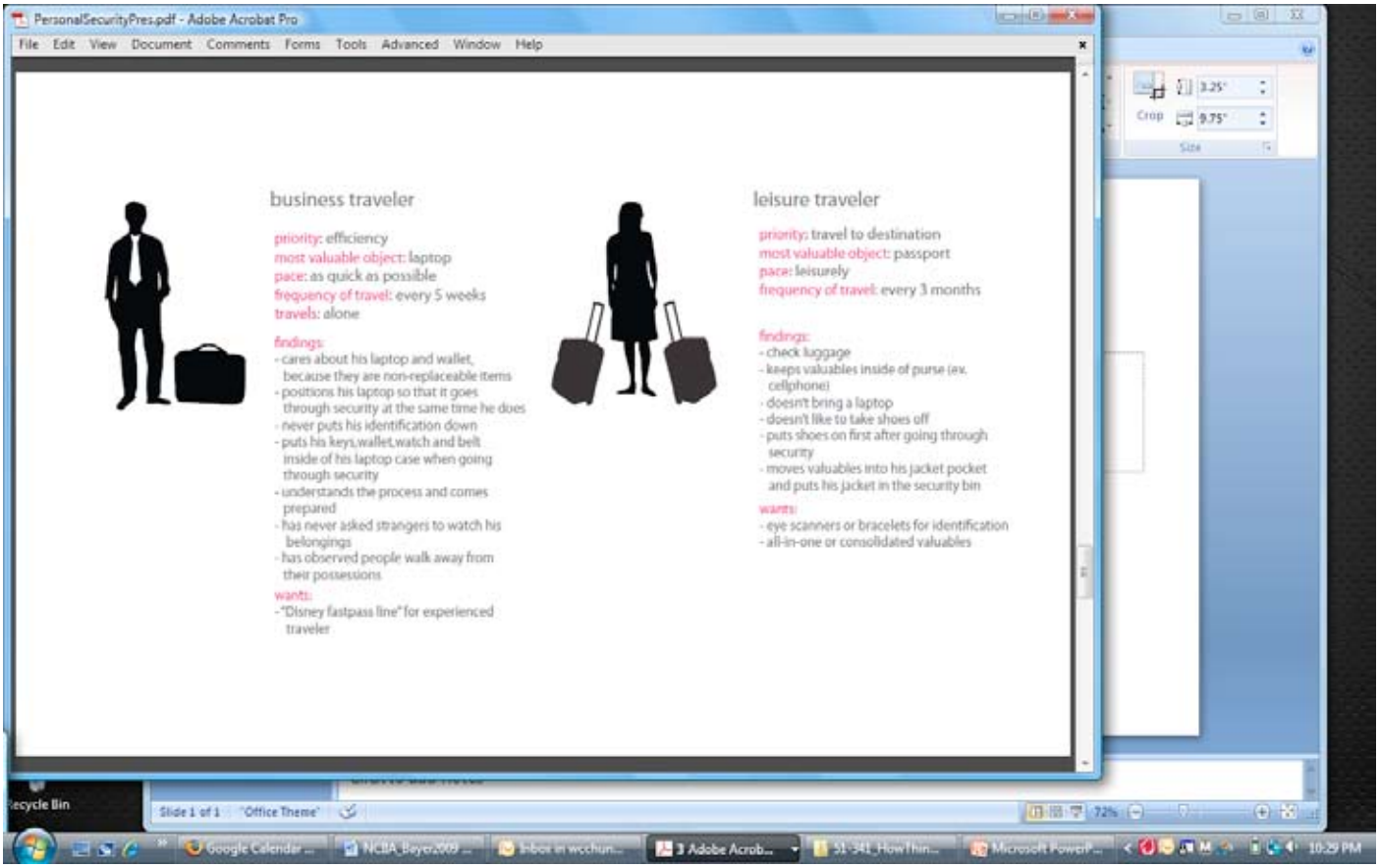

Figure F. Traditional Research Method/Analysis Summary and Persona

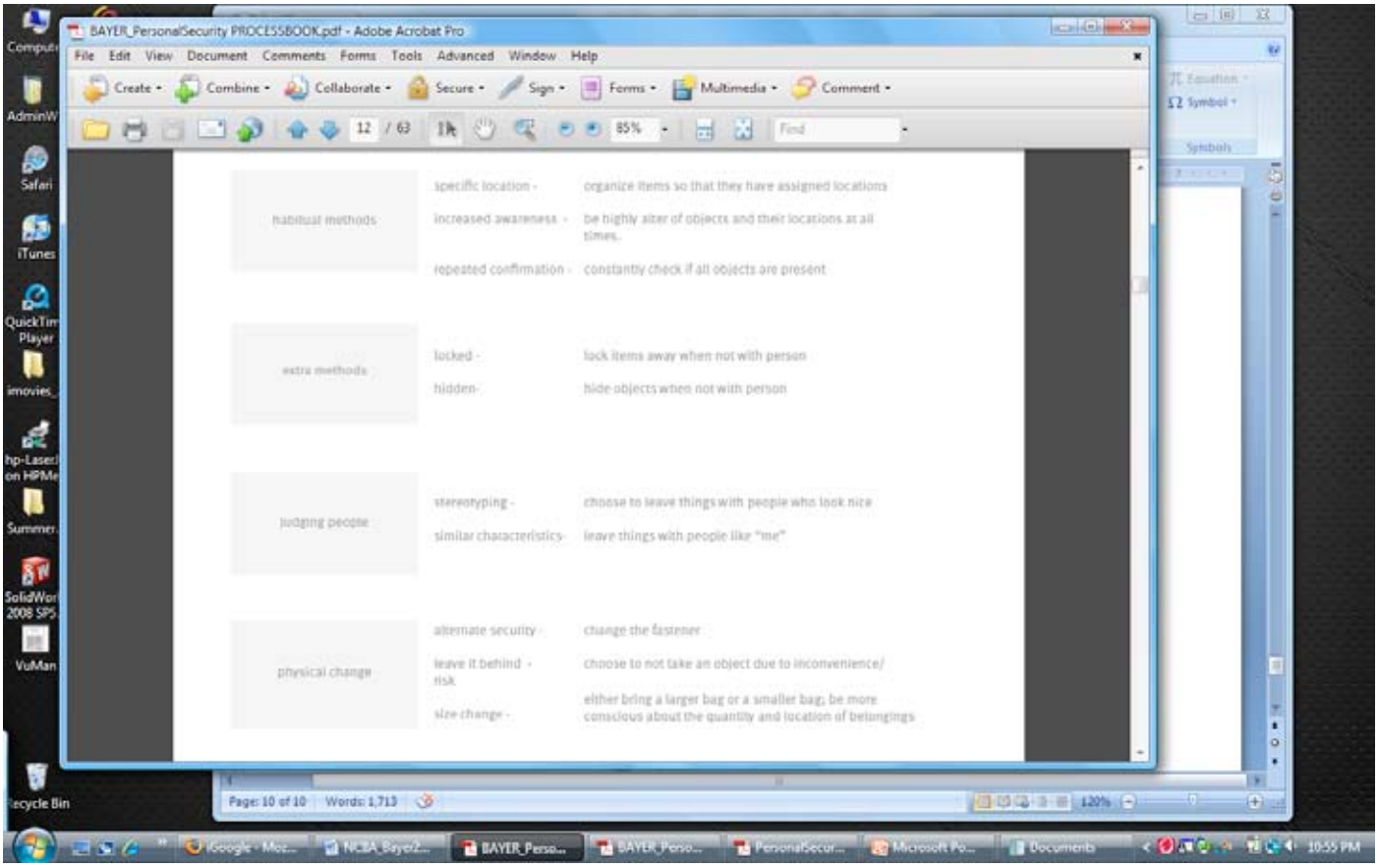

Figure G. Traditional Research Method/Analysis Summary Current Solutions

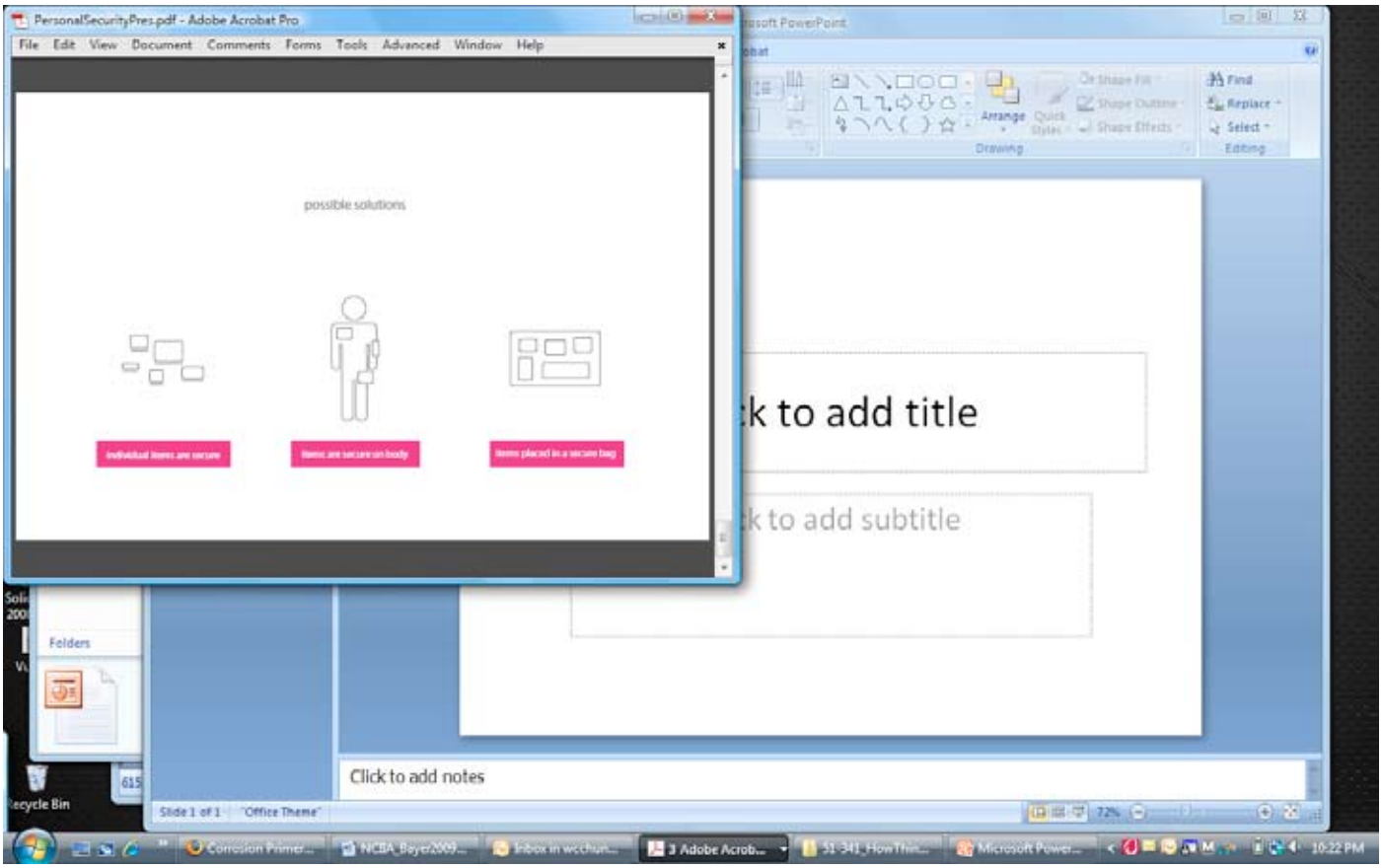

Figure H. Traditional Research Method/Analysis Summary Possible Solutions