

Inspection Strategies in Airport Security Systems

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ABSTRACT

The IRRE supplement was used to send a graduate student researcher, Kimberly M. Ghlyin, to the University of Zurich for a three month period. While at the University of Zurich, Ms. Ghlyin worked on a number of activities that extended the basic work being done in the main grant. The availability of screening data in the University of Zurich laboratory allowed Ms. Ghlyin to extend the work on the effect of queue length on screener efficiency. The basic work in this area was done earlier in the main grant. This extended work is planned to be reported in a series of journal papers that are currently under preparation. Furthermore, this work will form the integral part of Ms. Ghlyin's doctoral dissertation.

INTRODUCTION

This report provides a summary of the international travel supplement awarded to SUNY at Buffalo. The current NSF award is broadly looking at ways to increase airline security throughput while reducing the occurrence of false alarms and maintaining the required security level. It is investigating the benefits of classifying passengers into different groups, so that the number of security checks may vary by the group. The goal is to determine the optimal number of groups, fraction of passengers in each group, and assignment of check stations for each group to increase airline throughput while reducing the occurrence of a false alarm.

Included in this work is a study of security screener behavior in response to queue length, determining the service quality implications as well as customer waiting time. Results showed a speed-up of x-ray screeners with queue length for one type of item. Correlations between queue length and service time suggested that Parkinson's Law as a possible explanation. The IREE supplement provided the ability to extend this research utilizing real-world data related to service quality and customer waiting time obtained through a certified x-ray training system in place in a multitude of airports by placement of the host university, University of Zurich.

This collaboration provided the ability to develop a study looking at various factors of service quality including image enhancements of x-ray images and effects of screener expertise on customer waiting time. It will also provide the start point of creating a working relationship with the University of Zurich to run similar studies in the future.

The Visual Cognition Research Group (VICOREG) at the University of Zurich was funded by Adrian Schwaninger in 1999. It aims at increasing the understanding of human visual information processing from both basic and applied perspectives. The interdisciplinary effort and success of the group is documented in a variety of publications, funded research projects, international collaborations, and software tools that are used by several hundred airports in Europe, Canada, and the USA. Their training tool, X-Ray Tutor, is utilized as both a training tool in numerous airports for security screeners, as well as a research device for the VICOREG group X-ray tutor is an excellent tool to utilize to collect security screening data due to its acceptance of use in the United States, and its real-world feel.

VICOREG offered to host Kimberly Ghylis as part of the international cooperation. The travel dates were September 23, 2006 through December 21, 2006.

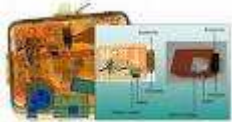


Figure 1: Example of X-Ray Tutor Graphics

RESEARCH ACTIVITIES AND ACCOMPLISHMENTS OF THE INTERNATIONAL COOPERATION

The cooperation with VICOREG allowed Ms. Ghylin to partake in the creation of new international research projects, analyze data related to x-ray security performance VICOREG already has obtained, and share the research of the SUNY at Buffalo with the research group through short seminars.

As part of the investigation of service quality and customer waiting time, the research



Figure 2: X-ray image without a threat

activities concentrated on ways of determining how the human operator is effected by various elements of the system, that are subsequently effecting both the level of quality and throughput levels of the system. Utilizing X-ray Tutor, a study was developed and internationally ran that looked at the effects of six image enhancement features on server behavior. This study was created in Zurich, and ran in cooperation with VICOREG and SUNY at Buffalo. Other data sets were also gathered from previous applications of X-Ray Tutor to help determine the effect of expertise on overall performance and detection time. The two studies outlined extend the current NSF grant by further pinpointing underlying effects of operator throughput, performance levels, and service quality. A brief summary of the research objectives for both the image enhancement and expertise studies can be found below.

Image Enhancements: Figure 2 shows a typical x-ray image seen by a security screener and most commonly utilized in experiments. However, in airports, screeners are often offered the option of enhancing this image through a variety of picture-changing options including black and white, organic only (shows only organic material), organic stripping (removes organic material) or metal stripping (removes metal from the image). A study was created and conducted utilizing both novice and expert screeners looking at how these enhancements affect overall screener performance in terms of speed and accuracy. This data was further analyzed in terms of time spent in the search and non-search phases. Results should provide information on the benefits of image enhancements, as well as performance information for ways to improve screener performance while optimizing throughput time of luggage. A journal paper will be created and submitted for this work.

Expertise – This study gathered data from a variety of security screening experiments having been performed at both the host and researcher’s university with the goal of identifying any overall trends in performance and search and non-search time performance related to either expertise or training. All gathered data was obtained utilizing a similar experimental platform, X-Ray Tutor. Over 1000 lines of data will be utilized from both experts and novices and trained (similar training) and untrained participants to help pinpoint any changes in performance speed or accuracy, as well as search and non-search time of the items. A journal paper will be submitted for this work.

As a temporary member of VICOREG, Ms. Ghylin was able to work closely as both a researcher and collaborator on a variety of projects. The aforementioned study looking at security screeners' performance with various image enhancements was designed in collaboration with VICOREG researchers. Subsequently, the data was collected through her VICOREG colleagues. Similar interactions took place with other colleague's research proposals, with Ms. Ghylin serving as a collaborator on the design and analysis of the experiments. As VICOREG is a predominantly Psychology based laboratory, Ms. Ghylin's background in statistical analysis allowed her to gain insight and experience with a multitude of studies beyond the original scope of the collaboration. She served as a mentor in statistical analysis to the members of VICOREG and they reciprocated through their knowledge of underlying psychology of human behavior. During her time, she also led discussions related to the application of a two-component model of reaction time that helps the locus of error be determined, her previous thesis work. This same model has been subsequently utilized on the studies related to image enhancements and expertise on the NSF grant. This model will allow the underlying behaviors of the server to be better understood, and lead to improvements in the training and scheduling of the screener's to enhance overall quality of the throughput and speed of the throughput. Currently two papers are in the progress related to her work performed at the host university. These papers will be submitted to high-quality journals within the next 4 months.

The research output will highlight how expertise affects the way the security screening task is performed as well as providing a better understanding of the underlying differences in novice and expert effects of image enhancements as well as performance differences in image enhancements.

BROADER IMPACTS OF THE INTERNATIONAL TRAVEL

The travel supplement allowed Ms. Ghylin to participate as a full member of the University of Zurich – VICOREG research group. As part of this research group, the intricacies of a foreign university and lab were able to be observed and actively participated in. Different ways of teaching courses and running lectures were seen, both from observance of her colleagues, participation in the weekly lab meetings, and presenting her own work. One unique element of VICOREG is its close connections with European airports. VICOREG consistently runs training tests and other experiments on-line in many of the European airports, including the Zurich airport. The design of these on-line experiments was monitored first-hand. As part of these experiments, the current NSF grant was able to be expanded by applying different model-fitting techniques to data obtained through the close VICOREG- airport relationships. The study on image enhancements was performed in these airport environments and data from experiences security screeners was also found.

At the close of the trip, University of Zurich and SUNY at Buffalo agreed on the joint publication of at least three journal papers, and the continued collaboration with the labs. As both universities have complimenting goals in the security field, and complimenting expertise in Psychology and Industrial Engineering, respectively, this relationship should be fruitful. Since returning from Zurich, the labs have been in close contact with each other, both for journal publication, and creating new research proposal ideas. The trip served as a stepping stone for this interaction to be solidified. It allowed both universities to better understand the capabilities of each university, resulting in a relationship with complimenting goals.

As Ms. Ghylin is a U.S. citizen, this trip also offered her the chance to better understand and experience how to effectively interact with another culture, which is very important in this globalized world. As Zurich is a mostly German speaking city, her language and international coping skills were quickly increased. Switzerland as a whole speaks mainly German, French, and Italian which provided her the opportunity to understand how to cope quickly in a foreign environment while still being an effective team player. During the weekly lab meetings, she was able to better understand and learn about the technological trends utilized in the research settings and became familiar with various programs including SQL server sequences that are predominant in the European universities.

During her visit, she was also able to participate in the 16th International Transport Security Human Factors Technical Advisory Group Meeting (InterTAG) being held in Zurich, Switzerland. This meeting provides updates on national programs and information exchange of technology development and implementation of airport security, as well as discusses issues related to selection, training, and certification of screeners. It is a forum to share expertise of civil aviation security human factors and to foster standards and guidelines. Participants included government agencies and Universities from the United States, Canada, England, Australia, Switzerland, Belgium, and Japan, as well as representatives from the European Civil Aviation Conference. During this small forum, she was able to share her research while learning about the upcoming

technological trends in aviation, such as liquid screening detectors, as well as international and national government initiatives currently taking place.

All together, this experience offered the opportunity to learn how to effectively communicate, strategize and teach in a foreign country, how to effectively communicate research objectives and goals to those whose first language is not English, learn how to be an effective team player in a unfamiliar environment, and how to build effective relationships with other research institutes in order to build-off of their respective strengths.

DISCUSSION AND SUMMARY

Altogether, this grant provided the opportunity for Ms. Ghylin to obtain a more global perspective of research occurring in her field and first-hand experience of collaborating with foreign researchers. Through the duration of the trip, effective communications with foreigners was learned in order to efficiently and effectively communicate research ideas and results. Similarly, effective listening and planning skills were learned in how to adapt to a different culture while still being an effective team player and meeting outlined goals. These skills will be very valuable in the future.

A significant amount of research was also performed that will effectively extend the current NSF grant to better understand human operator behavior in different conditions. Data related to how the human security operator reacts to various elements of the system was collected and is currently being analyzed. Findings should provide more insight into how image enhanced x-ray images effect both screener performance, and ultimate throughput levels of the screening system. A collaboration of other data was also obtained and will be analyzed to try to determine overall effects of expertise and training in the security screening system. These findings will provide insight into ways to enhance the quality of the screening system by providing ways to increase screener performance, while the image enhancement data may provide clues for ways to increase both customer throughput due to shorter screener search times and quality of screening due to better screener performance. Both studies that were performed during this grant period are currently in process of being written up for strong journals in the Human Factors field.

The IREE Program provided the opportunity for Ms. Ghylin to enhance her research capabilities while building ties with an international university. It further provided the opportunity for her to get first-hand knowledge of international upcoming technology and business and government practices in her research field of aviation security.

ACKNOWLEDGEMENTS

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BRIEF BIOGRAPHIES OF RESEARCHERS

Kimberly Ghylin received a B.S. in Industrial Engineering and Management from Oklahoma State University in 2003. She received her M.S. in Industrial Engineering from SUNY at Buffalo in 2005. She is currently pursuing her Ph.D. in Industrial and Systems Engineering from SUNY at Buffalo. Her dissertation work centres on the validity of security inspection as a general inspection process, along with the effects of expertise, time on shift, and image enhancements on overall screener performance and search and non-search component times.