

*27164A4
Fund: R5706
Deliv. #3
(Final Report)*

PR/Award Number: H133G040151
Reporting Period: 11/01/2004 to 10/31/2007

Award Information > Award Information

Most information in this section has been preloaded from your annual report. Please enter your Catalog of Federal Domestic Assistance (CFDA) number and make any necessary changes.

1. PR Award #	H133G040151
2. Grant Title	Analyzing Universal Design Resources Needs for Practitioners in Industry and Government
3. Host Institution/Grantee Name	Julie A. Jacko, PhD
4. CFDA #	84-133
Overall Grant Period	
5. Start Date	11/01/2004
6. End Date	10/31/2007
Principal Investigator	
7. Last name	Jacko
8. First name	Julie
9. Phone	404-385-5041
10. E-mail	jacko@hsi.gatech.edu

I. Financial Information > Budget Expenditures

Note: this section must be completed by your Business Office.

Report your actual budget expenditures for the entire previous budget period, the entire final budget period, and the entire project period (performance period). Your project period (performance period) start and end dates are shown on the first page of this report under "Award Information." They are also found in Block 6 of the GAN.

Enter all amounts rounded to the nearest dollar. Include any carryover amounts from previous budget periods.

Please separate expenditures into federal grant funds and non-federal funds (match/cost share).

1. Actual budget expenditures - Entire previous budget period	
a. Federal grant funds	149411
b. Non-federal funds (match/cost share)	0
c. Total (system generated)	149411
2. Actual budget expenditures - Entire final budget period	
a. Federal grant funds	149411

b. Non-federal funds (match/cost share)	0
c. Total (system generated)	149411
3. Actual budget expenditures - Entire project period (performance period)	
a. Federal grant funds	448556
b. Non-federal funds (match/cost share)	0
c. Total (system generated)	448556

I. Financial Information > Indirect Cost Information

1. If you are claiming indirect costs under this grant and have an Indirect Cost Rate Agreement approved by the Federal government, please indicate the type of rate applied:
 - a. Provisional
 - b. Final
 - x- c. Other
 - d. N/A - do not meet criteria

Specify (if other): Modified Total Direct Cost (Fixed)

II. Outcome Goals of the Award > Outcome Goals of the Award

For your reference, this section lists the outcomes goals you developed in response to the announced priority under which you were awarded this grant (Source: your annual APR)

Goals Entered: 1

- G1 Increase understanding of the influence of resources on universal design

III. Most Important Accomplishments Since Last APR > Instructions

The tables in this section summarize information from your previous annual reports, beginning with your report for the period ending May 31, 2007. The summary tables show: (1) most important publications; (2) most important tools; (3) most important technology products and devices; (4) most important informational products; and (5) other accomplishments and contributions reported for this grant.

If you have completed any other such accomplishments since you submitted your last APR, please add those in the appropriate table. Otherwise, this information is for reference in completing Section IV, following. (You cannot edit or delete previously entered records.)

NOTE: It is important to stress that outputs reported in this section can be based on research and related activities conducted in a previous reporting period or NIDRR funding cycle as long as they are related to the objectives of the current award and are delivered or disseminated during the period of this award to external audiences. NIDRR defines "external audiences" as audiences that exist outside of the boundaries of project staff and collaborators associated with an award, including outside of NIDRR-sponsored project directors' meetings.

III. Most Important Accomplishments Since Last APR > Type 1 Outputs - Publications

Enter **as many as 3** "most important" peer-reviewed and non-peer-reviewed publications associated with this award that were published by a source external to the project since you submitted your last APR. DO NOT include documents that are currently in review, accepted for publication, in press, or self-published.

Include only publications supported by NIDRR funding that are related to the objectives of the current award.

For any new entries: The last column indicates whether the journal title that you entered is contained in the Institute for Scientific Information database. NIDRR uses this database to determine which citations entered by grantees can be included in its performance measures. It is extremely important that journal titles be entered correctly (e.g., with no abbreviations or spelling errors) so that your citations, where appropriate, will match the ISI database, and can be counted. The master list of ISI journals can be found online at <http://www.thomsonscientific.com/cgi-bin/jrnlst/jloptions.cgi?PC=master>.

After entering a journal title or proceeding, please **be sure to check the last column of the summary table to see whether the title you entered matches an entry in the ISI database**. If it does, the "ISI" column will say "yes."

If the "ISI" column reads no, please choose "lookup" to view a list of entries in the database. Select the correct title, if it appears in the database, and click "OK."

Only journal articles and proceedings will have matches in the ISI database.

ID #	Year Reported	Full Citation	Key Findings or Lessons Learned	ISI
1.2	2007	Choi, Y.S., Yi, J.S., Jacko, J.A., and Law, C.M. (2006). Are "Universal Design Resources" Designed for Designers?. <i>Proceedings of the 8th International Conference on Assistive Technologies</i> (pp. 87-94). Portland, OR: ACM Press, New York, NY, USA.	<ul style="list-style-type: none"> - Many of the UDRs have a considerable number of problems especially in adequately supporting the typical design process and design psychology. - The contributors to Section 508 (Resource A) acknowledged that they failed to incorporate the designer's perspective in their development. Given the fact that Resource A was evaluated poor in our heuristic evaluation, we could see that the heuristic evaluation results are consistent with the contributors' survey response. - The survey results showed that contributor's confidence in his/her experience did not guarantee that relevant issues were dealt with in the development process by the entire committee or team. - The results of this study show that the tailored heuristic evaluation can provide a big picture of the problems with the UDRs. - Further heuristic evaluation could reveal the shortcomings of a wider variety of UDRs. - It is important to have designers' perspectives in mind in the development process of future UDRs. 	No
1.3	Final Report	Law, C. M., Yi, J. S., Choi, Y. S., and Jacko, J. A. (2007). A systematic examination of universal design resources: part 1, heuristic evaluation. <i>Universal Access in the Information Society</i> , 0, 0-0.	This paper presents the evaluation of eight published Universal Design Resources (UDRs) to measure how effectively they support typical design processes and design psychology. New heuristics and principles to evaluate the UDRs from the point of view of designers who were universal design novices were created. Established methodologies for heuristic evaluation were used with the new heuristics. The evaluators found numerous problems in seven of the eight UDRs, providing evidence in support of the hypothesis that the content UDRs does not facilitate the design process and is not commensurate with what is known about typical design psychology.	No
1.4	Final Report	Law, C. M., Yi, J. S., Choi, Y. S., and Jacko, J. A. (2007). A systematic examination of universal design resources: part 2, analysis of the development process.	In this paper, the development process of four Universal Design Resources (UDRs) was analyzed. The results of a heuristic evaluation (HE) of UDRs (Part 1) were used in this (Part 2) study to create an online survey. Thirty-one individuals involved in the creation of the four UDRs responded, 15 of whom were also interviewed. For three resources, the	No

Universal Access in the Information Society, 0, 0-0.

hypothesis was confirmed that meeting the needs of end-users was assumed to be satisfied without systematically addressing them. Additional findings also revealed a common lack of a clearly defined "central idea" among many of the committee members of two US-based ICT accessibility/UD guidelines.

III. Most Important Accomplishments Since Last APR > Type 2 Outputs - Tools

Type 2 outputs focus on the most important tools, measures, or intervention protocols produced under this award since you submitted your last APR. NIDRR defines "tool" (which includes measures and intervention protocols) to include instruments or processes created to acquire quantitative or qualitative information, knowledge, or data on a specific disability or rehabilitation issue.

"Most important" tools refers to those that, **in your judgment**, contribute the most to achieving the outcome-oriented goals for the award by advancing knowledge; increasing capacity for research, training or knowledge translation; or facilitating changes in policy, practice, or system capacity.

You may enter **as many as 2** type 2 outputs produced since you submitted your last APR.

ID #	Name of tool	Type of tool	Corresponding outcome goal	Described in current publication	ID number of publication/Citation or source where description can be found	Year Reported
2.1	Unique heuristics and principles to evaluate universal design resources.	diagnosis or assessment instrument, including physiologic measure	G1	Yes	1.3	Final Report

III. Most Important Accomplishments Since Last APR > Type 3 Outputs - Technology Products and Devices

Type 3 outputs focus on the "most important" technology products and devices produced under this award since your last APR. The determination as to what is "most important" is left to the judgment of the principal investigator. Technology products and devices include but are not limited to: specifications, industry standards and guidelines; software or netware; inventions; patents, licenses, and patent disclosures; working prototypes; products/concepts evaluated; products transferred to industry for potential commercialization; and products in the marketplace.

"Most important" technology products and devices refer to those that contribute the most to achieving the outcome-oriented goals for the award by advancing knowledge; increasing capacity for research, training or knowledge translation; or facilitating changes in policy, practice, or system capacity.

You may enter **as many as 2** type 3 outputs produced since you submitted your last APR.

ID #	Name of technology product	Type of technology product	Corresponding outcome goal	Described in current publication	ID number of publication/Citation or source where description can be found	Year Reported
3.1	Heuristics and guidelines specifically created for conducting evaluation of universal design resources in printed format.	industry standards/guidelines	G1	Yes	1.3	Final Report

III. Most Important Accomplishments Since Last APR > Type 4 Outputs - Informational Products

Type 4 outputs focus on the "most important" informational products produced under this award since your last APR. Information products can include training manuals or curricula; fact sheets; newsletters; audiovisual materials; marketing tools; educational aids; web sites or other Internet sites that were produced in conjunction with your research and development, training, dissemination, knowledge translation, and/or consumer involvement activities.

"Most important" informational products refer to those that contribute the most to achieving the outcome-oriented goals for the award by advancing knowledge; increasing capacity for research, training or knowledge translation; or facilitating changes in policy, practice, or system capacity.

You may enter **as many as 2** type 4 outputs produced since you submitted your last APR.

ID #	Name of informational product	Type of informational product	Corresponding outcome goal	Described in current publication	ID number of publication/Citation or source where description can be found	Year Reported
4.1	The "Universal Design In Practice" Web site	Web sites or other Internet sites		No	http://www.hsi.gatech.edu/cise/udip/	2007

III. Most Important Accomplishments Since Last APR > Other Accomplishments and Contributions

In addition to the outputs previously described, please describe any other accomplishments that occurred since you submitted your last APR that contributed to the achievement of your outcome goals for this award. This can include: (1) awards and other forms of recognition key personnel have received for activities and accomplishments associated with this award; (2) organizational accomplishments that strengthen the infrastructure for conducting high-quality disability and rehabilitation research and related activities; and (3) more consumer-oriented accomplishments that affect the lives of individuals with disabilities and their family members more directly. For all accomplishments that fall into this "other" category, be sure to provide enough detail to describe the nature of the accomplishment and how it is related to your outcome goals.

Year Reported	Other Accomplishments and Contributions
2007	not available
Final Report	<ol style="list-style-type: none"> 1. Ji Soo Yi, a Ph.D. student who is and has been an integral member of this research team was awarded the 2007 Korean-American Scientist and Engineers Association Scholarship. This scholarship honors high-achieving scholars who are working on high-impact areas in their graduate work. 2. This project and the resulting information provides unique insight to the utility of various current and in-development universal design resources. The knowledge gained can be capitalized on by stakeholders within industry and government who are recipients of guidance, standards, and legislation from the universal design community.

IV. Award Summary Over Entire Performance Period > Award Summary

The information you provide in the Award Summary and Future Implications sections should be considered an "Executive Summary" of your award overall.

For reference, your project abstract is provided below.

This research initiative involves a series of studies of stakeholders involved in the process of creating and purchasing universally designed products. The motivation for the studies stems from the continued lack of universally designed products available on the market, despite recent legislation that was intended to boost developments in this area. In attempting to change the behaviors of stakeholders who are involved in introducing new mainstream products the primary vehicle for universal design resources will be information delivered via print and the web (including standards, guidelines,

handbooks, and web-based design and education tools). Lessons from the human factors field are considered in relation to studies of universal design practice in industry, and needs analysis to support universal design resource creation. The target population for this project is people who utilize universal design resources in industry and government. The objective of the proposed research is to understand and document actions/behaviors practitioners involved in design or procurement activities in relation to their use of universal design resources. A systems analysis approach has been employed in the design of research activities. Through observation and measurement, the relevant elements of the system will be examined. Four sequential research activities are proposed for the three-year study: (1) an analysis of universal design guidance in the context of practitioner use employing heuristic evaluation, survey and interview methods; (2) a field-based analysis of supply-chain stakeholder activities, which conducts a needs and task analysis using various contextual inquiry methods; (3) controlled laboratory-based usability studies of resource use during universal design projects; and (4) a summative resources and training effects study, which examines how professionals who are new to universal design concepts approach design, and succeed or fail depending on the level of tuition and the level of resource access that they have during design activities. The needs of end-users of universally designed electronic products (which includes all people but particularly for our interest the needs of people with disabilities) will be met sooner with universal design resources which are as clear as possible, brief, and easy-to-use. The research activities of this project will be an innovative step towards understanding how this can be achieved, by generating dissemination materials which may help those in academia and standards / guidelines committees improve the design of their resources to meet practitioner needs. To this end, the project benefits from a comprehensive dissemination strategy that includes a project website, conference and journal articles for research activities, a 3rd year conference symposium, and a final report that will be available to all via the web. The project team are assisted by an advisory committee which includes national and international experts on matters relating to the project.

1. For each Research and Development project conducted over the entire course of this award, what are the key findings or discoveries that resulted from it? Please respond using a bulleted format. List the findings or discoveries neatly under the title of each research or development project that generated them.
(Limit: 20,000 characters)

Summary of Research Activity 1 - Analysis of Universal Design Guidance in the Context of Practitioner Use:

This study utilized questionnaires and follow-up telephone interviews as data collection instruments. Recruited subjects were those directly involved in the creation and/or authoring of universal design resources. Most were still active professionals and a few retired. The questionnaire was designed to focus specifically on the creation process of universal design resources (standards, guidelines, design tools, databases, etc). The questionnaire was comprised of a combination of multiple-choice, scalar, and open responses. Questions related to respondent's professional skills and roles were limited to those aspects which directly influenced production of the resources being evaluated. Subjects were asked if they would be amenable to a follow-up interview and additional follow-up questions were asked by phone. 31 people were surveyed and 15 of them participated in follow-up telephone interviews.

Key Findings & Discoveries from Research Activity 1:

- Evaluation results showed that most UDRs are poorly rated according to the evaluation criteria. Most importantly, UDRs are not designed optimally for their direct users (e.g., industrial designers and procurement officers).
- Results confirmed that creators/authors of resources being evaluated did not employ systematic procedures to incorporate real user's perspectives.

Summary of Research Activity 2 - Analysis of Supply-Chain Stakeholder Activities:

This activity utilized field studies of individuals and groups who were working in industry and government. This group included practitioners of universal design (e.g. designers, procurement personnel, project managers, and accessibility specialists). Sessions were conducted with 11 subjects from a total of 4 government agencies and 12 subjects from 3 companies in industry. A total of 23 sessions were conducted at the respective subject's workplace. Our field study utilized questionnaires, in-person interviews, and direct observation. At those organizations allowing recording, video and audio recording were obtained. Data collection methods allowed for real-time changing environments – sessions were conducted simultaneous with subject's carrying out their daily work. A combination of in-person interviews, and telephone and email correspondence was used to collect additional data. All subjects were of working age.

Key Findings & Discoveries from Research Activity 2:

- The levels of compliance with UDRs vary, and there is no direct law enforcement despite existing laws (e.g., section 508).
- In both government agencies and companies, a separate organization exists to deal with necessary compliances. Other related teams or organizations (e.g., procurement officers or designers/engineers) simply consult the separate organization to address compliance problems.
- Additional findings during this phase included, ambiguity in UDRs, lack of profitable markets for universally designed

products, lack of enforcement

Summary of Research Activity 3 - Controlled Studies of Resource Use During Projects:

This phase of our research was lab-based. We conducted sessions with 14 university students and 9 industry professionals within the disciplines of industrial design, human-computer interaction, etc. Subjects were given a task that would inherently rely upon the use of online universal design resources to produce an ideal outcome. Both students and professionals were compensated for their participation. Subjects were asked to incorporate universal design into a self-service kiosk that, in the provided scenario, would be located in an airport. Each subject's session was approximately 3 hours in duration with audio and video being recorded throughout. During certain periods the subject would work alone while the research team observed from an adjacent room. Once an hour a research team member would conduct a semi-structured interview to understand and monitor the subject's cognitive status over time. A detailed survey was administered at the conclusion of each participant session. Subjects in this phase of the study possessed little or no experience or exposure to universal design.

Key Findings & Discoveries from Research Activity 3:

- Detailed analysis revealed that preference was influenced by particular aspects of UDRs, such as document structure, writing style, and illustrations/diagrams.
 - Results were generally consistent with those of the previous heuristic evaluation with a few exceptions.
 - UDRs that are too complicated, written in legal terms, and lack relevant content were quickly disregarded.
-

Summary of Research Activity 4 - Longitudinal Studies of Resource Use During Projects:

This phase of your study involved assigning a design based task to subjects who worked online at their convenience for a total period of 4 weeks. Subjects were categorized into 2 groups. Subjects in Group A were instructed to utilize a guideline determined by our previous research findings to be poorly designed (Section 508), and subjects in Group B were instructed to utilize what was previously determined to be a well designed guideline (Irish NDA). The purpose being to conduct comparative analyses of the two resources, and the varying impacts they had on design outcomes of individuals within the two groups. Subjects with no previous universal design experience were recruited for this study. Subjects worked remotely during this study, at their convenience, through accessing a website designed by our team. The website included capture of time spent by each participant as well as a survey to track progress. Each participant spent a total 12 hours during a four week period.

Key Findings & Discoveries from Research Activity 4:

- When enough time is given, designers tend to seek for more detailed information regarding detailed measures and exemplary designs.
- External links to related UDRs are important in enriching participants' ideas and design alternatives.

2. For all other types of projects (e.g. Knowledge Translation, Capacity Building, etc.), what are the key contributions of this award? Please respond using a bulleted format. List the key contributions under the title of each Knowledge Translation, Capacity-Building, Training or Other Project you conducted.
(Limit: 20,000 characters)

N/A

3. Please list in bulleted format the most significant problems you encountered in carrying out the grant.
(Limit: 20,000 characters)
 1. There is a relatively small academic community addressing universal design of Electronic & Information Technology compared to the thousands of companies producing (inaccessible) E&IT. The thousands of companies can be broken down into many thousands of products, and an even greater number of individual designers and other stakeholders who are potentially going to be tasked with creating products that meet legislation such as 255 and 508.
 2. It proved difficult to find within much in the way of current outputs of academic and consulting communities. A study of the current literature on universal design resources reveals little evidence of the systematic consideration of the needs of designers and other individuals who are recipients of universal design guidance.
 3. Obtaining participation in this study from subjects representing industry and government agencies required additional effort from our research team than was originally anticipated.
 4. Obtaining participation in this study from industrial designers who possess an appropriate level of experience in

universal design and accessibility required additional effort from our research team than was originally anticipated.

5. More effort than anticipated was required to manage participation of industrial design students who participated in our longitudinal study.

4. Please explain your methods for addressing the problems listed above and describe their impact on the final outcome of the grant.
(Limit: 20,000 characters)

Addressing Problems 1 and 2

1. Because limited information of existing studies of universal design resources, our team utilized existing heuristic evaluation methodology from the field of human-computer interaction as well as developed a new set of heuristics specifically for evaluating universal design resources. A summary of the newly developed heuristics is as follows.

Principle 1: Address the pertinent product design aspects

H1.1: A coherent vision, purpose, and central idea should be provided.

H1.2: End-user and product goals should be addressed.

H1.3: Potential end-user errors and failure scenarios should be addressed.

H1.4: The factors in product development that are beyond the domain of the designer should be considered.

Principle 2: Support the design process and design psychology

H2.1: Action oriented approaches should be supported and encouraged for readers.

H2.2: Inevitable trade-off decision-making should be supported.

H2.3: Designers should be able to bring past experience into prescriptive problem-solving activities.

H2.4: Commonly employed self-referential viewpoints of readers should be actively countered.

Principle 3: Design the document effectively/*

H3.1: The design of the document should be clear and appealing.

H3.2: Different types of readers, and different usages over time should be supported.

Addressing Problem 3 and 4

Our research team relied upon professional contacts and public information to secure participation from subjects representing government agencies and information and telecommunication technology companies. One of our research investigators resides in Washington DC and was able to rely upon his personal network to create working relationships with several government agencies in this area. Similarly, we secured participation of companies in the Atlanta, GA area through a research team member who is a longstanding member of the accessibility and industrial design communities. Participants were also obtained through affiliations with organizations such as the Industrial Design Society of America (IDSA), and the Association of Computing Machinery Special Interest Group on Computer-Human Interaction (ACM-SIGCHI). Ultimately, our team successfully obtained participation from a sufficient number of government and industry agencies and companies.

Addressing Problem 3 and 4

3. In Research Activity 3, we conducted a lab-based controlled experiment in which designers attempted to perform the task of creating a kiosk as an example of an information and telecommunication technology product. We recruited student designers as being representative of novice designers. We recruited professional designers as representative of experienced designers. Recruitment of student designers was done in collaboration with the industrial design program and human computer interaction program at Georgia Institute of Technology.

Addressing Problem 5

4. In the Research Activity 4, we studied designer usage of universal design resources during the course of a mock project. Tasks were completed online by participants at their convenience - this phase was not conducted in a lab

setting. Similar to R3, student designers participated during a four-week time period. Subjects completing their assigned tasks was initially a bit challenging and therefore a continuous monitoring scheme using clock/in clock/out system was developed and applied by our research team. Participants were required to clock in/out of the system and to complete a survey on their progress and/or difficulties during each 'session'.

5. Looking over all of the projects you conducted and the outputs you produced over the course of the entire grant, what outcomes (changes in learning or knowledge or policy, practice, behavior, or systems capacity) can you say your work helped to bring about? Outcomes do not happen on their own. Therefore, it is important to show: (1) how the research, development, capacity-building, training, and knowledge translation projects you carried out relate to the outputs you produced and (2) how the documented use of these outputs by intended audiences resulted in the occurrence of the type of outcome you are claiming.
(Limit: 20,000 characters)

This research, to the best of our knowledge, is truly novel. Meaning, our look at improving the resources that designers rely upon, will ultimately and inevitably effect the end-user, in this case being those with disabilities. As a result, we're confident publications in every format will be utilized and relied upon by current and future researchers. Published work resulting from this project has been cited on numerous occasions.

Summary of Discovered Problems and Solutions:

Problem 1: Neither the audience nor its needs are clearly defined.

Solution 1: Explicitly define the target user groups of the guidance, research their needs using objective HF/E methods, and systematically address those needs with the way the guidance is constructed and delivered.

Problem 2: The terminology of accessible and universal design is imprecise

Solution 2: Clearly define accessible and/or universal design (and other terminology, if necessary) and gain consensus from the group. Present the definition(s) in a way that is unambiguous for the audience. Test the definition(s) with a representative sample of target users who are not involved in the creation of the guidance.

Problem 3: There is no universally accepted standard of measurement

Solution 3: In developing any guideline or standard, publish the testing method for measuring conformance with the requirements. Conformance reports based on testing methods should allow comparison with similar products.

Problem 4: Enforcement of standards is lax and fails to buy industry's cooperation

Solution 4: Work together with the appropriate authorities to produce a separate enforcement guide based on the legal requirements and on conformance reporting methods, when creating guidelines and standards that are based on legal requirements.

Problem 5: Usability of the guidance is compromised

Solution 5: Using human factors and usability testing methods, conduct user testing on the guidance throughout its development.

Final Project Findings and Recommendations:

From the results of this study, we came up with the following recommendations. As mentioned previously, these recommendations may not be universally applicable and are not intended to be comprehensive, due to the limitations of our study. However, these recommendations should help future authors of UDRs become aware of the kinds of difficulties that designers might have while using currently available UDRs. The most frequently mentioned one in this study (i.e., make it relevant and simple) was listed at the top, and the least frequently mentioned one in this study (i.e., Provide a checklist) is listed at the bottom.

1. Employ UDR heuristics: The heuristics that were developed to evaluate the UDRs in this study (see Section 2.1) can be used to help create effective guidance.
2. Relevance and simplicity: Provide designers with only relevant information. Designers appear to quickly assess whether a UDR contains necessary information or not. If a UDR contains much irrelevant information, especially on its first page, the whole resource could be quickly ignored. Use straight forward and easy language to tell what to do. Do not employ intricate and complicate jargon to indirectly describe what kinds of design practices should be avoided.

3. Illustrate: Provide illustrations with necessary dimensions (e.g., anthropometric data). Provide visual examples and scenarios that show how users interact with products and environments.
 4. Provide aids to navigation: Eliminate unnecessary navigation and provide tools to navigate through a UDR. Simplify the structure of the whole documents. If possible, make a version with the entire UDR in a single HTML file. Provide a table of contents to show the overview. Provide short-cuts to sections that need to be referred repeatedly, mostly illustrations and dimensional data.
 5. Provide checklists: Provide checklists that designers can use to quickly evaluate their own design outcomes.
 6. Seek professional help: Authors of UDR's are usually people who know a great deal about the technical problems and solutions for providing access. Translating that knowledge into a useful UDR requires a number of processes. Editing, technical writing and technical illustration are best performed by skilled professionals.
 7. Usability testing: Is the guidance going to be usable as intended?
Usability testing, conducted by usability experts with representative end users (e.g., designers) will reveal where improvements to readability and understandability can be made.
6. What are the most important "lessons learned" in conducting the activities associated with this award? Note: Lessons learned are different from problems encountered; lessons learned focuses on what you might have done differently if you had to do the work in your grant over again.
(Limit: 20,000 characters)

Our research team is currently planning to seek funding to further work specific to this area. Tangible insight has been documented that the impact of less than optimal universal design resources hinder and/or prevent designers from incorporating adequate accessibility provisions, and ultimately the end-user suffers.

Universal design can be thought of as the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design. Universal design targets mainstream products, and specifically their use by all through accommodation of functional limitations such as use without vision, without hearing etc., regardless of the cause of that limitation (the user's situation, environment, or from a disability).

It is thus critical to determine the utility of various current and in-development universal design resources in order to provide academic, governmental, and standards institutions with a more complete picture of the needs and behaviors of those on the front-lines of electronic device production, with respect to universal design.

Our research team seeks to continue investigating and contributing to the revision and improvement of the presentation of information within and associated with Section 508.

Even within the low numbers of available products, we should consider whether products are universally designed. A cursory analysis of the information provided by manufacturers on GSA's "Buy Accessible" website, for telecommunications and self-contained products shows that few products meet more than one or two of the six functional performance criteria in Section 508. Our research shows it is not simply lack of willingness or even eagerness within the design community to seek to utilize a resource such as Section 508.

In summary, we would seek to broaden the scope of this project. Ever since the academic community took an interest in the universal design field, there has been resource dissemination, which over the years has been presented in virtually every format, to very wide and diverse audiences. There are and have been an abundance of information theoretically available to designers such as national and international standards, how-to-books, websites, database-driven collections of guidance and case-studies. The tacit aim of the producers of universal design resources is to improve the lives of end-users of technology, and therefore the guidance is usually written based on an understanding of the needs of those users who have been discovered via laboratory and field studies, case studies, and other collected experience. However, the recipients of the guidance are not the end-users of the technologies; they are the producers of the technologies. Logic clearly dictates that the needs of the developers (recipients of guidance) must be met in order for them to then be able to follow the guidance embodied in said resources so that they then can meet the needs of end-users.

V. Future Implications > Future Implications

The information you provide in the Award Summary and Future Implications sections should be considered an "Executive Summary" of your award overall.

1. Please describe any anticipated outputs (e.g., publications, tools, and products and/or outcomes, advances in knowledge, increased capacity to conduct or use high-quality research, and changes in policy, practice, behavior or system capacity) that will result in the near future from activities associated with this award, although they have not yet been published or otherwise disseminated or delivered to outside audiences.
(Limit: 20,000 characters)

Publications have resulted from Research Activity 1 in various venues and formats. Additionally, results from Research Activities 2, 3, and 4, have been submitted to journal publications and/or further data are being analyzed. The following papers are included below with their respective status of publication.

1. Yi, J.S., Choi, Y.S., Ginn, J., Jacko, J.A., and Law, C. M., "How Do Designers Use Universal Design Resources in a Design Task?" - submitted to ACM Transactions on Accessible Computing (Based on Research Activity 3)

2. Choi, Y.S., Yi, J.S., Law, C. M., and Jacko, J.A., and Ginn, J. "Universal Design in Practice - The current organization and processes of Universal Design Practitioner (tentative title)" - Manuscript is currently being finalized by authors

3. Choi, Y.S., Yi, J.S., Ginn, J., Jacko, J.A., and Law, C. M., and Ginn, J. "Affects of Universal Design Resources on Design Outcome - A Longitudinal Study (tentative title)"

2. What implications for future research and related activities, if any, do you think have emerged from the work conducted under this award and the findings, discoveries and accomplishments produced to date?
(Limit: 20,000 characters)

Implications of this research will be realized during 1) future development of universal design resources 2) changes of work processes in government and industry of information and telecommunication technology products.

The research activity 1 of the award reported heuristic evaluation of universal design guidelines. We published the developed set of heuristics which can be used for future evaluation of universal design guidelines. Existing universal design guidelines will be modified based on the changes of technology and social and economical environments. For example, section 508 of the Rehabilitation Act is in the process of being revised. Universal design guidelines and standards will also be added in the countries where they did not previously exist. In developing new resources, the experiences and methodology reported in this research will be helpful in those authors and creators effectively catering to the recipient of such information. Additionally, Research Activity 2 has produced a published paper in the area of current work practices and problems encountered in government agencies and companies.

Research Activities 3 and 4 will seek to publish results of the controlled study and longitudinal observations. The analysis will demonstrate practitioner preferences of resources as well as their impact on design outcomes. Ultimately from research such as this, industry and government agencies within the information and technology sectors can improve design and development of products with improved accessibility.