ICED13
INTERNATIONAL CONFERENCE ON ENGINEERING DESIGN, ICED13
19-22 AUGUST 2013, SUNGKYUNKWAN UNIVERSITY, SEOUL, KOREA

APPLYING MODELS OF HELP DESK CONVERSATIONS TO THE DESIGN OF A CUSTOMER SALES SUPPORT INTERFACE

Stan RUECKER (1), Gerry DERKSEN (2), Ted POLLARI (1), Piotr MICHURA (3), Amanda GEPPERT (1), Lauren BRAUN (1), Kwame GREEN (1), Samia PEDRAÇA (4), Scott AUDETTE (1)
1: Illionois Institute of Technology, United States of America; 2: Winthrop University, United States of America; 3: Academy of Fine Arts, Poland; 4: University of Alberta, Canada

ABSTRACT
In this paper, we describe a case study using 3D conversational modeling as an approach to the design of an online interactive system. The system was intended to help customers select electric motors from a wide range of options, and to be used on its own by a customer, or else in conversations between customers and salespeople or motor experts. The primary function, however, was to encourage selection and input of relevant information from the customer. It was in meeting this goal that the conversational modeling was most useful, since it suggested not only the types of information that were central to the process, but also an appropriate structure. Our user study had 17 participants matching motors using the current online Motor Match system and two prototype versions produced by the research team. One of the most significant findings was the participants' interest in the ranking of near-match motors displayed as 'possible matches'. In addition, people using the prototype systems found the correct motor as often as the current online system (prototype 1), or more often (prototype 2), and ranked their level of confidence higher than users of the current system.

Keywords: user centered design, visualization, communication, design methods, conversational modeling

Contact:
Prof. Stan Ruecker
IIT
Institute of Design
Chicago
60654
United States of America
sruecker@id.iit.edu

1 INTRODUCTION

Conversational modeling (e.g. Pask, 1976, Pask 1980; Kunz and Rittel, 1970) is the process of creating visual representations of dialogs, that do not necessarily involve the actual sequence of the discussion as it occurs over time, but allows us to understand features of dialogs in order to build adequate interface to support them. In this project, we combined help desk observations and interviews of experts with chat records and audio transcripts, in order to create physical 3D models of some characteristic help desk conversations. These models were then applied to rich-prospect browsing theory and used as the basis for the design of an interactive visualization for a multitouch surface to help customers make decisions about the purchase of new or replacement electric motors. In cases where a decision might require further consultation with salespeople or experts, the system could also serve as the basis for those consultations, with key pieces of information already in place.

2 CONVERSATIONAL MODELING

At the preliminary stage we used two techniques to get an idea of the important aspects of help desk conversations regarding motors. The repertory grid technique, which is meant here to allow us to compare customers' and help-desk experts' personal constructs (Kelly 1955/1991) about the issue at hand and see to which extent they overlap or where are the gaps in understanding. The second technique was Issue Based Information System (IBIS), which provided us with ready-made structure of argumentative process. We used this structure to filter and order the contents of the conversations. Both methods used in the project have provided us with different perspectives on the customer and expert conversations.

Repertory Grid – personal constructs identification tool

Pask (1980) argues that problems of interaction can and should be considered within the research context of conversation rather than communication. He suggests that the ecology of conversation better reflects the specific idea of interaction and mediation. He is interested in methods of eliciting explanations of problems as well as how the knowledge is represented for the external observer of the conversation.

Pask (1976) recalls experiments by Piaget and Vygotsky aimed at providing means for examining "hidden cognitive events" (p.13). The aim of these experiments was to draw out the concepts formed by a respondent about the given problem situation through the externalization of otherwise inaccessible "data structures". In both cases, the participant is urged by the experimenter to reveal his/her concepts about the problem. The process may go in the direction of revealing the participant's knowledge about a particular topic or to examine her way of thinking. Vygotsky and his associates developed a methodology in which the problem faced by a participant of the study was embedded in a physical artifact. The problem poses some obstacles to the participant who is encouraged to deal with them by verbal explanation or manipulation of the object. The participant works in the presence of the experimenter, who moderators the scenario. The experimenter is involved in the conversation, which topic is exteriorized and acted upon by both people in the form of a physical artefact: the experimenter as well as the participant interprets actions taken during the conversation. In Piaget's case, the problematic situation is also modeled by a physical object. Especially in the case of children the possibility of manipulations of an actual object is stressed as crucial elements of the whole experimental situation. The reification of abstract constructs is required because children need to concretize their operations. They manipulate objects explaining concepts due to trouble in providing verbal explanations that would be coherent.

Pask points to another problem of differences and inaccessability of conversants' "data structures", which are basically what both parties know. Ideally, for a good conversation to take place, there must be some points of overlap between data structures, namely mutual understanding of some shared points in data structures must be present in order to start. How to find those without imposing anything on participants is a serious concern of researchers dealing with learning experiments. Pask states that there are compromises that allow using descriptions made by participants and at the same time set conditions for controlled observations.

Pask then introduces the repertory grid (Kelly 1955/1991), which allows elicitation of personal constructs about a particular topic represented in participants' own terms. During the process participants create their language themselves. The repertory grid allows then to compare participants' conceptualizations in order to find mutually overleaping areas within the conversational domain. A "universe of interpretation" is constructed. The repertory grid was one of the method to operationalize Kelly's Psychology of Personal Constructs.

The repertory grid is a matrix consisting of columns and rows with elements associated with columns and constructs attached to rows. The elements should be examples (instantiations of the particular research topic of interest) with help of which participants can pinpoint their perceptions or constructs. As Tan and Hunter (2002) point out: 'The elements represent aspects considered important (by the researchers and the research participants) within a specific domain of discourse.' The characteristics of elements are to be: "precise, homogeneous, not evaluative, representative, meaningful and relevant to participants, with the examples covering a range" (Alexander and Loggerenberg, 2005). Participants are then asked to decide what example elements they would like to include in the grid. The next step deals with identification of constructs, which score elements accordingly. Participants take three elements and decide in what way two of them are similar and at the same time different from the third one. The process is called triading and results in pairs of contrasting descriptions, or in other words "bipolar statements".

The resulting list of constructs is then used to evaluate and score all the elements included in the column heads in the grid. The general rule for assigning scores is that, if the 1 to 5 scale is used, there should be at least one element scored 1 and one scored 5 for each construct (row). So the evaluation of each element within a particular construct is relative (compared to the group of elements which were included in the grid). The process is repeatable and can last until it produces useful results.

After the scoring is finished, the researcher starts to categorize, what has been gathered by comparing all the constructs and finding the similar ones. To keep a certain level of rigor and objectivity, several researchers can be asked to consolidate the constructs. That would show how people as a group conceptualize the domain of interest, but also by comparing what elements were used and how they were described (as good and bad examples, for instance), how values are placed within the domain by participants.

The process described above is considered a 'classic' one. Over the last 55 years, different variations on the method have been produced (for examples and discussion see Tan and Hunter, 2002).

In our case the clients' conceptualizations can be compared to company experts' and prepare the system to accommodate the differences.

Issue Based Information System (IBIS)

Issue Based Information System IBIS (Kunz and Rittel, 1970) is an information system for documenting and structuring arguments as they appear in context of complex problem situations discussed by a group. The authors's rationale is based on the observed complexity of issues, which have to be solved in everyday practice further named as "wicked problems" (Webber and Rittel 1973).

The problem pointed to by researchers is similar to the one stressed by Pask's concerns about building an adequate conversational domain knowledge representation. Kunz and Rittel (1970) contention is that documenting systems already in use are often too general to properly capture the content of discussions, resulting in the loss of too much information. It results in further problems in retrieving examples of similar problem situations, which were already dealt with. On the other hand "ad hoc" vocabulary used in discussions is not stable, not confined to dictionary meanings of the words used. The challenge is to precisely document key points in discussion for further reference in a way showing what was really meant by participants. To achieve this an inclusion of contextual information is necessary. Documentation of the discussion should incorporate ways to provide descriptors, with contextual information usually being an important part (Kunz and Rittel 1970). Finally, they argue that a transparent working procedure can result in better reasoning, more explicit arguments, and easier development of proper questions, revealing the actual core of the problem.

It is perhaps worth noting that Kunz and Rittel (1970) focus only on the conceptual structure of IBIS. They are not concerned with the actual representation of the system, i.e. what physical form should it take. Instead, the description in the article is aimed at explaining the principles of the system. The only suggestion for possible visual embodiment of the system is an "issue map" as a part of the IBIS structure. It is meant to provide a graphic representation of relationships between system elements but still without any particular proposal about the actual visual realization.

The general structure, provided as scaffolding, consists of:

- topics

- issues
- positions
- questions of facts
- agruments for and against issues or positions
- model problems

A topic can be any problematic situation, even if it may appear unstructured at first. A topic triggers some response from the group. Issues related to topic area are identified. They are results of represent different positions of stakeholders involved in problem-solving activity. Issues or positions are statements, which are discussed by the group. Issues are discussed until a certain level of agreement is reached. The difference between issues and positions is based on their relation to a particular problem situation - issues are about specific cases, while positions are more general, taking into account information from other similar cases. Issues brought to the fore are discussed, namely arguments are raised either supporting them or against them.

The questions of fact are posed to experts if needed. The answers from experts, if controversial, may become issues. The issues can be followed by questions as well as new positions, which again might be questioned and/or argued for and against. Through this kind of arguing for and against, stakeholders build their understanding of the problem components, their interconnections, and possible and possible new positions towards the problem at hand. The process is recursive, open and flexible, and can be extended or changed in any part, at any time. This recursive process is meant to structure the problem situation.

Model problems are generalizations of similar problems; they are classes of problems. Kunz and Rittel note (1970) that the usefulness of such model problems depends on the variables used. Variables applied in the model problem may or may not describe accurately a specific situation at hand.

3 CONVERSATIONAL MODELING

Conversational Modeling

Based on our examination of the audio files, chat texts, and help desk observations, we created 3D models of conversations between customers and motor experts using both an emergent repertory grid and an IBIS-based template (e.g. Figure 1). The models were physically constructed by printing statements from the chats and audio transcripts, color-coded by speaker, and placing them on a layered framework of wires.

Figure 1. A 3D IBIS model of a help desk audio transcription. The analysis of a helpdesk call according to IBIS structural components in 3D space. The columns contain the actual speeches, ordered according to (going from left to right): an introduction of topic, questions and answers regarding facts, issues/proposals, arguments pro and against an issue or a proposal). Time is associated with a vertical axis going from top to bottom. The third dimension marks contextual parts of a conversation (phatics and logistics). They are included in layers behind the actual dialogs about the issues.

Motors Help Desk Observations

We had 3 observers spend approximately 2 hours in the morning and 2 hours in the afternoon at the Motors Help Desk. In total, we spoke with 5 motors experts and the manager, and observed approximately a dozen motors calls. We used a semi-structured interview divided into general and specific questions, took field notes, and made a video record of an hour's worth of calls with one expert.

Review of Existing Motor Match Tool

In addition to having participants try to identify a motor using the existing online motor match tool, we also reviewed the system by attempting to use it to identify the same motor that would be used with study participants.

User Study of Prototypes

The prototypes (Figures 2 and 3) were developed from the conversational models, and also use the rich-prospect browsing theory, where some meaningful representation of every item in the collection is combined with tools for manipulating the display. In this case, the interfaces have distinct areas for the different phases of the conversation, including information exchange, available options, questions about the options, additional facts, and suggested results. These categories are related to the IBIS model but also derive from the repertory grid that we used to understand the structure of conversations in this particular context. The prototype interfaces also show all the motors in the inventory of the hardware catalogue. The number of motors reduces as the specifics of the motor type, phase, model number and seven other characteristics are input. Several design features needed to be tested at an early prototype stage: in particular, we suspected problems with the general layout and how people may perceive the importance of one characteristic over another, which may negatively affect their experience. This was the primary difference between the two prototypes.

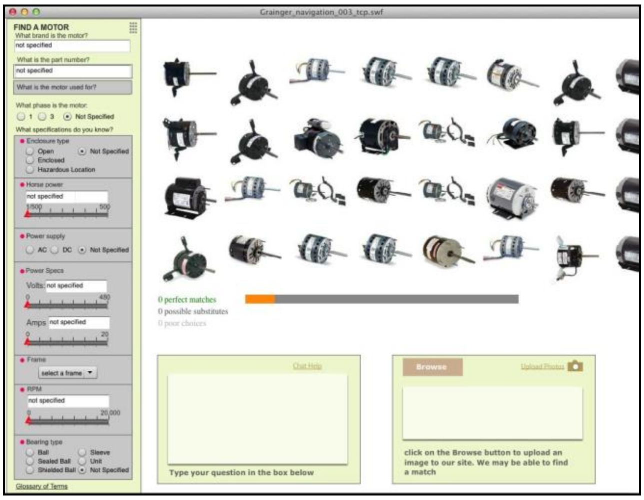

Figure 2. Partial screen shot of prototype v1, with specifications on the left

Figure 3. Partial screen shot of prototype v2, with specifications on a carousel

What we tested:

- The different strategies people use to find a motor.
- User responses to the motor display, clarity and readability.
- If people identify the input of information with a change in search results.
- The slider tools to see how users input data within the specification panels.
- The quality of search to see if a match can be identified within a reduced set of motors.

User profiles:

- Customers who are field engineers (10 participants)
- Customers who are purchasing agents (3 participants)
- Sales agents - (4 managers, sales staff, sales rep.)

The study included usability testing, a questionnaire and follow up interviews. During the usability evaluation, 17 participants, each matching one of the user profile(s), were asked to spend one hour with the system. During this hour, participants:

- Answered a user background questionnaire
- Answered questions about the current site use
- Performed real-world tasks on the system while 'thinking' aloud
- Answered questions about their overall satisfaction

Expected Outcomes:

We expected the tests would reveal a number of technical problems associated with this kind of interface. We were aware that the model name and use fields would not function during the test and might cause users some difficulty. The test was constructed to examine the use of the motor specifications menu items and their ability to filter motors with the same specifications from the included data set of motors. The test was also intended to determine if the concept of rich-prospect browsing can be usefully applied in matching motors. The interface should build confidence in the user to select a motor that has a high level of matches. It was also expected that at least 75% of users would indicate they have found a replacement motor with a high to very high level of confidence. As well we expected users to become more comfortable using the interface as they did the tasks.

4 RESULTS

Results of Conversational Modeling

The conversational modeling tasks produced the following results: Summary of Help Desk Conversations, Analysis of Audio Transcripts and Chats, 3D Repertory Grid, and 3D IBIS model.

Summary of Help Desk Observations

There is a great deal of conditional and contextual information usually needed for motor matching, which is hard to formalize. There are, however, predictable types of calls depending on contextual information (weather, cataclysms, season of the year, approaching holidays, and even Mondays).

Experts would prefer to have more information from the customer than they actually need, but it needs to be reliable. It enables them to filter the important pieces by themselves (e.g. non-standardized way of numbering motors by manufacturers creates confusion when customer reads all the digits, which are on the nameplate).

Resources can be broken down into five primary categories:

- Internal information systems.
- Informally produced/shared databases – tech support staff members have built multiple tools that allow them to quickly access relevant pieces of information.
- Go-to websites
- Physical cheat-sheets. Every expert observed had a significant number of paper-based "cheat sheets" posted around their workspace. The specific items posted varied from individual to individual, with a few frequent items usually included.
- Google. While listed last, this is a very frequently used resource. One frequent use case is to enter an unrecognized part number into Google to find the manufacturer or more information.

Each expert kept a personal log of calls, which included the date/time, name of caller (and salesperson, etc., often with store # or extension #) along with a brief description of the problem and possibly the solution. These logs were kept for about a week, for use as a memory aid. Each expert formatted these differently, but the contents and intent were generally the same.
Experts recognize the need for more widespread availability of online technical documentation (i.e.: wiring diagrams) so that customers don't need to contact them directly for them.

Analysis of Audio Recordings and Chats

In general, calls appeared to yield more successes than chats, in less time. Despite the longer chat durations, the knowledge hand-off from the salespeople to the experts was much more consistent (and consistently used by the experts) in the chats, likely because of the availability of complete transcripts.
We also addressed the following questions using the "nineteen" visualization tool (e.g. Figure 4). Does anything correlate to the success of the call or chat? Possibilities include:

- The use being given (seems to make no difference to the outcome)
- The # of pieces of information given by the customer (no obvious pattern)
- The # of expert questions (Failures usually came in under 4 questions)
- Hand-off quality (no obvious pattern)
- Purpose for the call (no obvious pattern)
- Audio vs text chat (audio calls appear to be more successful; their duration is also shorter)
- Opening gambit (i.e. part number vs specifications) (having a part number may give a slight advantage but specifications are nearly as good)

What correlates to total time?

- The use being given (no obvious pattern)
- The # of pieces of information given by the customer (no obvious pattern)
- The # of expert questions (fewer questions didn't always mean shorter calls)
- Hand-off quality (no obvious pattern)
- Purpose for the call (Problem solving calls were either fairly long or relatively quick, but rarely in the middle-range, by time)
- Audio vs text chat (chats are significantly longer)
- Opening gambit [i.e. part number vs specifications]
- Outcome (The shortest calls were the most frequently successful and outright failures either happened relatively quickly or were significantly longer calls)

Figure 4. The nineteen visualization showing outcome and # of expert questions

Results of Review of Existing Motor Matching Tool

The interactive motor matching tool currently used on the website (Figure 5) was designed to aid the field specialist, maintenance worker, shop technician, etc. to find a motor replacement, parts, or new applications. It has a number of problems with its visual design. The tool is based on a tree structure of inputs (drop down menus and pick lists) that are listed from top to bottom on the screen. There is some confusing language, an implied hierarchy of information – which is inaccurate – and a search structure that does not necessarily yield accurate results. We also questioned the visual representation of the information, which in some cases could be too long or too short to justify a drop down menu, when a check box or radio buttons would suffice.

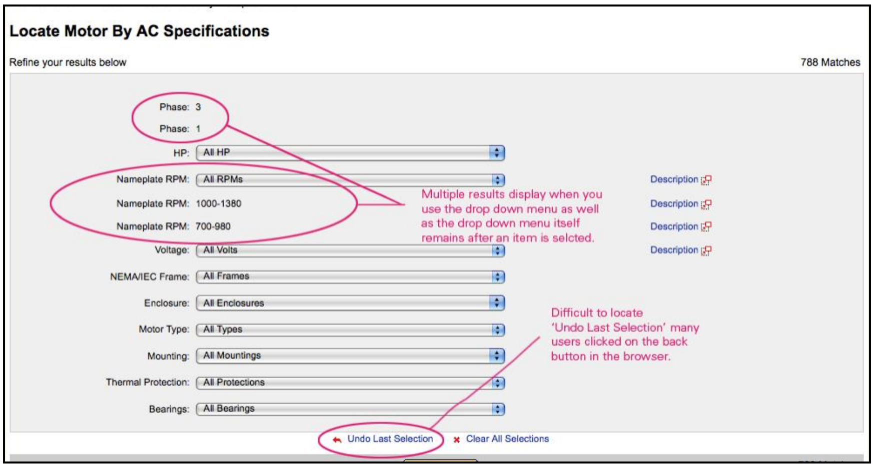

Figure 5. Existing online motor matching tool with annotations

Results of Interface User Study

Profile 1 Field Person - Testing Current Online Motor Match System

Within the first user group there was a distinct difference between those participants who use technology more often and those who are more mechanically inclined. The multitouch surface requires some technique to operate, and while more frequent users of technology tried various techniques, participants who were less technically inclined opted to retry their technique until they were successful in selecting a value. This approach often took twice as many attempts as the other participants.

All participants found the drop down menus difficult to interpret because after a selection is made the drop down remains if more than one other item is available. For example, if the selection of RPM, which has five possible range items, is 1000 - 1350 then the drop down will position itself above the selected range. If a second range is also selected, both selected items will be displayed and the drop down menu will again position itself above the selections. This is confusing to users because it suggests to them more options exist when in fact they do not. “Did it select all three items?” (participant 4) Similarly, when only two options exist in the menu the drop down disappears and both items, the one selected and the other are displayed. This appears to the user as if both have been selected. “Why are both phases listed – I only selected one”. (participant 1)

Often users would ignore the problem with the drop down menu and move on, returning additional motors that made selection more difficult. Two of the four participants were able to match the motor correctly; however, one of those ranked their certainty of selecting the right motor as low. “I would say 2 or 3 on a scale of 1 to 5. I am really not sure and I wouldn’t want to order it because if it was wrong I would have to send it back”.

Profile 2 Field Person and Profile 2 Purchasing Agent – Testing Prototypes

There was no significant difference between the field person and the purchasing agent performance in the usability test; therefore the analysis combines the two groups. A group for purchasing agents was created because we assumed they would focus on cost and availability rather than motor specifications, but it appears that the importance of a correct match is the same for both groups. All participants who entered a part number used the F48SQ6L72 AO Smith model number rather than the 4KA38 number, most likely due to the tendency of reading from the top left and following to the bottom right. (Figure 6) However, many participants did not notice the part number match even after they had found the correct motor replacement. We had only included the part numbers in the test database, so using the manufacturer’s model number reduced the ‘perfect matches’ to zero, resulting in either a failed task or hesitation in making the choice of motor that is suitable. A deployed system would naturally support either model number.

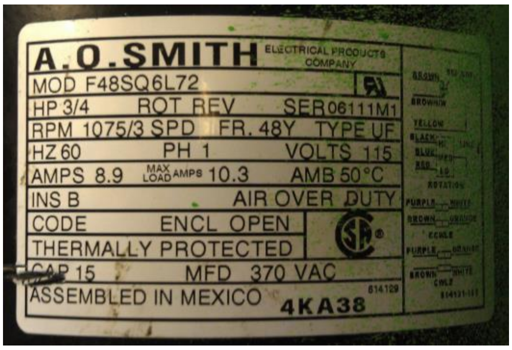

Figure 6. Label on the Broken Motor

In some cases, participants would enter information that resulted in no change to the returns (no animation) or else the animation was not noticed by the participants. Understanding what the animated changes meant was never expressed by participants, however many could explain the total return differences from one input to another: "I had 553 results and now I have none" (participant 8), Experienced users would learn that the animated changes expressed changes of results but a better indication of filtering returns is needed.

Profile 3 Salespeople - Testing prototypes

The participants in group 3 were experienced salespeople from the office in Chicago. Their approach was similar to the customers in entering information from the motor to the panel on the left but it was clear considerations and decisions made by this group were directed toward different priorities within the specifications. Top priorities such as voltage and part number as well as horsepower were entered first before other specifications. Interestingly, all the participants in this group also entered the AO Smith manufacturer's number rather than the stock number.

Fewer alternate strategies were used within this group such as clicking on motors to see what the thumbnails could reveal, or selecting other options to see what happens even if it is not a correct specification. The failure to select a thumbnail directly related to failing to find the correct motor. Progress was halted in some cases through assumptions about the thumbnails that are greyed out as possible choices, as well as the indication that zero perfect matches were returned. Once information was entered, this group did not change the entry unless it was incorrect. Task three, which asked the user to change a value that was different from the broken motor, seemed like an odd request to this group. Conversely, some specifications such as Amps were deemed not necessary and left out even if they knew what the correct value was.

5 DISCUSSION

The structure of the prototypes was based on a combination of IBIS and repertory grid modeling. The potential seen in the prototypes to improve motor identification include a systematic approach to data checking against motor specifications, rich-prospect browsing, and granular matching results that show returns in three categories: 100% perfect matches, 99% near perfect matches, and everything else. The first iteration of the prototype attempted to incorporate all three of these improvements with moderate success. To some extent, the ordering of specifications in the left panel implied their typical significance. For instance, voltage is placed higher than amps because voltage is more often used than amps. Brand name, while not as important from a technical perspective, is important from the client's point of view. Two brands that meet all specifications should still return 100% matching but an indication that the exact brand is higher ranked may be provided by positioning the brand specified by the client before the alternative brands with the same specifications.

Rich-prospect browsing gives the user the advantage of seeing all of the possible motors but had mixed results, in part because of implementation errors in the prototypes.

The greatest change from version 1 to version 2 of the prototype interface was the change in orientation of the specification panels from vertical to horizontal. Somewhat surprisingly, this seemed to have little impact on the order in which participants input the specifications to find matches. A variety of approaches for inputting information to each specification field was taken by participants. The focus of attention did seem to shift to the motor results in the second version (horizontal); however, more participants indicated they liked the left panel layout for ease of reading and usability.

Most people missed inputting phase information, including the sales people. A possible reason for this omission of information was the radio buttons were outside the panel of all the other specification inputs. A simple design fix would be to move it within one of the other input areas off of the background. The phase was one of the first specifications asked of customers in the sample of calls we recorded from the help desk and considered important information in determining the type of motor needed.

6 CONCLUSIONS AND FUTURE RESEARCH

During this phase of the project, we attempted to answer the following questions: using the prototypes based on the conversational models, can people match a motor to one they need? Can they find details to confirm they have the right motor? Can they use the tool to see other motors in the database that don't exactly match but could be substituted? Our initial study suggests that the answers to all these questions is yes. Continued refinements of the interface are needed to ensure user feedback, build confidence in their potential choice making, and ultimately select to purchase a replacement motor.

Beyond the functional aspects of the interface, a number of issues outside the scope of this project became evident. For instance, screen sharing is a feature worth pursuing. Often too much time is spent asking customers to repeat information for the salesperson and motor expert. If technical help is required and screen sharing can be accomplished between all three parties, it would reduce errors and speed the conversation toward the actual problems experienced by the customer.

Greater prominence of the chat feature would encourage users to stay on the site, particularly if screen sharing was an option. However, no one selected the chat as a possible path when they were unsuccessful at locating a motor. Participants may not have thought to use chat or they may have discounted it because of the nature of the tasks asking them to use the specification tools. Our initial considerations for the project began with help desk conversations that are included in the concepts of the prototype interfaces, but further study should integrate more of these sharing and communication tools as a help measure for anyone who has difficulty using the tool.

In addition, we hope to apply the approach of using 3D conversational modeling more widely, most specifically in the realm of adapting the models as mediating objects for conversation in various settings. We have already begun experiments with using this approach for constructing collaborative understanding of shared readings in graduate seminars. Another opportunity is suggested by Boujut (2011), who makes a case for the design of improved mediating objects for use by dispersed design teams.

REFERENCES

Alexander, P.M. and J.J. van Loggerenberg (2005). The repertory grid: 'discovering a 50-year-old research technique'. *Proceedings SAICSIT'05*, 192-199.

Boujut, J-F. (2011). Supporting Annotation-Based Argumentation Linking Discursive and Graphical Aspects of Design for Asynchronous Communication. International Conference on Engineering Design, ICED11. 15-18 August 2011, Technical University of Denmark.

Kelly, G.A. (1955/1991). *The Psychology of Personal Constructs. Vol. 1.* London: Routlege.

Kunz, W. and H.W.J. Rittel (1970). Issues as Elements of Information Systems. *Working Paper 131*. Institute for Urban and Regional Development, University of California, Berkeley.

Pask, G. (1976). Conversational techniques in the study and practice of education. *Journal of Educational Psychology,* 46, pp. 12-25.

Pask, G. (1980). Limits of togetherness. *Proceedings IFIPS'80,* 999-1012.

Tan, F.B. and M.G. Hunter (2002). The repertory grid technique: a method for the study of cognition in information systems. *Management Information Systems Quarterly,* Vol. 26, No. 1, pp. 39-57.