Collecting product-based usability requirements

by M. F. DiAngelo
C. J. Petrun

Customer requirements play an essential role in product development. Accurate definition and assessment of customer needs and wants form the basis for product offerings. Functional requirements have always been central to product definition, and several methods are available to determine required function. Emphasis on product usability and the end-user interface is continuing to increase as computer products are more widely used. This paper describes a requirements-gathering methodology that focuses on usability and user requirements. The Customer Requirements and Task Specification method was developed over the last six years to meet the growing need for more precise user requirements. Each of the major steps is discussed, as is the role of computer-supported cooperative work techniques. Summary findings from a broad cross section of customers are presented.

Defining customer requirements for product development is a dynamic and continual process. Several factors may cause change. New competitive products, advances in technology, government regulations, and changing economic cycles are just a few factors affecting product direction and composition. To keep pace with the ever-changing marketplace, a fast, accurate method of obtaining and processing requirements is needed.

There are several different levels of requirements. At the highest level, information is obtained, analyzed, and considered to delimit the overall direction of an enterprise. Strategic direction, market segments, and product line are determined. At the next level, information is used to ascertain the future of specific product lines and associated services. The third level has to do with specific product attributes, product function, appearance, price, capability, and so on.

This paper deals primarily with the last level of requirements, product-specific requirements. The methodology that is discussed was initially developed to establish a realistic testing environment for IBM software products. Since its introduction in 1988, the base methodology has been modified and expanded to fit several diverse needs. However, the base method with its focus on product requirements emphasizing product usability attributes remains the most popular use.

As levels of requirements differ, so do customers' views of the product. Throughout this paper the word *customer* is used to describe the broadest level of product audiences. Lower-level audiences such as implementers—those who install and maintain products, end users—people who use the product in its normal and intended manner, or technical decision-makers—those who make the purchase decision but may never use the product, are identified when the distinction is required. In some cases one person or customer

0018-8670/95/$3.00 © 1995 IBM

may fill the role of all customer audiences (e.g., a customer for a home personal computer makes the purchase decision, installs and maintains the product, and is the end user). Lower-level audiences are presented for comparison purposes. The methodology used to collect requirements remains the same from audience to audience.

Product requirements can come from many different sources. For existing products, a common and necessary vehicle is the analysis of error or defect information. Product help lines, customer complaints, and information gained from field personnel are just a few ways in which defect information is collected. Defect elimination is an essential process, yet by itself, incomplete. Simply correcting defects may lead to a stable but stagnant product. Getting to customer wants and needs is the heart of requirements gathering. As product cycles become more and more compressed, a fast, accurate method of obtaining customer, or potential customer, information is needed. Many different methods are available; all of them share some basic elements. Known collectively as full-cycle customer information research methods, these approaches have four general sequential steps: preparation, discovery, measurement, and analysis. A problem common to most of these methods is the amount of time it takes to complete them. Customer Requirements and Task Specification (CRTS) was developed using computer-supported cooperative work techniques that have greatly reduced the amount of time needed to complete a full requirements-gathering cycle.

CRTS methodology has three distinguishing features.

Three distinguishing features are associated with the CRTS methodology. First, requirements information comes directly from the customers in their own words. There is no interpretation by anyone other than the customers themselves. Second, requirements are based on tasks—the work and activities people perform or will perform with the product. Both current and future tasks are considered. Third, the customers define product measurements in their own terms. Customer-based measurements are used to assess satisfaction and productivity as well as to define the product.

The remainder of this paper takes the reader through a discussion of customer requirements, usability requirements, the evolution of CRTS, and a more detailed description of the tools and methodology. Along the way summary results and representative data are presented. Each phase of the methodology is discussed in sequence. Task categories and definitions from the IBM BookManager* project are provided to illustrate the contents and detail level obtained in a sample project.

Computer-supported cooperative work, or CSCW, tools are evolving rapidly. The tools described in this paper are parts of a product named TeamFocus. In the time since these projects were completed, TeamFocus has been replaced by GroupSystems V**, which contains a more advanced and complete toolkit.

Customer requirements

Two of the best-known full-cycle customer information research methods used in IBM are the Voice of the Customer and the Structured Brainstorming and Evaluative Survey Technique. These methods, and CRTS, use a customer-based approach to defining requirements. The methods vary in their specific techniques, tools, and procedures. The end result for each method is a series of customer requirements, usually prioritized and defined both in detail and in short form.

Typically, customer requirements studies are conducted for one product, a set of similar products, or a version or release of a single product. Unfortunately, there is little consistency in the way in which customers define their requirements. Without direction customers will develop a grouping or categorization scheme for requirements that is intended for their particular study only. It may or may not be repeatable in a follow-on study, and it may not be comparable to other studies on similar products. To make the

most out of each requirements study, a certain amount of standardization and consistency is necessary so that results can be compared and contrasted with existing or planned projects. However, too much standardization and direction can in fact distort the data and lead to erroneous representation.

The CRTS methodology addresses the problem of "over control" in two ways. First, all data are collected directly from the customer and are captured precisely as the data are written. Some other methodologies rely on interview techniques to gather initial data. In most cases an interviewer will either paraphrase the respondent's words or interpret them to some degree. Either way the original expression is lost. Other recording techniques include video or audio taping or having trained observers take notes during group sessions. No matter what way is used some interpretation of the data will take place, either by the original recorder or the person(s) reviewing the tapes or notes. In CRTS, participants use computers connected by a local area network (LAN) to enter their ideas. Each keystroke is captured and can be recalled later in the session for use by the group. The work group, which is comprised of customers, has control over the categorization of items as well as category labels. This freedom to add, delete, or change categories is the second way in which participants have control. Every idea, or requirement, submitted is categorized by the group. Each item is reviewed and discussed until the group reaches a consensus on its disposition. This technique and other related topics are discussed in detail later in the paper.

The CRTS methodology stresses customer requirements.

To guide the customers through a CRTS session, the session leader, known as a facilitator, has prepared a good deal of information and process structure ahead of time. The key point here is that although the session is well-planned and follows an agenda, the participants are free to say whatever they like and to assign priorities to ideas as they wish and with anonymity. When all ideas have been collected and are ready to be categorized, the group is presented with a list of proposed attribute categories. This attribute list is based on previous sessions and has proved to be adequate for most computer products. The group may accept the list, change it in part, or elect to discard it and create one of their own. In most cases, they elect to stay with the original list with some minor changes. After all of the ideas or requirements have been categorized, the remainder of the group's work is with the attribute categories. They are prioritized and further defined in later steps of the process. Using a consistent categorization scheme allows for comparisons among groups and products.

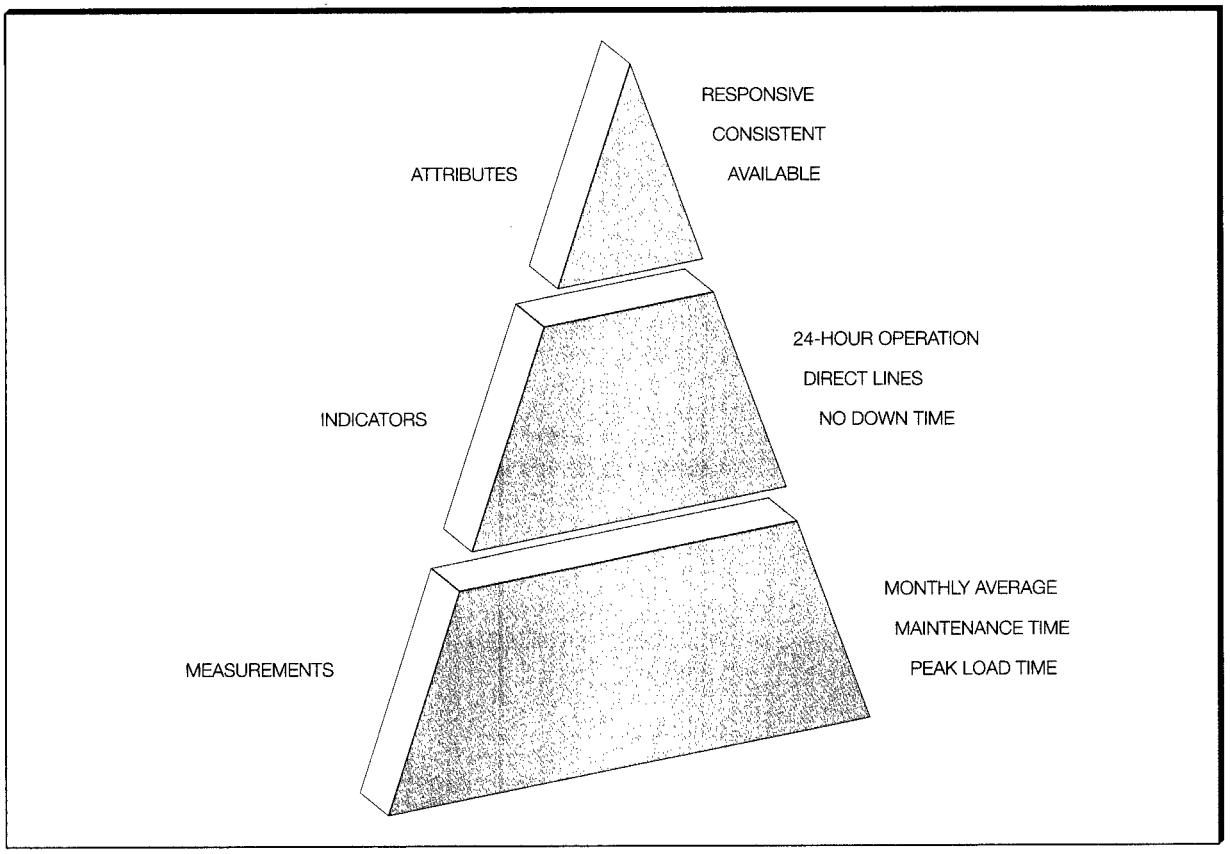
Frequently, product requirements are thought of as specific functional capabilities or in engineering terms (e.g., "must be a 386**"). Most nontechnical customers are not able to express their needs in these terms. They can, however, tell you in their own terms what they want. They may state that they need to be able to go from a shrink-wrap package to an operating application in less than one hour. This statement is a user requirement. It says nothing about the engineering techniques that would allow it to happen, only that the customers need to perform a specific task within a stated period of time. The CRTS methodology stresses customer requirements. When the process is completed, the development team has both technical requirements and customer requirements.

Customer requirements are expressed at several levels. During the session, customers are asked to state what "indicates" a usable computer product to them. These indicators are collected, categorized into higher-level "product attributes," and then further defined by associated measurements and amounts.

The relationship among the three elements—attributes, indicators, and measurements—is illustrated in Figure 1. In this example availability is the high-priority attribute.

Three indicators—24-hour operation, direct lines, and no downtime—were identified. The primary

Figure 1 Relationship among attributes, indicators, and measurements



indicator, no downtime, is measured in time during peak load time. This information was taken directly from a CRTS session dealing with an internal administrative program.

For each of the attributes specified, customers are asked to identify related indicators and measurements. For each attribute there may be several indicators and for each indicator several measures. As seen in Figure 1, measurements are taken in context. In this example, downtime is most critical during peak load time. Although this relationship may seem self-evident, it provides needed information that can determine how and when system maintenance may be performed.

Usability requirements

Product usability is increasingly important to customers. It is difficult if not impossible to deliver usable products if the sole source of requirements is based on defect elimination or functionality. To understand product usability it is helpful to begin with a common definition. Usable products are "ones people can easily learn, that have (consistent) functions that allow people to do what they want to do, and that are well-liked." This definition is attributed to Gould.[1] The CRTS methodology deals primarily with customer tasks (what they want to do) and satisfaction (those things that are well-liked).

Product usability is seen in task context.[2] Using a product to accomplish a particular task or series of tasks will determine whether it is usable. CRTS methodology defines customer tasks in two categories: current tasks and future tasks. Current tasks are those the customer is performing today; future tasks are those the customer wishes to do at some later time whether or not the customer

now has the capability. Once tasks are defined, task scenarios can be developed for use in product usability assessments. Applying the same set of task scenarios to a company's product and to competitive products can yield an accurate assessment of the capability of a product, focusing on those features and functions that are used most frequently and downplaying those that are not. Task definition is also essential for determining the fit between product technology and customer tasks. Although such comparisons may seem obvious, the lack of complete, accurate task descriptions can lead to erroneous conclusions. For example, if the customer set defines tasks as performing general arithmetic calculations, it could be concluded that almost any computer product would suffice. However, a fairly sophisticated computer system may be indicated if the task is further defined as being done in an office environment, frequently throughout the day, for several minutes at a time, dealing with large amounts of data available in a central database, and the final results are required to be in printed form and combined with other printed material. An entirely different type of computer is needed if, in contrast, the task is defined as occurring primarily in the field, of short duration, performed by several different people on the same piece of equipment, where no electrical power is available, and the weight of all equipment is a primary consideration.

The CRTS methodology allows the determination of what measurements can be used to assess customer satisfaction. Customers define satisfaction measurements, techniques, and acceptable levels. In the absence of CRTS or a similar methodology, products may be developed without customer-based satisfaction measurements or by measuring things that may be of importance to the product developer but of little interest or consequence to the customer. Once a product has been introduced to the using population, usage by itself may be considered a surrogate for success: "If they are using it, they must like it, and the product is a success." Often use is an indication of satisfaction and successful product introduction, but only if other alternatives are available and the product is being used for the intended purpose. A product introduced to perform document processing can hardly be considered a success if in fact customers spend their time setting margins, changing fonts, formatting, and performing other activities that deal with document appearance and navigating the computer interface. In this case actual productivity and perhaps satisfaction may decrease.

Evolution

The CRTS methodology came about from the emphasis and research on tools and techniques for group decision-making.[3] Early in 1987 computer-supported cooperative work (CSCW) meeting facilitation was introduced in IBM. Known generically as groupware products, or Electronic Meeting Support (EMS), CSCW applications were demonstrating reductions in total meeting time, cycle time, and improved quality and customer satisfaction.[4] Several Decision Support Centers (DSCs) were established in the company. These centers, also known as TeamRooms, were equipped to run computer-supported meetings using TeamFocus software. At this time many of our internal development organizations were conducting joint application development sessions, or JADS. In a structured setting, representatives of the development team would meet with other associated organizations as well as with customers to define or review design issues. The concept is sound, but there are drawbacks. Occasionally members of the development staff would dominate the meetings, notes were not recorded in a structured manner, there was little or no feedback to the attendees, and some of the customers would report they felt intimidated by the proceedings and did not contribute to the degree that they would have liked.

CSCW meeting facilitation seemed to be a practical solution to the problems associated with JADS. The first attempts were held with internal customers and for specific audiences, those who were either implementers of the system or end users. Implementers are those customers who are engaged in installing, maintaining, updating, and operating the system, while end users are those who use the system or application for its normal and intended purpose, such as creating bills or documents. These first sessions were awkward but showed promise. The base methodology was revised through several other internal product sessions until a standardized tool flow, categorization scheme, and facilitator script were produced. The original attribute list was compiled by a team of IBM human factors professionals and based primarily on their experience. Early product sessions led to a revised list that was later

validated through customer sessions. At this point the methodology was known as TDUR (Task Definition and Usability Requirements).

The primary use of TDUR was to prepare for usability testing of products prior to release. The task definition section provided first-hand customer information to construct task-based test scenarios, and the usability requirements section provided specific measurements and in some cases target amounts. TDUR was used successfully for several projects. Table 1 shows the original attribute categories, their associated indicators, and their priority. Generic indicators are those most frequently mentioned by customers during requirements-gathering sessions. Priority was established by customer rankings.

Application of the TDUR methodology to the AS/400* (Application System/400*) requirements-gathering process led to a list of product attributes that has since been formalized in the AS/400 report card system. This system, developed by Janine Fix of IBM Rochester, is currently used to assess customer satisfaction with the usability of all products in the AS/400 line. An interesting finding of the AS/400 study was the variation in priority given to the same attributes of one product by different customer audiences. Although each group chose the same attributes in five out of six cases, the order of the top five varied by group. Overall, for the AS/400 the top five attributes remained quite consistent.

The same pattern was observed in other product studies. As shown in Table 2, end users of different systems seem to have more common priorities than different audiences of the same product set.

In this comparison, the two office audiences only agree on two items as top priority: ease of learning and walk up and use. The small numbers accompanying each check mark indicate the rank within a group of the top priority items. For example, functional effectiveness was the top priority item chosen by multimedia authors, network operators, and system programmers. The most noticeable difference is between users of office systems and the technical decision-makers who are responsible for selection of the office system.

Table 1 Customer definitions of usability

Attributes	Generic Indicators	Top Priority
Adaptable	Software expandable Software works with other machines Compatible	
Available	Dependable/operational Support multiple users Obtainable	
Easy to learn	Minimum training time Manual well-written and organized Good tutorials and help	✓
Exploitable by experienced users	Macro language Minimum steps for user interface	
Functionally effective	Does what I want it to do Does not force me to change task Complete, no add-ons needed	✓
Learning transfers	Consistent with my programs Builds on my experience	
Operationally efficient	Speedy task completion Minimum steps required Easy error recovery	✓
Satisfying	Good screen color WYSIWYG Appearance	
Supported well	Telephone support available On-line contextual help Clear documentation Action-oriented help	✓
User-appropriate interface	Customizable screens Fast paths Choice of input devices	
Valuable	Cost Eliminates manual tasks Return on investment	
Walk up and use	Immediate productivity Can use without manual No prior training required	✓

As previously stated, TDUR was originally used to prepare for usability testing prior to product release. Current requirements-gathering sessions

Table 2 Key customer requirements

	Home Users	Office Users	Multimedia Authors	Office Technical Decision-Makers	Network Operators	System Programmers
Operationally efficient	1 ✓	4 ✓	2 ✓		3 ✓	5 ✓
Supported well	2 ✓	2 ✓	5 ✓			2 ✓
Ease of learning	3 ✓	1 ✓	4 ✓	2 ✓	4 ✓	4 ✓
Functionally effective	4 ✓	5 ✓	1 ✓		1 ✓	1 ✓
Walk up and use	5 ✓	3 ✓		1 ✓	5 ✓	
Learning transfers				3 ✓		
User-appropriate interface				4 ✓		
Exploitable by experienced users				5 ✓		
Valuable						
Adaptable			3 ✓		2 ✓	3 ✓
Available						
Affordable			1 ✓			
Satisfying						

are conducted at the very outset of a project, not near the end. Information obtained from these sessions provides the basis for early design and prototyping as well as later testing and evaluation.

Later in this paper we will discuss how CRTS methodology was used to gather requirements for BookManager. A product-specific list of attributes and indicators was used. Task analysis and scenario development are also discussed. Since the early work with TDUR/CRTS, many projects have created product-specific attribute and indicator lists.

As the methodology matured and became more widely used, more attention was directed to various cost elements. A major cost element was travel expenses for customers to attend a session at either the home site or an existing Decision Support Center. To reduce travel costs, portable decision support facilities were created. Based on portable or laptop computers, these portable centers can be set up in a matter of hours in most standard conference rooms. Using the portable center, one can move the meeting to the customer instead of the customer to the meeting. In addition to reducing travel costs, it has the additional advantage of increasing participation. Customers are more willing to spend a few hours at a local meeting than they are to spend a day or two traveling to a distant one.

Future plans for CRTS include more changes to basic meeting facilities. For example, work is under way to merge videoconferencing and groupware to allow multiple locations to participate in the same session with full facilitation. Other plans are in place to allow one or two remote participants to join the standard TeamFocus meeting.

Tools and methodology

IBM participated in CSCW research and now commonly refers to its entry as the TeamFocus Center.[5] These centers are located at several sites. A center consists of a room containing a series of personal computers linked together by a LAN. In addition, the room is equipped with a large-screen projector that enables an entire group to view results from use of various software tools. The chief software tool associated with the center is TeamFocus.

The TeamFocus software tool is actually comprised of several different programs, all of which support the enhancement of group communications and decision-making. We now describe the most commonly used software tools.

Electronic brainstorming. The electronic brainstorming (EBS) tool enhances the ability of the group to simultaneously and anonymously exchange ideas and information in response to a specific question or issue. An electronic page of comments is randomly distributed to a participant's terminal each time the Enter key is pressed. The participant can either reference, respond to, or enhance one of the comments or

create a new idea or topic stimulated by the exchange of ideas.

Idea organization. The idea organization tools give the group the ability to interactively classify and organize all of the ideas generated during the EBS session. After the group has developed a set of attributes or categories describing the EBS output, the members jointly review each comment and agree on assigning them to one of the categories. After they have been assigned to a category, the items can be reviewed or changed as the group proceeds through the list of EBS ideas.

Voting tools. Voting tools provide several different measurement tools that allow the participants to define the relative importance of the attributes or the strength of their relationship to criterion items (i.e., decision to buy), or both. The two most commonly used are Ranking (Rank Order) and Alternative Evaluator (a rating scale from 1 to 10). The software then allows the group to immediately view a graphic representation of the results and allows the group to gain insight into their degree of consensus (see below). In CRTS sessions, just as in other group meetings, the amount of agreement required to achieve consensus is determined by the group or project sponsor before the start of the session. In addition, for the Rank Order vote, the tool immediately calculates the mean, standard deviation, and Kendall coefficient of concordance.

We now provide an example of Rank Order vote data.

Vote Session Report
Session: Rank Process Date: 12/16/19933:45pm

Group name: Total Group
Group size: (14 of 14)

Rank Order (no bypass)
Number of items = 9

Participant instruction:
Please rank from most important to least important.

Items Sorted By Rank Sum (Descending):

1. Solution design
2. Relationship management
3. Opportunity management
4. Solution delivery
5. Service and support
6. Resource management
7. Market management
8. Business planning
9. Skills development

The data for this example are given in Table 3.

Group consensus. One of the hallmarks of the CRTS methodology is working with the customer group to obtain consensus on the information obtained in the session. In order to facilitate the consensus process, the results of voting can be viewed by the facilitator and shared with the group. When they are viewed by the group, these results can be used to discuss the rankings within the group. Following the discussion another vote can be taken in an attempt to measure the increase in group consensus. This procedure is important if the group was selected to be homogeneous since it could indicate that variables other than those used for the customer segmentation may be confounding the ability of the group to reach consensus.

For example, let us say that you have segmented your customers on the revenue opportunities they represent in the word processing market. It is possible that you may invite them to a CRTS session, assume they are homogeneous, and believe that if you build a product to their requirements that it will meet the needs of that opportunity segment. During the CRTS session you might find that although the tasks they work on may be similar, their priorities are very different. This dichotomy would show up very clearly during the Rank Order vote. Further discussion or data collected during the collection of task detail in topic commenter may indicate that additional segments exist in this market based on either the task goals or completion criteria. When detected early in the requirements-gathering process, this finding could eliminate the collection of contaminated data that ordinarily would not be discovered until the organizational phase of the research. The result would be significant cost savings to the project.

Topic commenter. Topic commenter is a tool that provides the group with the capability to treat each category created as an index card so that each individual can add more in-depth comments and ideas to the topics. Essentially it provides the function of a basic word processor so that the participants can elaborate on the categories that

Table 3 Rank Order vote data

A. Number of Votes In Each Rating

	1	2	3	4	5	6	7	8	9	Mean	STD	N
1. Solution D	5	2	4	1	2	–	–	–	–	2.50	1.45	14
2. Relationsh	5	4	2	1	–	–	1	1	–	2.71	2.23	14
3. Opportunit	2	1	3	1	3	3	3	–	–	4.07	1.94	14
4. Solution D	–	2	–	7	3	1	1	–	–	4.29	1.33	14
5. Service an	–	2	1	1	1	–	5	4	–	5.93	2.27	14
6. Resource M	1	–	1	2	3	1	–	3	3	6.00	2.54	14
7. Market Man	1	1	2	–	–	3	–	3	4	6.21	2.86	14
8. Business P	–	1	–	1	1	4	3	2	2	6.43	1.91	14
9. Skills Dev	–	1	1	–	1	2	3	1	5	6.86	2.28	14

Coefficient of concordance: 0.36 (1.00 = Most Agreement)

B. Graph (Rank Sum)

```
1. Solution D  **************************************************105
2. Relationsh  ********************************************102
3. Opportunit  ************************************83
4. Solution D  ************************************80
5. Service an  **************************57
6. Resource M  **************************56
7. Market Man  ************************53
8. Business P  **********************50
9. Skills Dev  ******************44
```

they are most familiar with or have gained the most knowledge about in a short amount of time. The importance of collecting this information will be elaborated on in another section of this paper.

The methodology

The research phases. Customer requirements-gathering techniques can be thought of as a series of research steps beginning with preparation and ending with a report. Between the start and end points are three phases: discovery, organization, and measurement. The CRTS method fits quite well into this research step or phase model with a few distinguishing variations. The current techniques for gathering requirements proceed through this research process in a serial manner, with a different group of customers participating in each of the middle phases. In the CRTS methodology, however, the middle phases of discovery, organization, and measurement are implemented in an iterative design. The same group of customers participates in all three phases on the same day, iteratively, until the agenda has been completed.

Current and future tasks, usability requirements. Using the above-noted tools, the CRTS methodology focuses on what people do with their computers, the tasks they perform, and the frequency and importance of the tasks in the customer environment. Current key tasks are defined to allow the development of customer task scenarios that are vital to the effective testing of IBM and competitive products. Future task definitions are also collected and are used to capture potential new product requirements and to ensure that test scenarios also address new tasks or solutions. Customers also define product requirements such as function, capacity, and reliability as well as attributes such as ease of learning, support, and documentation. All information is gathered directly from customers in their own words. The customers themselves reach consensus on a common understanding of terms and the priority of each item. CRTS work products are used directly in usability testing for establishing quantifiable objectives and as input into other quality deployment processes.

Implementation

Preparation stage. The preparation stage for CRTS is quite similar to that for any other customer information-gathering technique. It is necessary to obtain management approval, funding, re-

sources, and market segment definitions and finally select and train a project team. Clearly, it is also necessary to establish management checkpoints and progress-reporting intervals. An important requirement for CRTS is use of TeamFocus Centers (TFCs) and TeamFocus software. Preparation includes preplanning meetings with TFC personnel and scheduling a center at the appropriate time in one of the many locations available within IBM or at one of the established non-IBM centers. Working with the TFC facilitator, the team lead or "initiator" works out a session plan starting with the base methodology and adding steps to address areas of particular interest. Several sessions may be required, depending on market segmentation, geographic areas, and sample size.

The following activities are required to conduct a CRTS session:

1. Determine what information is needed about a product
   - Purpose of session
   - Desired results
   - Application of results
2. Identify planning session participants
   - Implementing team
   - Other participants
3. Define audiences and scope of research
   - Determine number of customer groups and segmenting variables by opportunity
   - Decide on number of CRTS sessions required to fulfill project objectives
   - Determine which product attributes should be focus of session
   - Read background product/project and competitor information to become content-knowledgeable of product
   - Determine location of sessions
4. Develop preliminary CRTS session agenda
5. Lead effort with product marketing representatives to contact customer
   - Develop letter to customers describing CRTS session and requesting their participation
   - Track customer response to letter to participate
6. Perform administrative preparation activities
   - Contact TeamRooms and schedule CRTS sessions
   - Serve as primary contact to TeamFocus facilitators to ensure acceptance and understanding of agenda by facilitators
   - Arrange for coffee, lunch, dinner as required or requested by product marketing representatives
   - Note: Sessions that require customers to stay overnight entail additional logistical activities (e.g., airline reservations, collection of and signature for travel expense accounts)
7. Obtain agreement on final agenda for sessions
8. Determine appropriate CRTS methodology, categorization procedure, TeamFocus tools required to complete agenda
9. Construct slides for meeting to support agenda as required
   - Examples of indicators, measurements, amounts
   - Detailed questions and templates to be used in topic commenter
   - Selection of voting tools
10. Conduct pilot session with facilitator (with customers if requested and available)
11. Conduct CRTS session (with facilitator to drive TeamFocus software)
12. Determine content and format of report to support intended use of CRTS session input
13. Conduct data summary and analysis
14. Deliver report to sponsor

During the preparation phase at least two of the items mentioned above are key steps to the success of the CRTS process. First and most important is the need to conduct a thorough market and customer segmentation analysis so that the correct set of customers may be obtained for the CRTS sessions. In our work to date we have found that this analysis is the most difficult and frequently overlooked step in the preparation phase. This step takes on greater significance for the CRTS procedure since it is recommended that the individual sessions contain a task-based homogeneous customer group audience. The other preparation task that is extremely critical is the selection of the actual questions to be used in the CRTS session. Although a base set of questions can be used as a starting point, some changes may be required by each project, and it is necessary that the project team agree on the questions. Since these questions are entered into the software before the session, lack of agreement on this task will lead to the collection of inadequate or incomplete requirements.

Discovery, organization, and measurement phases. One unique aspect of CRTS is that the customers

provide all the input and do high-level analysis on line in one sitting. This is made possible by use of the TeamFocus software described earlier. These tools not only accelerate the rate at which information is collected but also improve the group's ability to communicate by diminishing some of the barriers to good communication found in most group meetings.[6] In traditional meetings the free flow of information is sometimes hindered by a dominant personality or the differences in status among group members. There are other hindrances: People have trouble sticking to the agenda; only one person can speak at a time. Individuals may not speak at all for fear of ridicule or censure because there is no anonymity. Often group members use abbreviations, acronyms, incomplete thoughts, and inaccurate or ambiguous wording. They speak in the order in which thoughts occur to them, rather than in an order useful to the listeners. The CRTS methodology combined with TeamFocus software and meeting facilitation personnel allow a group of customers, ranging in size from eight to over thirty, to generate, organize, prioritize, and view their progress on large amounts of task and requirements data in a fraction of the time it takes using traditional methods. A typical session lasts just six hours.

CRTS allows customers to provide all the input and do high-level analysis on line in one sitting.

Analysis and reporting phase. Task information as well as usability attributes and other requirements are all captured by the system. Each comment and keystroke is recorded and available for review by participating customers and is printed in final format at the end of the session for the initiator. TeamFocus software eliminates the need to have people take notes or to videotape sessions. All high-level analysis such as task categorization, detailed task definition, attribute definition, and prioritization is available at the end of the session in written form, in the customer's own words, without any "filtering" by IBM. Finer-level analysis such as specific measurement criteria, aggregated task scenarios, and measurement objectives can also be collected by the project team. To do this, team members combine the high-level data available at the end of each session and analyze the data to lower levels by using frequency counts. Soft copies of customer data facilitate further analysis by eliminating the need to rekey information. Although the data reduction phase of any requirements-gathering technique can be very demanding, we have a set of host-based software tools that will do most data reduction automatically.

The reporting stage does require some additional thought as project team members take task and attribute data and decide how to best visually present the information. A high-level report is generated providing current task descriptions, future task descriptions, attributes, associated measurements, and in some cases recommended amounts. This information can be critical in setting product objectives, planning advertising, determining support levels, and predicting product acceptance.

Application of CRTS method. CRTS was first used in 1988 to prepare for the usability testing of a personal computer product. Since that time the methodology has been refined and applied to a wide variety of products, including hardware, software, and large and midrange systems. In addition, the basic CRTS process has been enhanced to allow it to be applied at the beginning, middle, or even the end of the development process. Beginning with the basic steps of task definition and usability requirements, each product group tailors its session to meet its specific needs. Several hundred IBM customers have participated in CRTS sessions at various locations in and out of IBM. Customer comments tell us that CRTS is seen as an indication that IBM is truly listening to them, thus becoming more market-driven. Their participation is a positive, enjoyable experience that benefits them as well as IBM. Not only do they have a chance to voice their opinions and requirements, they are also able to hear from customers just like themselves who may feel the same way, or to offer workable solutions to problems on the spot, a true exchange of quality information.

Table 4 Summary of task categories across all BookManager sessions

Task Category	Description
Primarily nontechnical and technical reader tasks:	
Find/search	Search for topic and keywords by index; search across books, bookshelves; search for help, reference, educational material
View/browse	View company books, documents, reference material, current notes, memos, bulletin board announcements, etc.
Read/proof	Read to learn, to keep current, proof manuals, books; read soft copy when no hard copy is available
Link	Link in and between books, to computer-based training, to soft-copy products for help
Note/annotate	Edit on-line books, manuals, documents; get approvals for reviews; keep current
Distribute	Distribute on-line notes to others (for approvals, etc.); upload or download documents for on-line use
Revise/update versions	Provide timely updates of documents
Edit/perform word processing	Cut and paste between documents, edit, format documents to put on BookManager
View graphics	View pictures for information, perhaps to make changes
Print	Eliminate use of hard copy, save space on bookshelves, print fewer pages
Specialized tasks—administrator:	
Educate	Train end users, answer end-user questions, keep current documents on line, debug, solve problems
Maintain host and PC	Apply test and fixes, maintain files, install upgrades to system versions
Solve problem	Identify and fix system problems, report problems, recreate reported problems (both on the converted documents and the system in general)
Administer documents	Organize and administer soft-copy documents
Test host and PC	Exercise BookManager in test environment, test software below release
Install/verify host	Customize system, install system, verify installed system works
Plan	Assist with project plan, plan for future systems, educate for planning
Secure/evaluate	Authorize users, librarians; evaluate products for future use
Specialized tasks—creator/builder:	
Create	Create documents (including markup conversions), format documents, edit documents for BookManager
Build	Build from BookManager source documents, from Script files, not from PSEG files
Integrate data/convert	Integrate data from various source files to BookManager format, and convert those files
Approve	Get signatures across and within company

As an example of an application, we now look at CRTS and BookManager.

The group responsible for the IBM BookManager product conducted six CRTS sessions in order to obtain a more complete definition of what their customers defined as usability. In addition, they wanted to identify and prioritize the tasks and future task requirements to ensure that their test scenarios reflected the current customer environment. The sessions were conducted in six different cities in the United States in August and September of 1991.

The agenda for these sessions followed very closely the basic CRTS session agenda and essentially focused on the following topics:

- What soft-copy tasks do you currently perform (collection of detailed input on tasks)?
- What soft-copy tasks would you like to be able to do in the future?
- What are the indicators of an easy-to-use soft-copy product, and can they be measured?

Ease-of-use characteristics. Tables 4 and 5 give a summary of the comments the customers made

Table 5 Overall top ten indicators for improving usability

Characteristic	Percentage of Total
Information presentation	15
Use of graphics	8
Speed and response time	7
Additional function	7
Availability on multiplatforms	6
Time it takes to do a task	6
Messages and system feedback	3
Ability to edit	3
Feedback, messages	3
Manuals	2
Total percentage	60

on ease-of-use characteristics (indicators) required for the usability of the product. The indicators were summarized over the attribute list (there were 403 comments) and the attribute associated with the indicators. In addition to obtaining which type of indicators customers judged to be important, CRTS was also able to collect detailed measurement-level information based on these indicators. This information can then be input directly into the development and design process to provide the project with measurable design goals so that costly overdesign does not occur. In addition, these measurement-level data can also be used to judge the successful attainment of the usability or design objectives for a product.

Application of data. For the IBM BookManager product, the CRTS data served to identify the tasks that users perform today with the product and the tasks that they would like to do in the future, and to identify how the users define and measure ease of use. The results of the sessions were utilized to develop task scenarios for benchmark testing of previous releases and iterative testing of follow-on releases now under development. The high-priority tasks identified by the user groups can be considered system-independent, in that they are not tasks *created* by a product, but rather tasks that a product enables users to complete. This concept is important because today products must not only offer many functions but allow users to be more productive in completing tasks that are important to their work goals. Thus, using the list of prioritized tasks in conjunction with the task detail collected with the topic commenter tool, the BookManager human factors professionals were able to generate a set of test scenarios that included the task-based needs of their users. In addition, the results can be used to:

- Develop a measurement framework for determining whether or not a new design is better than the existing design. For example, one recurrent suggestion is that a product user interface should be compatible across platforms but still provide users with good response time.
- Help prioritize future user interface design enhancements. With the methodology, high-frequency tasks, high-priority indicators of ease of use, and difficulties with the current system were all identified. This information can be used by product development people to make the best use of their resources in charting a course for improving users' perceptions of the ease of use of a product.

Future directions. In addition to the original CRTS method, new approaches to using these same techniques on related areas of requirements gathering have also been investigated. Initial feedback from some of the product development groups that have used CRTS indicated a demand for additional types of CRTS procedures to maximize its use throughout the development process. In response, CRTS has also been adapted to reflect the changing world of project and product needs for collecting different types of requirements. For example, CRTS has been changed to:

- Take greater advantage of new TeamFocus tools to reduce session time
- Expand use of CRTS for both local and remote sessions (using TeamKit/VM)
- Expand use of CRTS/TeamFocus to include procedures that can handle a broader scope of requirements-gathering needs (i.e., documentation, prototypes, customer value)

These types of changes are necessary to ensure that CRTS remains customer-driven and flexible enough to meet the changing needs of the development and design processes. Finally, we must never lose sight of the need to constantly strive to reduce cycle time and costs for gathering customer requirements as compared to traditional requirements-gathering procedures (e.g., focus groups, paper and pencil brainstorming). To meet this challenge CRTS continues to evolve to better meet the needs of its customers.

Using electronic meeting support. CRTS methodology is closely tied to electronic meeting support tools. The tools provide increased process speed, anonymity to the participants, and a printed record of results. However, use of the tools must take into account other factors. Participants are required to think while at the keyboard, and all ideas, good and bad, are given equal time and consideration.[7] Since participants are anonymous, individuals cannot be recognized for exceptional contributions. The meeting facilitator requires specialized training in operation of the system. Some breaks in the meeting flow are necessary to run the system or generate reports. Clearly, if electronic meeting support tools are used, access to a computer system is required, and thus there is the risk of system failure. The daily costs associated with software, facilities, and the facilitator ranged between $2500 and $5000 in Canada.[8] Portable systems relieve some expense but require setup, additional planning, and shipping, and they may cost $10,000 or more.[9]

Since the writing of this paper, the use of electronic meeting software products has continued to increase, and its popularity as an approach to conducting many different types of meetings has also increased. For example, GroupSystems V has been used to conduct strategic planning sessions, business process re-engineering sessions, and organizational re-engineering sessions, and it even has been used as an aide to facilitate the questioning of speakers during presentations. As the technology to support GroupSystems V has become more available and its portability has improved, many more meetings now have access to this type of electronic meeting software. It is also apparent that the importance of groups reaching consensus quickly and efficiently will also continue to increase as project development cycles continue to decrease. The authors have one cautionary note regarding this proliferation. Although it has been our experience that the potential to help groups collaborate more effectively with electronic meeting software has increased, many times we have also witnessed cases where it has not been used efficiently. Like common power tools (e.g., electric drill or saw), it is easy to misuse these electronic software tools and therefore end up with results that are neither satisfying nor an improvement over the original way of conducting a meeting.

Finally, we would caution those who wish to use the new electronic meeting software that it is even more important in this environment to plan meetings prior to conducting them. It is imperative that users of these electronic tools meet with their clients and ensure that the required outputs are documented and that a thorough analysis of the best meeting tools is conducted so that the information required by a particular customer or client is delivered. We would recommend that once users have discovered a preferred technique for utilizing the tools, they should be sure to document it so that they can start to develop a specific methodology segmented by meeting type that will allow them to consistently obtain reliable results regardless of the experience or qualifications of their meeting facilitator.

Enhanced CRTS activities. The original CRTS questions have been updated and changed to aid projects that need to focus on improving their customers' satisfaction with the documentation of the projects. For example, in one project that used CRTS to investigate a customer's documentation needs it was discovered that the manuals shipped with the product were very rarely used as intended. Instead the customer's task process required that the manual be rewritten. In addition, it was discovered that the different customer groups for the product had significantly different needs for their manuals. Results such as these led to the discovery of several new requirements that could be implemented to improve customer satisfaction with the documentation.

Prototyping. Another area that has been demonstrated to increase the usability of an interface is the feedback one can receive from the various prototypes that can be created during the development process. As the importance of prototyping has increased, CRTS has also been updated to allow a project to obtain individual feedback on a prototype design in a group meeting environment. This is extremely valuable in reducing the cycle time needed to collect and analyze feedback from customers. Some of the changes that were introduced in CRTS to accommodate the prototype process include changing the EBS questions to focus on some of the common areas of interest in prototype development, such as:

- How can the navigation among the windows be improved?
- For screen xxxxxx what improvements could

be made to increase the ease of understanding the icons, fields, or intention?

Of course, the responses to these questions will benefit from the same advantages as those available for the original CRTS with all customers being able to contribute equally and anonymously and to build on the ideas or comments of the other customers. After this input is organized using the idea organization tool (i.e., drive the group to consensus just as in CRTS), the information can be prioritized, and then additional detail can be collected using topic commenter.

CRTS in Europe. In addition to expanding the focus of the original CRTS methods, CRTS has also been used in Europe at the TeamFocus room in La Hulpe, Brussels. Through the use of CRTS in Europe, customers from six different countries were able to participate in requirements-gathering activities in a manner that minimized their language differences. Because English is the common language used to communicate when individuals from different countries meet, CRTS and TeamFocus enabled each participant to contribute equally to the meeting despite their different levels of mastery of the English language. The feedback received from the participants was very positive and indicated that they were better able to participate as equals in the meeting.

Conclusions

CRTS has been used successfully on many products and projects within IBM, both for internal and non-IBM audiences. The popularity of the methodology is due to several factors; foremost among them is reduced costs and cycle time. Several variations of the base methodology now exist and more are sure to come. Advances in CSCW applications, portability, and extensions to same-time, different-place meeting formats will further increase usage.

Product usability can be measured and improved. Information provided by the CRTS methodology, task descriptions, direct customer input, and customer-defined measurement can help provide the basis for improved product usability.

Acknowledgments

We would like to extend our appreciation to our many colleagues in IBM who have adopted the CRTS methodology and influenced its development. Among the primary contributors are Janine Fix, Mitsuo Tanaka, Nancy Grischkowsky, Rob Johnson, Joe DiCecco, Gail Fey, and Joan Gadek.

Cited references

1. *Handbook of Human-Computer Interaction*, M. Helander, Editor, Elsevier Science Publishers B. V. (North Holland) (1988), pp. 757–789.
2. B. Shackel, "The Concept of Usability," in *Visual Display Terminals: Usability Issues and Health Concerns*, J. Bennett, D. Case, J. Sadelin, M. Smith, Editors, Prentice-Hall, Inc., Englewood Cliffs, NJ (1984), pp. 45–87.
3. A. Dennis, J. George, L. Jessup, J. Nunamaker, and D. Vogel, "Information Technology to Support Electronic Meetings," *MIS Quarterly* **12,** No. 4, 591–624 (December 1988).
4. R. Grohowski, C. McGoff, D. Vogel, B. Martz, and J. Nunamaker, "Implementing Electronic Meeting Systems at IBM: Lessons Learned and Success Factors," *MIS Quarterly* **14,** No. 4, 369–384 (December 1990).
5. J. Nunamaker, D. Vogel, A. Heminger, B. Marz, R. Grohowski, and C. McGoff, "Experiences at IBM with Group Support Systems: A Field Study," *Decision Support Systems* **5,** No. 2, 183–197 (1989).
6. R. Dennis, J. Valacich, and J. Nunamaker, Jr., "Group, Sub-Group and Nominal Group Idea Generation in an Electronic Meeting Environment," *Proceedings, Hawaiian International Conference on Systems Sciences*, HICSS-24 (1991), pp. 573–579.
7. C. Deutsch, "Business Meetings by Keyboard," *The New York Times* (October 21, 1990).
8. C. Thornton, "Team Communication—Both High-Touch and High-Tech," *CMA Magazine* (April 1993), p. 37.
9. M. Finley, "Meeting Tools Organize Brainstorming Process," *Public Relations Journal*, 39–40 (March 1993).

Accepted for publication August 19, 1994.

Michael F. DiAngelo *IBM Intelligent Communications Division, 1000 Northwest 51st Street, P.O. Box 1328, Boca Raton, Florida 33429-1328 (electronic mail: mfdiang @bcrvm1.vnet.ibm.com).* Mr. DiAngelo is a senior technical staff member. His areas of specialization are requirements-gathering techniques, computer-supported cooperative work-meeting facilitation, and usability measurement. In his 25 years at IBM, he has held a variety of management and staff positions in the area of human factors. In his last assignment as manager of the Advanced Methodologies and Tools group, he led the team that refined and distributed the CRTS methodology throughout IBM. In prior positions he was instrumental in forming usability and human factors organizations, staffs, and facilities in various IBM software development organizations. His current responsibilities are interface development and requirements definition for the Intelligent Com-

munications project. Mr. DiAngelo holds a graduate degree in psychology from Marist College. He is a member of several technical and professional societies, including the Human Factors Society. He has published papers in the area of usability and human factors, requirements gathering, and customer satisfaction assessment. He has presented papers at IBM human factors technical conferences, the Potomac Chapter of the Human Factors Society, and the Software Psychology Society. He has also co-taught tutorials at the annual meeting of the Human Factors Society and for ACM SIGCHI.

Craig J. Petrun *Coopers and Lybrand, 1530 Wilson Boulevard, Arlington, Virginia 22209 (electronic mail: cpetrunn@reach.com).* Dr. Petrun recently left IBM, where he had been a senior human factors engineer in the Application Development Consulting Practice of the IBM Consulting Group. He specialized in developing and integrating requirements methodologies with electronic meeting software and meeting facilitation. His expertise is in improving product usability through requirements definition and in integrating usability development activities into the software development process. In recent years he has consulted with a variety of product divisions and clients to enhance the usability of software and hardware solutions using electronic meeting support software tools and methodologies. Dr. Petrun is also a licensed psychologist and a certified professional ergonomist. He has led numerous product development and product improvement efforts for a variety of business systems and product development applications. His current responsibilities include using groupware methodologies to facilitate change management and organizational re-engineering projects. Dr. Petrun has presented papers at the Human Factors and Ergonomics Society and the American Psychological Association. He received a Ph.D. and an M.S. in experimental psychology, with an emphasis on information processing, from the University of Kentucky. He received a B.S. from Temple University. He is currently a managing associate and groupware manager for the Coopers and Lybrand Government Consulting Practice in Arlington, Virginia.

Reprint Order No. G321-5555.