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A SURVEY OF THE SOFTWARE REUSE ENVIRONMENT: A STUDY FOR THE NSRS

by

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March, 1994

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The study focuses on eight core questions that are the central issues for the NSRS. On the basis of these eight core questions, a survey was developed that elicited the opinions of Department of the Navy software developers. The analysis of the survey provides conclusions for seven of the eight core questions. These conclusions lead to recommendations that for the most part are completely within the control of Naval Computers and Telecommunications Station (NCTS) Washington. NCTS Washington is the agency presently building the NSRS.

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A Survey of the Software Reuse Environment:

A Study for the NSRS

by

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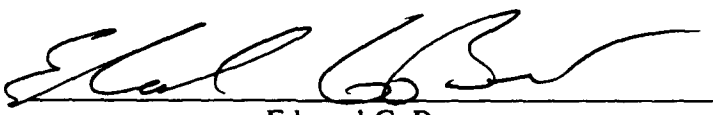
Author: 
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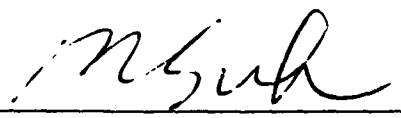
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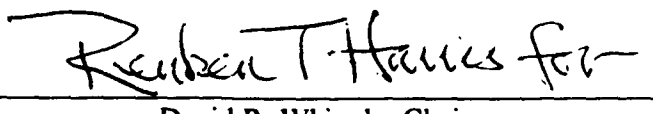
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ABSTRACT

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The study focuses on eight core questions that are the central issues for the NSRS. On the basis of these eight core questions, a survey was developed that elicited the opinions of Department of the Navy software developers. The analysis of the survey provides conclusions for seven of the eight core questions. These conclusions lead to recommendations that for the most part are completely within the control of Naval Computers and Telecommunications Station (NCTS) Washington. NCTS Washington is the agency presently building the NSRS.

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I. INTRODUCTION

A. OVERVIEW

Software development represents an increasingly large portion of the military systems' development budget. The escalating costs are a result of the rapidly increasing size and complexity of these software projects. Many articles and papers have already been published on how software development will be changing in the future. The old process of build it from scratch each time you start a new application is finally starting to give way to a new process. Now an increasing number of software development organizations are taking existing components off the shelf and putting them together to build a totally new application. These off the shelf components are often referred to as Reusable Software Components (RSCs) [Ref. 11]. The RSCs are normally stored in a software repository that resembles a conventional library system. A developer can access this library and search for an RSC that fits his/her needs and withdraw it from the library.

Managers of software development projects learned early on that the documentation, testing, specifications, and requirements data associated with the components were at least as valuable as the executable code. In many cases the executable code was considered the least important piece of the reusable package. Being able to understand how the component was designed

and the process used to build it could be applied to design aspects throughout the overall project. [Ref. 2]

Using RSCs to build a new application increases the quality of the end product while decreasing the development costs. The quality of the end product will be higher since the RSCs within the main program have already passed extensive testing and have been used by other activities as well. If an error is detected in an RSC by a developer, then the error is reported back to the repository. The maintainers of the RSCs will then make the necessary corrections. As more users utilize the library, the components will progressively become more reliable. The costs of correcting errors in the later stages of the development process are dramatically greater than the initial design stages. Since the components from a library should be more reliable than a component built from scratch, fewer errors should be showing up later in the design process. [Ref. 8]

The concept of reusing software components is not a new one. The software industry has routinely reused various components on an opportunistic basis. However, the concept that the practice of software reuse should be an integral part of software development is a novel one. [Ref. 12] Figure (1) illustrates the stages that new ideas and technology will go through before they become institutionalized. In our opinion the software development industry is currently at the understanding phase with respect to software reuse. We are

attempting to understand the concept of RSCs and develop the most suitable process to implement it. It may require that we travel up and down the curve a few times between understanding, evaluation and trial use until a suitable approach is found.

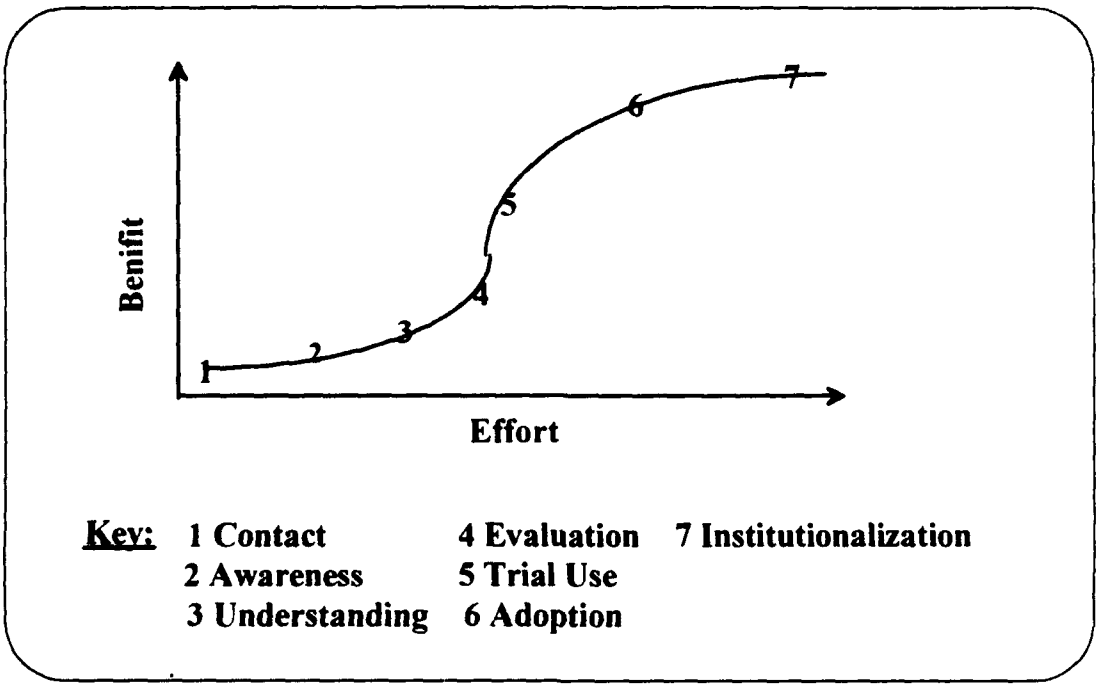

Figure 1. Stages of Software Reuse Maturity. [Ref. 3]

Recently there has been a trend toward centralizing the RSCs so that many unrelated activities can utilize each other's components. In the past, it was normally in-house components that were being reused, not another institution's components. As a result, we now have a collection of relatively small libraries scattered about the industry.

One of the major stumbling blocks to making an institutional standard is understanding what the software developers, the customers of repositories, want

and need. Based upon discussions with several professionals in the software reuse field it is the authors opinion that the initial focus of software repositories was not on who would actually be using the resources. Several of the centralized libraries that have already been established were initially created with a goal to populate the library with as many components as possible in the shortest amount of time possible. One of the main reasons for this initial goal was a political one. The managers of these libraries felt that it was imperative to present some numbers to the people that held the purse strings to continue to be funded. In the budget climate of today this is an understandable concern and tactic. The goal can only work in the short term though. Eventually, the repository must tailor itself to meet the needs of the users and let the justification for the system become its' value to the customers.

B. OBJECTIVE

The objective of this thesis is to determine what software developers in the DON want from a software reuse library system. The information that we collect will be passed on directly to NCTS (Naval Computers and Telecommunications Station) Washington which is in the process of building the NSRS (Naval Software Repository System). The results should enable the repository system and its customers to better serve each other.

C. RESEARCH QUESTIONS

To meet the objective of the thesis we first devised a set of "Core Questions". These questions would form the basis of our analysis. All further study would be based on these questions and answering them would satisfy the thesis objective. The "Core Questions" and the motivation for them are listed below:

- Core Question 1: Which domain[1] or domains lend themselves to becoming customers of the NSRS?

- Motivation: We are investigating to see if the domain of the development activity will influence whether an activity would more likely become NSRS users. If there is an impact what is it and what should NCTS do as a result of the finding. We will be targeting three types of domains for this question: CC/Tactical, MIS, and the horizontal domains.

- Core Question 2: Should NCTS concentrate their efforts on developing electronic links to various sources of RSCs or should NCTS incorporate as many RSCs into their own library?

- Motivation: This question addresses the issue of whether NCTS would be better served pursuing a decentralized or centralized repository scheme. A centralized scheme is where all the assets are collected into one central repository and subscribers have access to the central library. A decentralized scheme would be a collection of smaller libraries interconnected in a network.

- Core Question 3: How much demand is anticipated for RSCs written in languages other than Ada?

- Motivation: All initial DoD efforts into reuse have focused on Ada as the language of choice for reuse. Question 3 is aimed at uncovering other languages that hold promise in the field of software reuse.

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[1] See section E of Chapter II for definition of domain as it applies to reuse.

- Core Question 4: What incentives would be required in order to motivate an organization to donate RSCs?

- Motivation: One of the major hurdles that a repository faces is populating the library with sufficient quality assets. By asking the representatives of development activities, we plan to determine the most effective means to motivate activities to donate their assets.

- Core Question 5: How much business could you expect from an individual customer?

- Motivation: This question is focused on uncovering potentially large reuse customers. We will be looking for activities that are receptive to reuse and are producing a large amount of code per year.

- Core Question 6: What level of documentation do the customers want before they will consider using an RSC?

- Motivation: From this question we expect to determine the optimum effort that should be placed into providing software documentation and testing data. Each asset is reviewed and evaluated before being placed into the repository. Assets that are donated to the repository come in different levels of quality and have various levels of documentation accompanying it. Establishing a critical value for the documentation and the testing required will be a useful tool for the library staff to use in order to focus their efforts more effectively.

- Core Question 7: What will the impact of fee for service be on NCTS? What can NCTS do to prepare for fee for service?

- Motivation: Fee for service will have a major impact on software reuse. This question may prove difficult to answer since a policy for implementing fee for service into the reuse field has not been established. This question is focused on exploring new ideas on how fee for service could be implemented into reuse and obtain feedback from the software development community. Based on the responses from the community we expect to determine a course of action that NCTS can take to better prepare for the change.

- Core Question 8: What is the preferred mode of access for organizations that currently have their own library system?

- Motivation: Activities that have a repository in place can be reasonably expected to be more involved in the field of reuse since they have made the

investment into a reuse library system of their own. We also felt that the components stored in these individual repositories are more likely to be written with reuse in mind than components from a development activity without an in-house repository. These activities need to be looked at separately from other respondents to see what trends can be detected since they are of a higher relative importance.

D. METHODOLOGY

From these core questions a survey was developed (Appendix A). Some of the "Core Questions" required several survey questions to answer, while others could be asked almost directly. We felt that some of the research questions were so broad in nature that if we asked them directly we would either not get a reply or the answers would be so varied that it would be impossible to draw a conclusion. The majority of the survey questions were constructed so that the respondent would answer by selecting from a list of possible choices. Two of the fifteen survey questions asked for written comments for answers. A great deal of effort was put in to make the survey quick and easy to answer to get a relatively high response rate. This was very important since the sample population was less than sixty people.

Feedback on the Core Questions and survey were solicited from NCTS Washington and many of their suggestions were incorporated into the final draft. NCTS was included into the research process to ensure that the conclusions and recommendations were relevant to their repository.

Once the data was collected, the Core Questions were matched with the survey question responses. The data was organized in tabular form and then analyzed in an effort to answer the Core Question.

E. SCOPE

We felt that since the repository that we were doing the research for was a Navy system, we focused on primarily Navy software developers. We came to this conclusion since it could be expected that the majority of the users of the Navy repository would be Navy software developers. Some administrators were also surveyed because they held key positions in the future development of software repositories throughout the DoD. Given the time and resources available, it was not feasible to get the names and addresses of every Navy related software developer. Through various contacts we were able to obtain approximately sixty people that fell within the scope of the research population by the time the survey was sent out.

II. BACKGROUND

A. THE NAVY REUSE CENTER

The Navy Reuse Center is located at NCTS Washington DC and is managed by NCTC (Naval Computer and Telecommunications Command). The Reuse Center was established on the 3rd of March 1992 and is sponsored by the Defense Information Systems Agency/Center for Information Management (DISA/CIM) [Ref. 10]. The center does not currently receive any funding from the Navy but it is targeted towards the Navy software development community [Ref. 9].

The mission of the center is to encourage and assist the Navy's software developers to institutionalize reuse practices in the development process. The center has a customer support component that provides a variety of services. These services include [Ref. 10]:

- Coordination of training for software engineers and managers.
- Individualized service to the customer by locating reusable products and assisting in their integration into the engineering effort.
- Identification and/or acquisition of high demand components within a family of systems.
- Systematic creation of a generic architecture for a specific and well-defined family of systems (i.e., supply, personnel, etc.)
- Assistance in the development of potential RSCs.

The products that the center can offer to the customer are listed below:

- Source code, designs, architecture, templates, documentation, test suites, and code metrics.
- Connection and coordination with other repositories to obtain the desired RSCs.
- Metrics on existing Ada code which provide measures of its reusability, maintainability, portability, and reliability.

The Navy Software Repository System (NSRS) runs on a Micro VAX computer and holds 593 RSCs as of 30 Oct. 93. The NSRS is a Navy version of the Defense Software Reuse System (DSRS) and falls under the jurisdiction of the The Center for Software Reuse Operations (CSRO) [Ref. 13]. The CSRO has overall responsibility for all DSRS facilities. The center has an ongoing effort of identifying and populating the library with high demand components from all possible sources [Ref. 9].

The center has not focused on a particular domain for two reasons. First, the field of software repositories is still relatively new and the process of building a repository is not well defined. Second, the center was established and funded by DISA/CIM for the Navy. The sponsor had an initial focus of Information Systems Domain but the majority of potential Navy customers are in the Communications Domain. [Ref. 9]

B. NAVY REUSE POLICY

The DoD established a policy on software reuse in the DoD Software Reuse Initiative Vision and Strategy Initiative. How to implement this vision and strategy within the DON is described in the Software Reuse Implementation Guide.

The vision of the DoD initiative is "To drive the DoD are community from its current re-invent the software cycle to a process-driven, domain-specific architecture, library-based way of constructing software [Ref. 12]." The strategy to achieve this vision is to incorporate reuse into the software development cycle. The strategy is broken down into ten elements that address issues such as:

- Targeting domains with the greatest potential for reuse.
- Solving the legal issues surrounding reuse.
- Establishing a metrics program to measure the payoff and guiding developers in the selection process.
- Exploiting near-term products and services which facilitate movement to a reuse paradigm.
- Integrating reuse into the software acquisition process.

The objective of the DON Software Reuse Implementation Guide is to provide the guidance to achieve the vision of the DoD Initiative. The guide seeks to institutionalize the practice within the DON.

C. SOFTWARE REUSE

A common misconception is that a software component, once isolated, is automatically reusable. To fully exploit the advantages of software reuse the components within the repository need to be designed to be reusable. A reusable component is one that is cohesive and loosely coupled. Cohesive means the component should be limited to a single topic or function. For example, a cohesive module that performs a sort routine would only sort data provided to it and nothing else. Loosely coupled means the component should require minimal interaction with other modules to perform its main function.

The reusable component should also meet the standards that all other software components are held to. They should be maintainable, efficient, reliable, correct and well documented. The importance of proper documentation is not trivial. The level and quality of documentation is as important as the code itself. The documentation is instrumental in enabling a reuse customer to identify the suitable RSC effectively. The documentation will also allow the user to understand the component so that it can be molded into the main program efficiently.

Building new software components so that someday someone else can use it may not make much sense to a program manager on a tight schedule. It is more time consuming and expensive to design generalized components than

specialized ones. It is not surprising then to see that software reuse has met with significant resistance.

The existence of a library system in itself does not ensure a significant level of reuse. A library could hold all the right assets, and be easy to use, yet still go un-utilized. To change the software development paradigm activities like NCTS Washington will have to play a key role to make the change a successful one.

D. THE ENVIRONMENT

There are many library systems operating today but they generally fall into one of three types of library systems. These general categories of library systems are faceted, bulletin board and an object oriented/ hierarchical style system. The NSRS uses a faceted structure to organize and allow retrieval of the RSCs. Bulletin board libraries such as Public Ada Library (PAL) and Ada Technical Support Bulletin Board are more simplified forms that use a series of directories and sub-directories to organize the RSCs within the repository. The Air Force has a system called CARDS that is a hierarchical system.

A faceted approach uses a list of facets to describe the asset [Ref. 7]. Each facet is filled with a descriptor that best describes the asset. The list of possible descriptors for each facet is predetermined and the descriptor selected must come from that list. The list can be modified as needed to meet the constantly changing environment of software development. Listed below are the nine facets for each asset held in the NSRS:

- Component type
- Function
- Object
- Language
- Algorithm
- Data representation
- Unit type
- Certification level
- Environment

The valid descriptors and their synonyms for the facet component type are:

Facet Descriptor	Synonyms
• Design	Specification
• Functional_spec	Functional_descript
• Implementation	Code
• Requirement	Need

This is not the complete list but it is illustrative of the facet. [Ref. 14]

The Air Force's Central Archive for Reusable Defense Software (CARDS) is a software reuse process. It uses a hierarchical organizational structure to organize the components in a repository. The system takes a specific domain of software development and arranges it into a hierarchical tree structure. This tree structure is similar to that of the directories and sub-directories that PCs use

to manage their disk drives. One of the libraries that has been modeled under the CARDS process is the CARDS Command Center (CC) Library. The CARDS CC Library like the NSRS is a full service library system. The library utilizes a graphic representation of the domain model to refine and clarify application requirements. Since the library is organized in a tree like structure the user can visually see the relationships between the various components within the library and understand how they interact. The knowledge contained in the library is not only in what is stored in it but how it is stored. CARDS was initiated by the Air Force with the goal to create a program to establish software reuse processes and support specific application domains. [Ref. 1]

A less robust but a rapidly emerging form of software repositories, is the Bulletin Board style. One such library is the Public Ada Library (PAL) which is a part of the AdaNet. The PAL is a library of Ada software, courseware, and documentation on an Internet-based host computer. PAL provides no warranties or guarantees as to the quality or functionality of the resources downloaded by users. It does provide quick and easy access to a large repository of software assets. PAL provides some help services on-line and a general announcement bulletin. One of its main attractions is its lack of administrative overhead. There are no middle managers, it is simply programmer to programmer. [Ref. 6]

E. DOMAIN ANALYSIS

The DON defines a "domain" as a functional area covered by a family of systems or across systems in which similar software requirements exist (DON Software Reuse Guide). Domain Analysis is a process of identifying and organizing knowledge that addresses a common class of problems. Once identified and categorized the knowledge asset can be grouped and stored with other assets in the same domain. In the process of building a software repository this is an essential tool to enabling efficient use of the modules within the repository. [Ref. 13]

Domains can be vertical or horizontal. A vertical domain would be a family of assets that correspond to one domain. The vertical domains are further broken down into sub-domains that categorize the assets down to a more detailed level. A horizontal domain would be a family of assets that apply across more than one vertical domain. [Ref. 13]

Examples of vertical domains and sub-domains include:

- Domain - Management Information Systems (MIS)

  SubDomain - Logistics

  SubDomain - Personnel

  SubDomain - Finance

- Domain - Command and Control (CC)

  SubDomain - Air Traffic Control/Carrier Landing Systems

  SubDomain - Local Communication Infrastructure/Base Communications

SubDomain - Naval Sealift

- Domain - Tactical

  SubDomain - Embedded

  SubDomain - Deployable Combat Service Support

Horizontal domains are related by their technical capabilities and features. Examples of horizontal domains include:

- *Communications* (MIS, CC, Tactical)
- Real-Time Scheduling (CC, Tactical)
- Simulations (CC, Tactical)
- User Interfaces (MIS, CC, Tactical)

F. ROLE OF THE REPOSITORY

The role of the repositories has been slowly evolving into being increasingly proactive in the software development process. Software repositories have begun to offer a complete line of services to assist the programmers. A typical repository would offer services such as those already listed for the NSRS.

Some may argue against this trend, seeing it as an intrusion on their field. A programmer at the Fleet Numeric and Oceanographic Center (FNOC) in Monterey CA, had the opinion that he did not want the software repository to "tinker" with the software held within the library. He also did not want any advice or unsolicited input from the library. In his words, "I do not mind the repository packaging and shipping the software to me, but I don't want them handling it. I

will take a look at it and see if I want to use it. I want to make any changes needed, not some third party who knows nothing about my programming problems." [Ref. 5]

Other repositories have taken more of the hands off approach. They make no guarantees about the available software and perform only simple tests to analyze the software component. The most common test is that the item be tested to see if it compiles. Both types of library systems are growing in their acceptance throughout the industry and in their level of sophistication.

III. ANALYSIS OF DATA

A. CORE QUESTION 1

Core Question 1 was: "Which domain or domains lend themselves to becoming customers of the NSRS?" It took several survey questions to answer the Core Question. We have arranged the survey data into tabular form. The table reflects the respective answers to the survey questions from each respondent.

1. Organization of Data

The survey respondents have been divided into four general groups, depending on the survey respondents' domain of activities (Table 1). Group A consists of the respondents that could be deemed as coming predominately from the MIS field. Group B consists of respondents who are equally or almost equally split between MIS and CC domains. Group C is categorized as coming predominately from the CC field. The final group, Group D, fits people that are strictly higher level administrators and do not do any software development.

TABLE 1. CORE QUESTION 1 ANALYSIS TABLE.

	Survey #	Q9	Q10	Q1	Q2	Q3	Q5	Do not utilize external S/W reuse services
GROUP A (MIS)	1	5	1	Y	Y	Y	2	
	5	5	0	Y	Y	Y	3	internal only
	6	5	0	Y	Y	Y	1	internal only
	21	5	3	Y	Y	Y	2	
	22	5	2	Y	Y	Y	1	
	9	4	2	N	Y	Y	1	
	18	4	1	Y	Y	N		
	20	4	2	Y	Y	Y	1	
	7	4	1	N	N	Y	2	
GROUP B (OTHER)	19	3	3	Y	Y	N	2	
	12	2	1	Y	Y	Y	1	
	13	2	2	Y	Y	N	2	
	16	1	2	Y	Y	Y	1.5[a]	
	2	1	2	N	Y	Y	2	
GROUP C (CC/ Tactical)	8	1	4	Y	Y	Y	1.5[a]	
	10	0	5	Y	Y	Y	1	internal only
	3	0	5	Y	Y	Y	2	
	4	0	5	N	N	N	2	none
	11	1	4	N	N	N	2	none
	17	0	5	N	N	N	2	none
GROUP D (NA)	15	0	0	Y	Y	Y	2	internal only
	14	0	0	N	N	N	2	none

1. Indicated that they were equally split between choices 1 & 2.

We used survey questions 9 and 10 to segregate the respondents into the various groups. Questions 9 and 10 are listed below:

- Question 9. What percentage of your software development projects would you categorize as being in the Information Systems domain?
    5) 100%
    4) 70% to 99%
    3) 50% to 69%
    2) 20% to 49%
    1) Less than 20%
    0) 0%

- Question 10. What percentage of your software development projects would you categorize as being in the Command and Control or Tactical domain?
    5) 100%
    4) 70% to 99%
    3) 50% to 69%
    2) 20% to 49%
    1) Less than 20%
    0) 0%

The number to the left of the percentage range represents the value to be placed into the analysis table. If a respondent checked 100% for question 9, and 0% for question 10, then a 5 would be entered into table column Q9 and a 0 for column Q10.

Questions 1, 2 and 3 are represented in Table 1 by entering a Y for a yes or an N for a no response to the respective question. Questions 1, 2 and 3 are listed below:

- Question 1. Do you or your organization have a policy for utilizing reusable software components in development projects? (Y/N)

- Question 2. Is this policy practiced by you and your staff? (Y/N)

- Question 3. Do you currently have a library of reusable components of your own? (Y/N)

Question 5 has three choices for an answer. The question is presented below with appropriate numbers next to the possible answers provided. For example, if the respondent chooses to "maintain your own library", then it would be shown on Table 1 as a 1. The abbreviation Q5 represents question 5 in the table. Question 5 is listed below:

- Question 5. Would you prefer to maintain your own library system allowing others to have access, or turn your library over to a centralized library.

  1) Maintain your own library with all maintenance responsibilities.

  2) Turn over reusable software assets to a centralized repository, with the library assuming the storage and maintenance responsibilities.

  3) Would not consider either

The column labeled "Do not utilize external S/W reuse services" is based on survey question 4. Question 4 asks, "What is the software repository system(s) that you are utilizing?" For this core question, it was not important to know which system they were using. We were only interested to see if they presently subscribe to any external service.

2. Analysis

We examined each domain in more detail to uncover any inconsistencies that may be present. Survey respondent number 7 appears to have an inconsistent answer since his command did not have a policy or

practice reuse, while they had a repository of their own. For this reason we excluded response number 7 from our analysis.

Figure 2 shows the relative breakdown of the groups. The MIS is the largest of the groups with CC/Tactical and OTHER groups being well represented. Group D is shown on the pie chart as N/A, as they didn't fall into any of the domains. Since they were a relatively small portion of the population we decided to exclude from this core question.

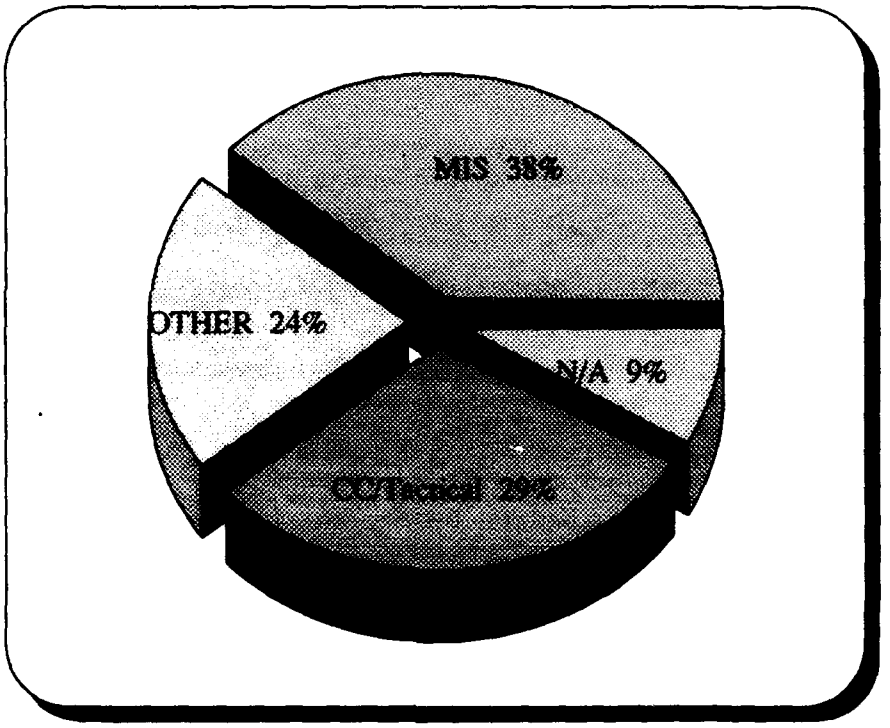

Figure 2. Domain breakdown

We felt that if a particular person or agency met four conditions then they would be prime candidates to become customers of the NSRS. The first condition was that they have a reuse policy in practice (Question 2). The

second was that they were willing to hand RSCs over to a software repository (Question 5). The third condition is found in question 3, which was included to gauge the level of sophistication of the respondent, asking if the person had a library of his/her own. The fourth condition was that they were presently using an external software repository system. If a developer was already using an external repository system then they should be more prone to trying another. Any negative answers in these categories would adversely affect their prospects of signing up to the NSRS.

The MIS group displayed a strong support for reuse. Excluding survey respondent number 7, all respondents practice reuse. (One respondent practices reuse even though they have no reuse policy.) Only one respondent within this group indicated that they did not have some sort of reuse library of their own. Only two of the eight restrict themselves to using only an internal repository system. The answers to question 5 show us that only two of the nine in the MIS group would consider turning their software components over to a central authority. The MIS group as a whole would be highly likely to consider the services of the NSRS but they would probably be less likely to become heavy users. This is based upon the higher percentage of internal repositories and their resistance to donate software to a central authority. The NSRS will need to adjust its operating practices in order to lure this group into becoming

substantial customers. We feel that NCTS Washington will have to offer a separate set of services to motivate this domain to participate in NSRS.

Group B, the "OTHER" group, also showed strong support for reuse. All within this group practiced reuse, with one that practiced reuse even though they had no reuse policy as in Group A. Two out of the five did not have a library system of their own. Only one would not consider handing their components over to a central repository. All in Group B use some sort of external library system. Group B holds high promise for the NSRS. Their relatively strong support for reuse and their willingness to donate their RSCs would indicate that they could easily become regular customers of the NSRS.

Only half of Group C, the CC/Tactical group, showed a strong interest in reuse. Of the three involved in reuse, only one appeared to be uninterested in utilizing the services of an external repository. Of the other half that were not involved in reuse, all were willing to hand over their software to a central system. We feel that CC/Tactical is a domain that will need to be managed on a more case by case basis. There is support within this group for donating software components, but they seem divided as far as their level of reuse involvement. It appears that each activity within this domain would need to be approached separately. Training in the field of reuse would need to be offered to each activity and would probably be required to make them viable users.

Research supports the assumption that a library needs to focus on a well-defined domain or collection of related domains to be an effective system. We support this assumption and recommend that the NSRS focus on one of the domains and not attempt to please all of them. [Ref. 2]

B. CORE QUESTION 2

Core Question 2 was: "Should NCTS concentrate their efforts on developing connections to various sources of RSCs or should NCTS incorporate as many RSCs into their own library?" This Core Question attempts to determine if NCTS Washington should look to establish a vast network of interconnected libraries or should they seek to have the smaller library systems donate their resources to a central library. The Core Question is not focused on the concept of linking major library systems together. The question is meant to address the smaller local library systems. It took several survey questions to answer the core question. We have arranged the survey data into tabular form. The table reflects the respective answers to the survey questions from each respondent.

1. Organization of Data

The data are segregated into three groups on the basis of survey questions 3 and 5 (Table 2). Group A represents people that indicated they would prefer to donate their software assets to a central agency and presently had a library system of their own. Group B represents the respondents that indicated that they preferred to donate their software assets to a central repository, but did not possess a library system. Group C consists of the people that indicated they would prefer to maintain their own system independent of a central activity. Survey respondent number 5 was included into this group. The purpose of question 5 was to identify people that would consider donating

TABLE 2. CORE QUESTION 2 ANALYSIS TABLE.

	Survey #	Agency	Q5	Q3 Own library system
GROUP A *Own library willing to donate*	1	NCTS	2	Y
	2	NAWC	2	Y
	3	FNOC	2	Y
	7	DISA	2	Y
	8	FNOC	1.5 [1]	Y
	15	U of Tenn.	2	Y
	16	DSR	1.5 [1]	Y
	21	NCTS	2	Y
GROUP B W/O own library	4	FNOC	2	N
	11	TELOG	2	N
	13	OASD	2	N
	14	Soft. Prod.	2	N
	17	SPAWAR	2	N
	18	NCTS		N
	19	NCTS	2	N
GROUP C *Own lib. not willing to donate*	5		Neither[2]	Y
	6		1	Y
	9	NCTS	1	Y
	10	NCCOS	1	Y
	12	Mntn. Net	1	Y
	20	NCTS	1	Y
	22	NCTS	1	Y

1. Indicated that they were equally split between choice 1 & 2.
2. Indicated that they did not prefer either choice 1 or 2.

software to a central authority. Since it appears that survey respondent number 5 is not interested in doing so, he/she also fell into Group C.

Questions 3 and 5 are represented in Analysis Table 2 in the same fashion as in Table 1. Questions 3 and 5 are listed below:

- Question 3. Do you currently have a library of reusable components of your own? (Y/N)
- Question 5. Would you prefer to maintain your own library system allowing others to have access, or turn your library over to a centralized library.

  1) Maintain your own library with all maintenance responsibilities.

  2) Turn over reusable software assets to a centralized repository, with the library assuming the storage and maintenance responsibilities.

  3) Would not consider either

2. Analysis

We looked at Group B first. Survey respondent number 18 was excluded from the analysis since they did not answer question 5. It is logical that this group would prefer to turn over their software assets to a central authority since they do not already have a repository system of their own. It is not surprising that an activity would prefer to turn over the responsibility of managing a repository, rather than start one up on their own.

Groups A and C are the focus of this core question and they are almost equally divided. Of the thirteen respondents in these groups, 6 would be willing to turn over their components while seven would not. Our data does not

show a majority of support for either a centralized library system or a more networked one. The overhead involved in linking up many libraries would be more extensive than incorporating various components into one central system. If you factor in the overhead costs, the centralized concept would probably hold a slight edge. A significant portion of the software development community that already has libraries of their own will need some additional incentives if they are to donate their software assets. Core Question 4 will address this issue.

C. CORE QUESTION 3

Core Question 3 asked: "How much demand is anticipated for RSCs written in languages other than Ada?" The purpose of this Core Question is to determine which programming languages should be included into the library besides Ada. We are addressing this issue on a domain by domain basis so that when the NSRS decides to focus on a particular domain they will know which programming languages need to be added to the repository. It took several survey questions to answer the core question. We have arranged the survey data into tabular form. The table reflects the respective answers to the survey questions from each respondent.

Survey questions 9 and 10 which were used to segregate the groups is not repeated in the table. Table 1 should be referred to if the reader cares to see the results of questions 9 and 10.

1. Organization of Data

The survey respondents have been divided into four general groups, depending on the survey respondents' domain of activities (Table 3). Group A consists of the respondents that could be deemed as coming predominately from the MIS field. Group B consists of respondents who are equally or almost equally split between MIS and CC domains. Group C is categorized as coming predominately from the CC field. The final group, Group D, fits people that are strictly higher level administrators and do not do any software development.

TABLE 3. CORE QUESTION 3 ANALYSIS TABLE.

	Surv #	Question 11							Q3	Q5	Use Ext. Lib.
		ADA %	C++ %	C %	FTRAN %	COBOL %	OTHER %	BRAND			
GROUP A (MIS)	1	25		20			55	ORACLE, FOXBASE	Y	2	Y
	5						100	XBASE	Y	3	N
	6						100	BASIC+2(90%), ORACLE PL/SQL	Y	1	N
	9	30	5	5		10	50	XBASE, 4GL	Y	1	Y
	7								Y	2	Y
	18								N		Y
	20	100							Y	1	Y
	21	100							Y	2	Y
	22		30	30	1	20	19	DBASE/CLIPPER, PARADOX, QUICK BASIC	Y	1	Y
GROUP B (OTHER)	2								Y	2	Y
	12	50		50					Y	1	Y
	13								N	2	Y
	16	80	10	10					Y	1.5[1]	Y
	19	60					40	FOXPRO	N	2	Y
GROUP C (CC/ Tactical)	3	0.5		3	96.5				Y	2	Y
	8			5	90		5	Assembler, Pascal, Basic, PL/M	Y	1.5[1]	Y
	10	90		10					Y	1	N
	4	1			99				N	2	N
	11	40		20	40				N	2	N
	17								N	2	N
D N/A	14			50			50	Pascal	N	2	N
	15			100					Y	2	N

1. Indicated that they were equally split between choice 1 & 2.

We used survey questions 9 and 10 to segregate the respondents into the various groups. Questions 9 and 10 are listed below:

- Question 9. What percentage of your software development projects would you categorize as being in the Information Systems domain?
  5) 100%
  4) 70% to 99%
  3) 50% to 69%
  2) 20% to 49%
  1) Less than 20%
  0) 0%

- Question 10. What percentage of your software development projects would you categorize as being in the Command and Control or Tactical domain?
  5) 100%
  4) 70% to 99%
  3) 50% to 69%
  2) 20% to 49%
  1) Less than 20%
  0) 0%

Questions 3 and 5 are represented in Analysis Table 3 in the same fashion as in Table 1. Questions 3 and 5 are listed below:

- Question 3. Do you currently have a library of reusable components of your own? (Y/N)

- Question 5. Would you prefer to maintain your own library system allowing others to have access, or turn your library over to a centralized library.

  1) Maintain your own library with all maintenance responsibilities.

  2) Turn over reusable software assets to a centralized repository, with the library assuming the storage and maintenance responsibilities.

  3) Would not consider either

Question 11 from the survey is the source of the percentages shown for each language. Question 11 is presented below:

- Question 11. Please indicate below the respective percentages of software development programs your organization has developed, or are in the process of developing in the last 24 months.

__% Ada	__% FORTRAN
__% C++	__% COBOL
__% C	__% Other _____

The column labeled "Use ext. Lib." is based on survey question 4. Question 4 asks, "What is the software repository system(s) that you are utilizing?" For this core question, it was not important to know which system they were using. We were only interested to see if they presently subscribe to any external service.

2. Analysis

In Group A, the MIS domain, there is a significant investment in 4GL languages. Programs written in 4GLs are not typically well suited for reuse [Ref. 8]. Investing time and effort into incorporating 4GLs into the library would not produce a good return on the investment required. If the NSRS desires to place 4GL software components into the repository then they might place these RSCs into a system similar to a BBS. The C programming language has the next highest concentration of use in this domain. C is an object-oriented language and would be well suited to reuse. All respondents that used C within this domain use external libraries and have a repository of their own. Only one of

the three expressed a willingness to donate their RSCs to a central repository. If a respondent is not willing to donate, this does not mean that they would not be interested in retrieving components from a repository. This lack of willingness to donate indicates that the library may have some trouble in acquiring RSCs from software developers. We would recommend that NCTS Washington include C components into their library if they are going to specialize in the MIS domain.

Group B, which composed of respondents that developed applications in both domains, paralleled the MIS domain. We recommend that if the NSRS is going to focus on this cross-domain group then they should incorporate components written in C into their library.

Only Group C, CC/Tactical, has a large concentration in the use of FORTRAN. All four of the respondents within this group that had significant investments in FORTRAN were willing to donate their RSCs to a central repository. These four respondents were evenly spit on their use of external libraries and ownership of an internal library system. This would indicate a lower level of software reuse activity but a higher interest in a centralized library concept. FORTRAN has been evolving over the years into a language that has begun to take on many of the same traits of Ada. The maturity of the language and the apparent significant support for it would make it a strong candidate for inclusion into the library if the CC/Tactical Domain was to be targeted.

D. CORE QUESTION 4

Core Question 4 was: "What incentives would be required in order to motivate an organization to donate RSCs?" It took several survey questions to answer the core question. We have arranged the survey data into tabular form. The table reflects the respective answers to the survey questions from each respondent. We decided to use the same groupings as in Core Question 2 so that it would be possible to understand more about the groups and possibly gain further insights. Survey questions 3 and 5 which were used to segregate the groups are not repeated in the table. Table 2 should be referred to if the reader cares to see the results of survey questions 3 and 5.

1. Organization of Data

The data are segregated into three groups on the basis of survey questions 3 and 5 (Table 4). Group A represents people that indicated they would prefer to donate their software assets to a central agency and presently had a library system of their own. Group B represents the respondents that indicated that they preferred to donate their software assets to a central repository, but did not possess a library system. Group C consists of the people that indicated they would prefer to maintain their own system independent of a central activity. Survey respondent number 5 was included into this group. The purpose of question 5 was to identify people that would consider donating

TABLE 4. CORE QUESTION 4 ANALYSIS TABLE.

	Survey#	Incentive	Policy	Feedback	Exposure	Royalties	Free
GROUP A *Own library willing to donate*	1	6	1	4	5	3	2
	2						
	3	1	6	1	5	1	1
	7	5	6	2	1	3	4
	8	2	1	4	3	6	5
	15	1	6	2	5	4	3
	16	3	2	4	5	5	2
	21	3	3	6	6	4	3
Group A Average		2.63	3.13	2.88	3.75	3.25	2.5
GROUP B *W/C library willing to donate*	4	5	6	1	3	4	2
	11	5	4	2	1	6	3
	13	4	1	2	6	5	3
	14	3	6	4	2	5	1
	17	5	6	1	2	4	3
	18	1	6	3	4	5	2
	19	5	1	2	6	3	4
Group B Average		4	4.29	2.14	3.43	4.57	2.57
GROUP C *Own library not willing to donate*	5	2	6	1	5	3	4
	6	3	1	4	6	5	2
	9	0	0	0	0	0	0
	10	2	1	3	6	5	4
	12	4	4	6	5	4	5
	20	1	1	4	6	6	3
	22	3	6	5	6	4	3
Group C Average		2.14	2.71	3.29	4.86	3.38	3
Overall Totals		64	74	61	88	85	59
GROUPS A, B & C	***# of 6s***	1	9	2	7	3	0
	# of 1s	4	7	4	2	1	2

software to a central authority. Since it appears that survey respondent number 5 is not interested in doing so, he/she also fell into Group C.

Questions 3 and 5 were used to segregate the respondents into the various groups and are listed below:

- Question 3. Do you currently have a library of reusable components of your own? (Y/N)
- Question 5. Would you prefer to maintain your own library system allowing others to have access, or turn your library over to a centralized library.

  1) Maintain your own library with all maintenance responsibilities.

  2) Turn over reusable software assets to a centralized repository, with the library assuming the storage and maintenance responsibilities.

  3) Would not consider either

Totals were tallied for each motivator/incentive, and we also counted the number of responses with a "6" or a "1". A "6" would indicate that this is the most desirable idea of the list and a "1" indicated that this is the least favorable idea. Identifying the number of ones and sixes served to further gauge the support and the level of controversy surrounding the idea.

Survey questions 7 and 7A were the sources for this core question. Questions 7 and 7A are listed below:

- Question 7. In your opinion what would be the most effective means or incentives that would ensure a sufficiently populated software repository system. Please rank with a 6 being the highest and 1 being the lowest.

___ Incentive credits towards free access to the library and customer support with respect to the amount donated. *(i.e., For a large donation, unlimited access for a year, or, one-for-one credit).*

___ A mandated DoD policy requiring all government software developers to donate their software components to a repository.

___ Feedback from library customers regarding your donated RSCs. *(i.e., ways they have improved upon your RSC)*

___ Donors gaining exposure to other development activities. *(i.e., If a development activity sees that you have done a large amount of work in a particular area they may subcontract out to you instead of attempting to build from your components.)*

___ Royalties paid to the donor activity when the RSC is used.

___ Free extraction of re-engineered components derived from your donated RSC.

- Question 7A. Please list any other incentives or policies that are not presented in the previous question, that would significantly motivate developers to donate components to the library system.

We graphed the Group averages and overall totals to better show the relationships between them. Figures 3, 4, and 5 are for Groups A, B and C respectively. Figure 6 is a graph of the totals for all groups. Figure 7 and 8 graphically compare the number of 6's and 1's given for each incentive/motivator.

2. Analysis

The advantage of gaining exposure to other software development activities proved to draw the highest overall response (Figure 6). When you look at the relationship between the number of 6's and 1's (Figures 7 & 8), exposure

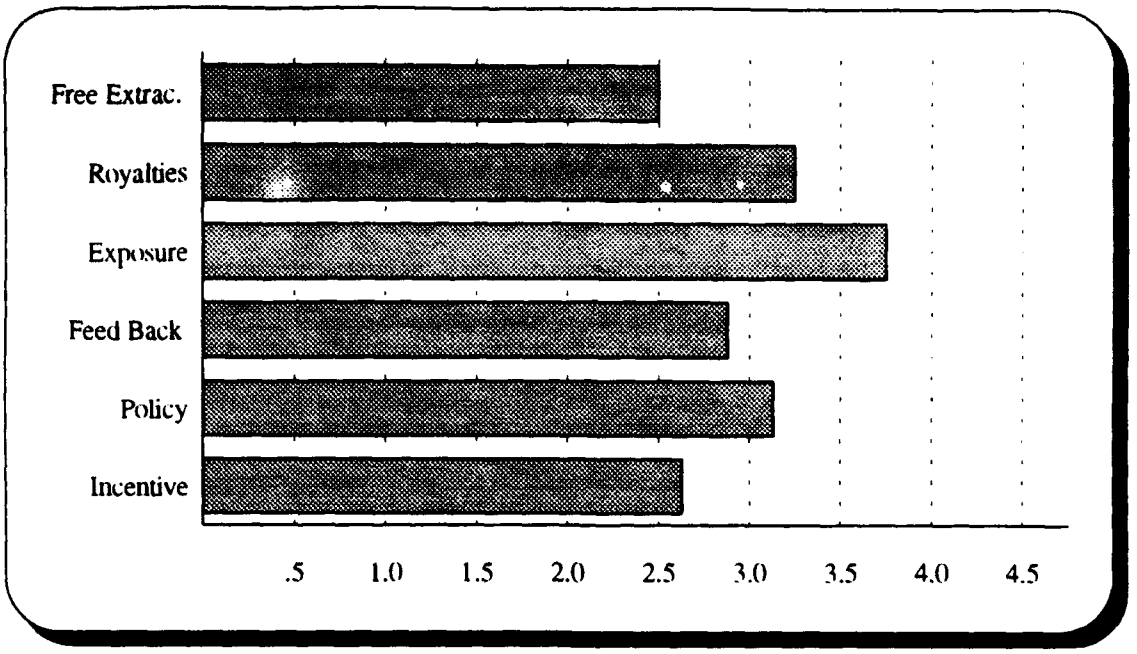

Figure 3. Group A Averages for Motivators/Incentives.

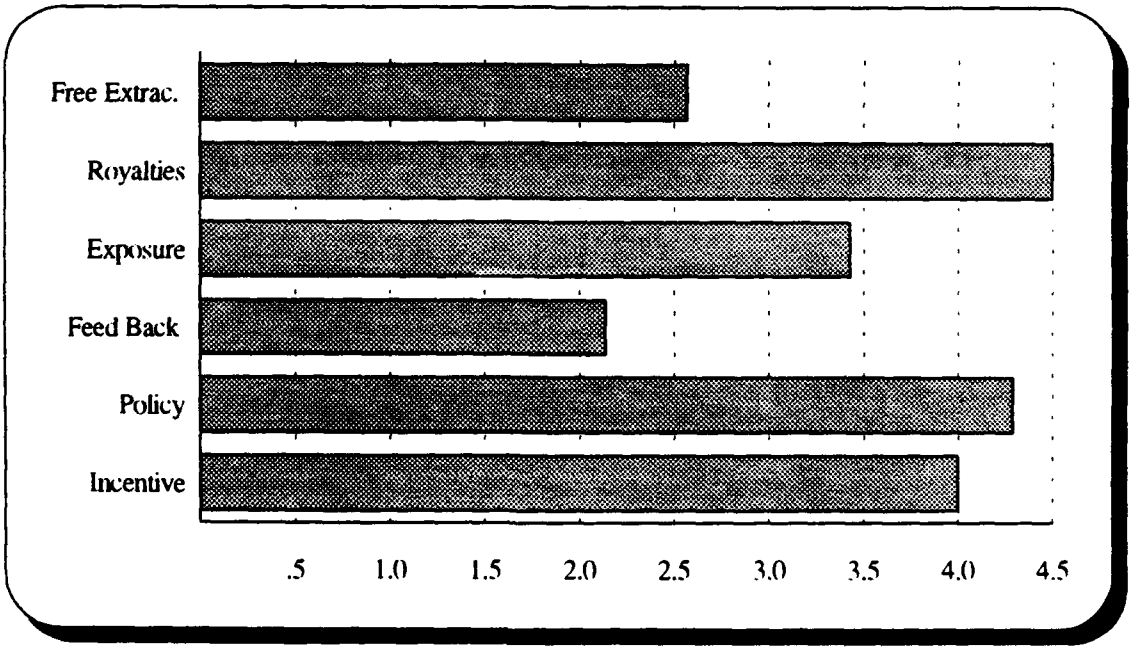

Figure 4. Group B Averages for Motivators/Incentives.

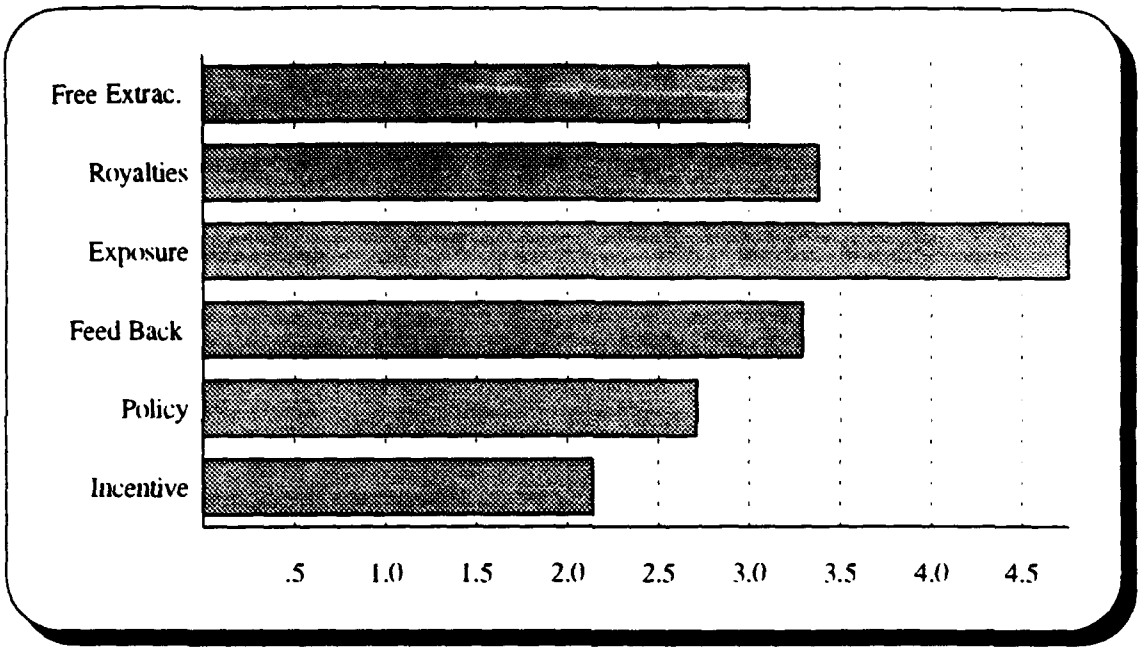

Figure 5. Group C Averages for motivators/incentives.

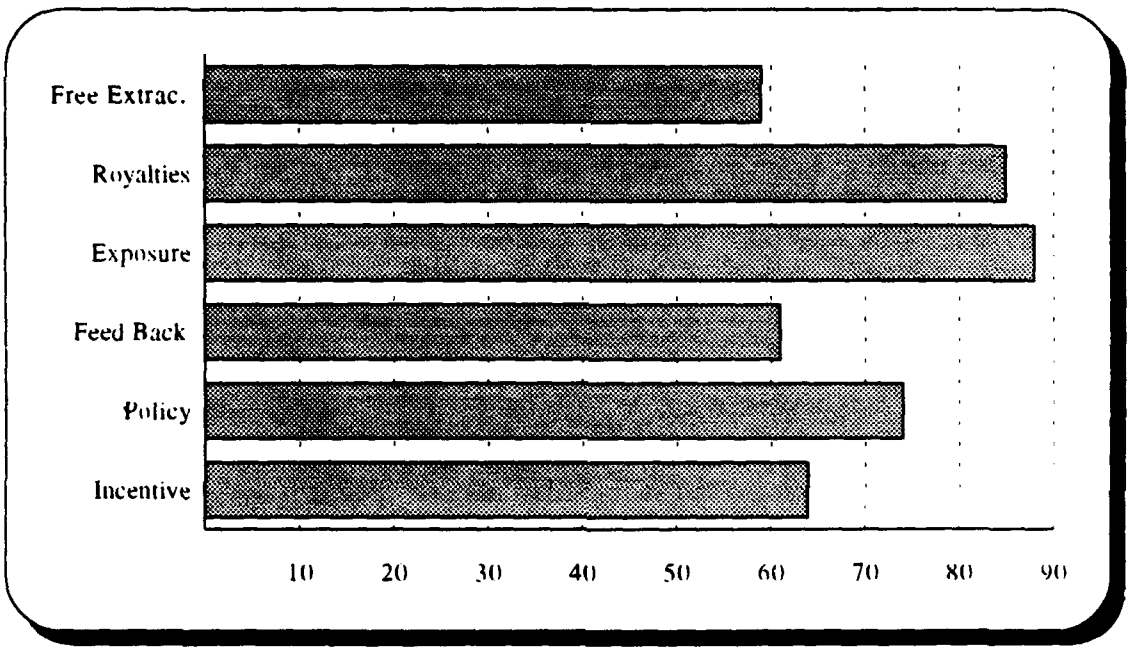

Figure 6. Totals for each Motivatior/Incentive for all Groups.

enjoys a seven to two ratio in favor of those that regard it as the best idea. Of the six possible choices available in the survey question, exposure is the motivator/incentive that would have the best impact for the repository. Along with having the highest score, providing exposure would also be the easiest for the NSRS to implement.

Royalties being paid to the donor of the RSC got the second highest score overall (Figure 6). When we look at the number of 6s received and the number of 1s, it does not come out as strong (Figures 7 & 8). Royalties received three 6s and a single 1. This would indicate that people generally felt good about it, but it was not a key motivator or incentive.

The third runner up was the mandated policy that would require all DoD software developers to donate RSCs to the repository. A mandated policy elicited the greatest number of extreme responses (Figures 7 & 8). The total number of 6s was nine and the total number of 1s was seven. This indicates that it is a controversial idea and would need to be carefully considered before it was implemented.

Core Question 2 investigates whether the NSRS should concentrate their efforts towards incorporating software assets into one central system or if they should attempt to network with existing libraries. The two groups with library systems already established, Groups A and C, had similar responses to the list of incentives/motivators (Figures 3 & 5).

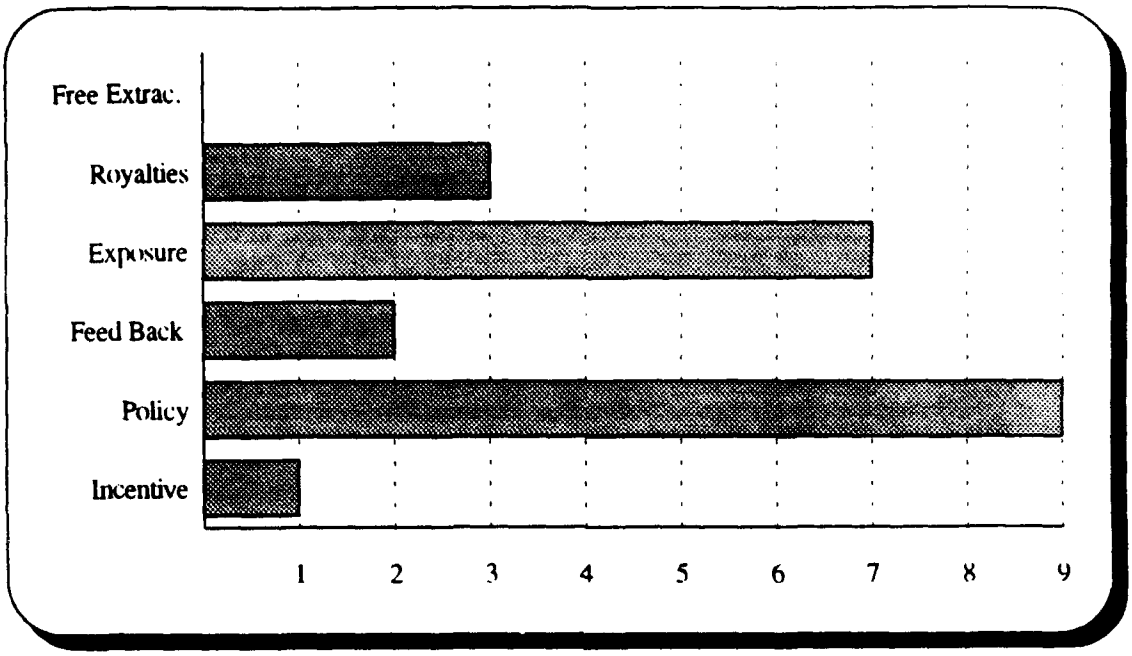

Figure 7. Number of "6"s Overall.

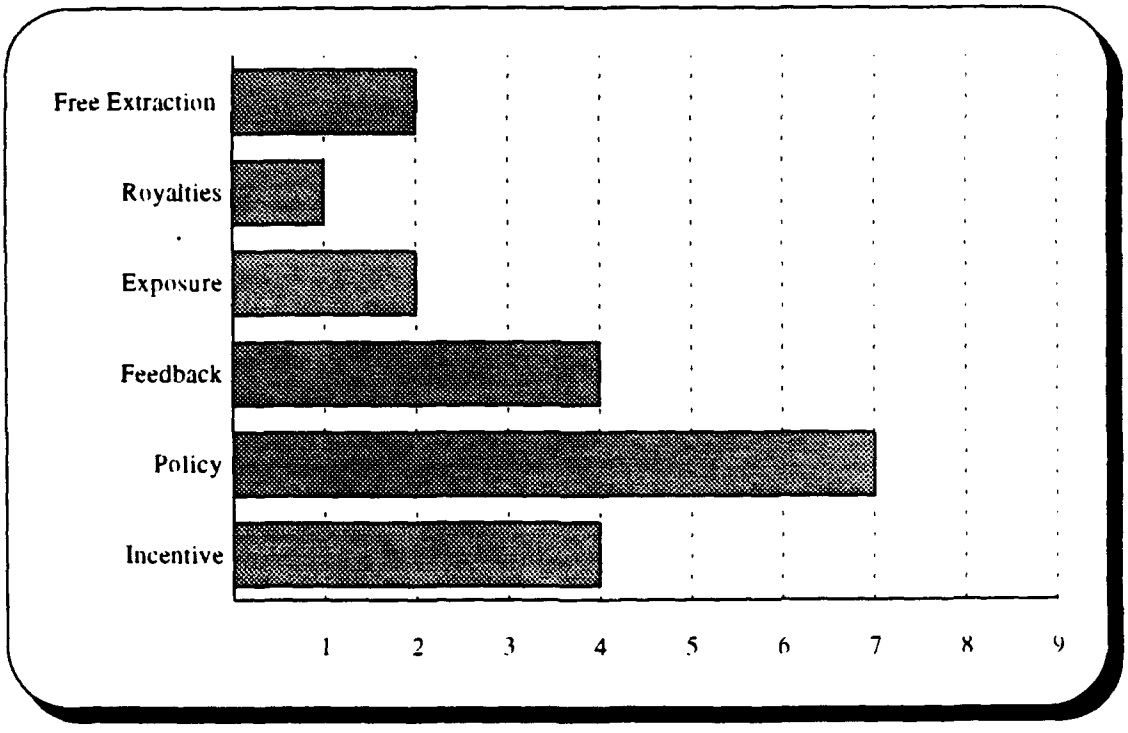

Figure 8. Number of "1"s Overall.

Exposure and royalties received the best responses. The difference between them is the degree to which "Exposure" won out in Group C, those who would not be willing to donate to a central repository. This would appear to be a motivator/incentive that may change the minds of these individuals, and bring them around to donating their assets to a central library.

We did not try and order the lower three by the motivator/incentive data provided since the differences were not significant enough to break them out. The conclusion that can be drawn about these three is that none of them could be expected to provide a strong enough incentive or motivation to make someone donate their RSCs. The one that proved to actually be a disincentive was the feedback provided back to the donator. The donating activity might view this as being graded by another agency.

We consolidated all of the responses given to question 7A into one list. We did not group them or segregate them as was done for Table 4. We examined the answers looking for repeating themes. The list of answers are provided below:

Answers to Question 7A

- Reduced IRM project funding as penalty for not using repository system(s).
- Need clear policy for contractors on who owns RSC, contractor or Gov..
- Designation that is clear on (1) who is the central repository for a specific business area and (2) an enforcement of use/sharing.
- Yearly award for the "most reused asset".

- Quarterly reports on where the assets were used. When, in what systems and at what dollar savings.
- Quarterly reports on how one agency's/ individuals donations compared in the total number of donated assets for the period.
- An easy to use access to the system.
- An easy to find S/W method employed in the system.
- Knowledge that all Navy was using this system.
- Knowledge that all Navy agencies that were producing domain specific S/W were also using the system (using = contributing to the repository).
- Ease of access.
- Newsletters that describe new and old RSCs. The Army has a newsletter called "The Army Reuse Center News".
- Free!
- Sorry I view my library as my competitive edge and I have no intention on donating it. Jobs are at stake.
- Easy Search engines.

The theme that was mentioned the most was that the repository must be easy to use and access. Building a system that is easy to use is a crucial ingredient to any new system. We echo these suggestions and cannot overemphasize its importance.

A clearly stated DoD policy was the second most often mentioned theme that emerged. From reviewing the Navy Reuse Implementation Guide and the DoD Software Reuse Vision and Strategy documents this is being addressed by the DoD. What is missing is the bridge between policy and

practice. The documents state that there is no one way to implement reuse throughout DoD. The documents fail to provide specifics on how to determine the best method for a domain. We feel the documents are a good start but they need more substance and more specific policies to be effective.

A newsletter or some form of reporting mechanism was a concern of two respondents. We agree with this suggestion and feel it could be a valuable addition to the library service.

E. CORE QUESTION 5

Core Question 5 asks: "How much business should you expect from an individual customer?" It took several survey questions to answer the core question. We have arranged the survey data into tabular form. The table reflects the respective answers to the survey questions from each respondent. We decided to use the same groupings as in Core Question 2. Survey questions 3 and 5 which were used to segregate the groups is not repeated in the table. Table 2 should be referred to if the reader cares to see the results of questions 3 and 5.

1. Organization of Data

The data are segregated into three groups on the basis of survey questions 3 and 5 (Table 5). Group A represents people that indicated they would prefer to donate their software assets to a central agency and presently had a library system of their own. Group B represents the respondents that indicated that they preferred to donate their software assets to a central repository, but did not possess a library system. Group C consists of the people that indicated they would prefer to maintain their own system independent of a central activity. Survey respondent number 5 was included into this group. The purpose of question 5 was to identify people that would consider donating software to a central authority. Since it appears that survey respondent number 5 is not interested in doing so, he/she also fell into Group C.

TABLE 5. CORE QUESTION 5 ANALYSIS TABLE.

	Survey #	Agency	QUESTION 12					Q1	Q3	Q5
			ADA	C++	C	FTRAN	OTHER			
GROUP A *Own library willing to donate*	1	NCTS	3		1		3	Y	Y	2
	2	NAWC						N	Y	2
	3	FNOC	1		1	4		Y	Y	2
	7	DISA						N	Y	2
	8	FNOC			1	4	2	Y	Y	1.5
	15	U of Tenn.			2			Y	Y	2
	16	DSR	2	1	1			Y	Y	1.5
	21	NCTS	4					Y	Y	2
GROUP B W/O own library *willingt o donate*	4	FNOC	1			4		N	N	2
	11	TELOG	2		1	2		N	N	2
	13	OASD						Y	N	2
	14	Soft. Prod			1		1	N	N	2
	17	SPAWAR						N	N	2
	18	NCTS						Y	N	
	19	NCTS	2				1	Y	N	2
GROUP C *Own lib. not willing to donate*	5						4	Y	Y	3
	6						3	Y	Y	1
	9	NCTS						N	Y	1
	10	NCCOS	4		2			Y	Y	1
	12	Mnt. Net	1		1			Y	Y	1
	20	NCTS	3					Y	Y	1
	22	NCTS	3	3	2	2	3	Y	Y	1

Questions 3 and 5 were used to segregate the respondents into the various groups and are listed below:

- Question 3. Do you currently have a library of reusable components of your own? (Y/N)

- Question 5. Would you prefer to maintain your own library system allowing others to have access, or turn your library over to a centralized library.

  1) Maintain your own library with all maintenance responsibilities.

  2) Turn over reusable software assets to a centralized repository, with the library assuming the storage and maintenance responsibilities.

  3) Would not consider either.

Question 12 is used in the analysis of this core question. It makes a reference to question 11 but only question 12 was needed in the analysis. Question 12 asks each respondent to provide some level of program development. We listed question 11 along with 12 for the purpose of clarification.

- Question 11. Please indicate below the respective percentages of software development programs your organization has developed, or are in the process of developing in the last 24 months.

__% Ada	__% FORTRAN
__% C++	__% COBOL
__% C	__% Other _____

- Question 12 What are the respective lines of code for the software programs listed in question 11? Check the appropriate level using the key provided below:

key: [A] = 1 to 10 KLOC
[B] = 11 to 100 KLOC
[C] = 101 to 1000 KLOC
[D] = Greater than 1000 KLOC

[A]	[B]	[C]	[D]	Ada	[A]	[B]	[C]	[D]	FORTRAN
[A]	[B]	[C]	[D]	C ++	[A]	[B]	[C]	[D]	COBOL
[A]	[B]	[C]	[D]	C	[A]	[B]	[C]	[D]	Other _____

In order to transfer the survey question into a tabular form, the letter codes of [A] to [D] were translated to a value of 1 to 4. An answer of [A] for Ada would be indicated with a 1 in the Ada column for that survey respondent. If the answer was [B] for Ada then a 2 would be placed in the respective column and so on.

2. Analysis

There were several survey participants that fit the mold of being receptive to reuse and in the process of developing large applications. However, we did not feel that the data gathered was sufficient enough to determine an expected level of business as we had hoped to do.

Further research into this subject area after the survey was constructed revealed that many more factors significantly affect the level of interaction with and participation with a reuse facility. It would take individual interviews with activity representatives and a more detailed analysis of their practices to arrive at an accurate level.

A future study into this question would require that the activity's history of reuse practices be examined. The level of activity with current repositories and what percentage of their current applications contain modules that have been reused would need to be determined. The fit between the repository and the activity would need to be explored. Do the services and modules contained within the library fit that of the activity? This question can not be answered satisfactorily until an in-depth study takes into account these factors on an individual activity basis.

F. CORE QUESTION 6

Core Question 6 asks: "What level of documentation do the customers want before they will consider using an RSC?" It took several survey questions to answer the core question. We have arranged the survey data into tabular form. The table reflects the respective answers to the survey questions from each respondent.

1. Organization of Data

We decided to make our analysis without segregating the survey responses into separate groups. The answers provided for question 8 were placed into tabular form (Table 6). We looked at the responses as one population since the question was one that cut equally across all domains. It was expected that the CC/Tactical domain would require a higher level of documentation than the MIS developers. CC/Tactical systems are generally more life critical systems and the tolerances are normally higher for them as compared to MIS applications. The data did not support our expectations, so we decided to treat the responses as one population.

TABLE 6. CORE QUESTION 6 ANALYSIS TABLE.

Survey #	No Ans	Level 1	Level 2	Level 3	Level 4
1		3	4	4	4
2		1	2	3	4
3		3	3	4	4
4		2	3	4	4
5		1	2	3	4
6		2	2	3	4
7		1	1	3	4
8	1				
9		1	3	4	4
10		3	3	4	4
11		1	2	3	4
12		3	3	4	4
13		3	3	3	3
14		3	3	3	3
15		2	3	4	4
16		2	3	4	4
17		3	3	4	4
18		1	3	3	4
19		1	3	4	4
20		1	2.5	3	3.5
21		1	4	4	4
22		2	3	4	4
Average		1.9	2.79	3.57	3.88

Question 8 from the survey formed the basis for Core Question 6 and is presented below:

- Question 8. A module within the library will be classified at one of four levels. How would the level of classification affect whether or not you would consider using an RSC? Please use the table below to indicate your answer. An explanation of each level is listed below the table.

Levels	Would not consider	Unlikely	May consider	Strongly consider
1				
2				
3				
4				

Level 1: As-is; immediate demand components; no additional testing or documentation; may not be complete or correct.
Level 2: Reviewed for quality; Metrics reported; Completeness has been determined; Has been compiled.
Level 3: Complies with CSRO Certification criteria and documentation guidelines; Approved test suites are provided.
Level 4: Complies with CSRO Certification criteria and documentation guidelines; Approved test suites and documentation.

The levels listed above are from the DoD Software Reuse Initiative and are used to classify components within the repository. The CSRO abbreviation stands for "The Center for Software Reuse Operations" and the CSRO has overall responsibility for the Defense Software Reuse System (DSRS). The NSRS is a Navy version of the DSRS and falls under the jurisdiction of the CSRO.

The matrix provided on the survey was transposed to make Table 6. The various levels became columns instead of rows and the choices of, "Would not consider", "Unlikely", "May consider" and "Strongly consider" took on the respective values of 1,2,3 and 4. Figure 10 provides an example of this conversion. An average of all responses for each level was calculated and the value was placed along the bottom of the table.

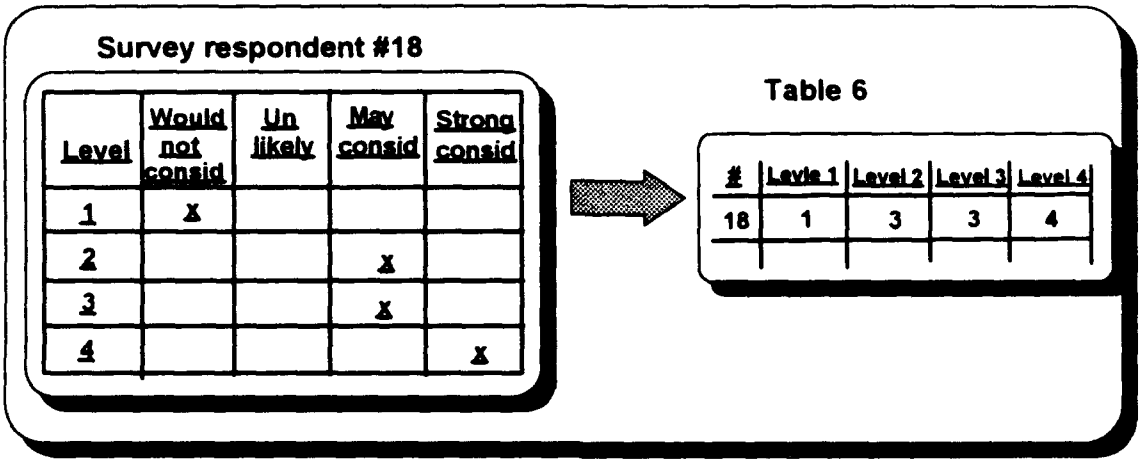

Figure 10. Survey to Table conversion.

2. Analysis

The greatest jump in the responses occurs from level 1 to level 2. This would indicate that the time invested in bringing an RSC from level 1 to 2 will yield the greatest payback. The flip side of this would be, what is required to bring a level 1 RSC up to level 2? This could only be answered on a case by case basis and would have to be balanced against available resources. The population that we surveyed does seem to support considerable investment on the part of the library in bringing an RSC up to Level 2.

The jump for the level 2 to 3 upgrade is also significant especially when you compare it to the jump for the level 3 to 4 upgrade. The added feature of test suites does seem important enough to warrant some additional investment.

The data indicates that the library is best served by populating the library with RSCs that meet level 2 certification or higher. We realize that as a library is starting out it may have to settle for RSCs that are only at level 1. As the library matures it should focus on weeding these out in favor of level 2 or higher. We do not feel that there is adequate support for additional effort for bringing assets up to level 4 from level 3. The added documentation provided by this higher level does not seem to be of great importance to the respondents. The main concern is whether the code compiles and whether some evaluation data is provided. The level 2 certification requires that the code pass a compiler and this fact provides some basic level of quality assurance to the user.

G. CORE QUESTION 7

Core Question 7 asks: "What will the impact of fee for service be on NCTS? What can NCTS do to prepare for fee for service?" It took several survey questions to answer the core question. We have arranged the survey data into tabular form. The table reflects the respective answers to the survey questions from each respondent. We decided to use the same groupings as in Core Question 1 so that we can better understand the characteristics and attitudes of each group and possibly gain further insights into their expectations.

1. Organization of Data

The survey respondents have been divided into four general groups, depending on the respondents' domain of activities (Table 7). Group A consists of the respondents that could be deemed as coming predominately from the MIS field. Group B consists of respondents who are equally or almost equally split between MIS and CC domains. Group C is categorized as coming predominately from the CC field. The final group, Group D, fits people that are strictly higher level administrators and do not do any software development.

TABLE 7. CORE QUESTION 7 ANALYSIS TABLE.

	Survey #	Q9	Q10	Q14[%]	Q15[%]	Q6
GROUP A (MIS)	1	5	1	1	1	2
	5	5	0	1	10	1
	6	5	0	5	5	1
	7	4	1			2
	9	4	2			1.5[1]
	18	4	1	20	20	2
	20	4	2	50	10	3[2]
	21	5	3	50	10	2
	22	5	2	10	3	1
GROUP B (OTHER)	2	1	2	5		1
	12	2	1	10	30	1
	13	2	2			1
	16	1	2	15	15	1
	19	3	3			1
GROUP C (CC/ Tactical)	3	0	5			2
	4	0	5	10	10	1
	8	1	4	1	1	2
	10	0	5	20	75	2
	11	1	4	25	25	1
	17	0	5	7	0	1.5[1]
GROUP D (N/A)	14	0	0	5	5	1
	15	0	0	25	25	2
Average				15.29	15.31	

1. Indicated that they were equally split between choice 1 & 2.
2. Indicated that they would prefer a Bulletin Board service.

We used survey questions 9 and 10 to determine the domain of the person or agency. Responses are shown in the analysis table using the ordinal number corresponding to certain percentage values as specified in questions 9 and 10. If a respondent checked 100% for question 9, and 0% for question 10, then a 5 would be entered into table column Q9 and a 0 for column Q10. Questions 9 and 10 are listed below:

- Question 9. What percentage of your software development projects would you categorize as being in the Information Systems domain?

  5) 100%
  4) 70% to 99%
  3) 50% to 69%
  2) 20% to 49%
  1) Less than 20%
  0) 0%

- Question 10. What percentage of your software development projects would you categorize as being in the Command and Control or Tactical domain?

  5) 100%
  4) 70% to 99%
  3) 50% to 69%
  2) 20% to 49%
  1) Less than 20%
  0) 0%

We used survey questions 14 and 15 to gauge the value that the participants placed on the RSCs. For both questions a level 3 RSC was used. It was felt that a level 3 RSC with its test suites and documentation would probably represent the top end of the market. We did not choose a level 4, since there

are so few of them available and we did not feel that the added documentation would significantly impact the value placed on the RSC. The percents selected by the respondents are summarized in table 7. If 3% was selected for either question, it would be shown as a 3 in the table. Questions 14 and 15 are presented below:

- Question 14. In a few years a fee for service program may be instituted for all Software Repository Systems. Under the fee for service structure what percentage of the projected development costs would you be willing to pay for a component? For example. (If a module is projected to take 2 months to develop, test and document at an estimated cost of $20,000, I would only be willing to pay a maximum of 10% or $2,000.)
  Note: For all cases assume a level 3 component and it would require only minor modifications to meet the module requirements.

O 1%	O 12%	O 30%
O 3%	O 15%	O 35%
O 5%	O 18%	O 40%
O 7%	O 20%	O 50%
O 10%	O 25%	O 75%

- Question 15. Assuming that you have donated a level three module to a reuse library, what would be the minimum royalty that you would be willing to accept for the use of the module by another party? The fee would need to offset the added costs that you would need to incur in order to prepare the module for level three certification.
  The fee would not however need to cover all of the development costs since the module was developed as a result of an earlier effort.

O 1%	O 12%	O 30%
O 3%	O 15%	O 35%
O 5%	O 18%	O 40%
O 7%	O 20%	O 50%
O 10%	O 25%	O 75%

Question 6 was added to this table in an effort to see if there was any connection between the type of access mode preferred and the value a customer would place on the RSCs. The first, second and third selections were represented with a 1, 2 or a 3 respectively. Question 6 is presented below:

- Question 6. Assuming a centralized library system, what primary mode of access would you prefer? An access mode where the user would primarily access the library via remote logon or primarily via a CD-ROM generated by the library. For the CD mode, the CDs would be distributed to the subscribers on a scheduled basis (quarterly / annually). The CDs would be targeted towards a particular domain so as to minimize the number of irrelevant assets.
    1) Remote Logon
    2) CD access
    3) Neither, would prefer (please specify)

2. Analysis

We calculated the averages for questions 14 and 15 for those that provided responses. We only did this for the overall sample population. The values were so scattered, we did not feel that a sub-average for each category would be useful. A write-in comment on questions 14 and 15 that is worth mentioning is that our scale did not go low enough. This comment suggested that the fee should be 0.1% to 0.5%. The reason for this reduced fee was that it would only take 100 reuses at 1% to recoup all costs. In addition, the RSCs were more likely not manufactured to turn a profit. Whatever funds that were generated from the reuse of the module would be profit. We agree with this statement and feel that the fees charged should not be to recoup all costs of

developing the software and documentation. The averages of 15.29% and 15.31% seem very high when you consider the earlier discussion. For both questions 14 and 15, less than half gave an answer that was 5% or less. This would indicate a significant gap between what a library should charge and what potential customers are willing to pay.

On the demand side of the equation, the numbers look extremely favorable. It could be surmised that if the library had a fee structure that charged no more than one percent of the projected cost of development, then you could expect that developers would be willing to pay this fee.

The supply side of this question is very interesting. The overall percentage for what the respondents wanted as compensation for their RSC being used by someone else was approximately even to what they were willing to pay. A closer look at the numbers shows that three respondents wanted a higher percentage compensation for what they donated than what they used from the library. This could be interpreted to mean that they felt the components that they held were of a higher value than what could be found in a repository. This mind set was not peculiar to a particular domain either. The opposite was also true. Four respondents selected a lower percentage compensation for what they donated than what they used from the library. These people were willing to pay more for what they pulled out of the repository than what they were going to put in. At first glance this would not seem to make any sense. The reasoning

behind this could be that if a developer could find an RSC that fit his/ her needs at a fraction of the cost then they would be saving money and time. If a developer gets any compensation for an already existing component then they are creating additional revenue at little or no cost.

In our opinion, we feel that the latter group is being more realistic and demonstrating a good business sense. We included question 6 in an attempt to see if the mode of interaction played a role in the fees that a customer would be willing to pay. We did not see any connection and do not feel that the method of access will have a direct impact on the fee structure. We feel that offering alternative methods of access should increase the customer base but the relative value of the RSCs would be the same.

If a fee for service is instituted at the NSRS, then the fee to be charged is going to have to be a low percentage of the projected development costs. We feel that it should not be any higher than 5%. From core question four we learned that customers want a clear policy concerning reuse and this would apply to the subject of the fee structure. NCTS will need to go to great lengths to ensure that their policy for charging and collecting is clearly understood by all the users. The policy must also be easy to understand, since a complicated policy would serve to hinder the emerging concept of reuse. Programmers will not spend a lot of time trying to figure out what something will

cost if they can go to a relatively free BBS style repository and get a similar product.

A quarterly subscription rate based on the level of service and access would be a possible method of charging users. If a customer wanted CDs sent to them then that would be added to the subscription rate. Each module in the repository could have a contract section within it that stated the compensation expected back to the developer in the same way shareware is handled. If the user tries the module and likes it, then they send a check to the owner of the module.

The Institute for Defense Analysis is presently doing research into this area. They caution against the repository getting into the field of setting the prices for the components. The lessons of economics have shown that it should be the market that sets the prices, not some agency. The IDA also recommends that some tolerance for cheating be allowed. It would not be cost effective to attempt to police everyone to ensure full compliance with a fee system. [Ref. 4]

H. CORE QUESTION 8

Core Question 8 asks: "What is the preferred mode of access for organizations that currently have their own library system?" It took several survey questions to answer the core question. We have arranged the survey data into tabular form. The table reflects the respective answers to the survey questions from each respondent. We decided to use the same groupings as in Core Question 1 so that we can better understand the characteristics and attitudes of each group and possibly gain further insights and gain further insights into their expectations.

1. Organization of Data

The data are segregated into three groups on the basis of survey questions 3 and 5 (Table 8). Group A represents people that indicated they would prefer to donate their software assets to a central agency and presently had a library system of their own. Group B represents the respondents that indicated that they preferred to donate their software assets to a central repository, but did not possess a library system. Group C consists of the people that indicated they would prefer to maintain their own system independent of a central activity. Survey respondent number 5 was included into this group. The purpose of question 5 was to identify people that would consider donating software to a central authority. Since it appears that survey number 5 is not interested in doing so, he/she also fell into Group C.

TABLE 8. CORE QUESTION 8 ANALYSIS TABLE.

	Survey #	Q3	Q5	Q6
GROUP A *Own library, willing to donate*	1	Y	2	2
	2	Y	2	1
	3	Y	2	2
	7	Y	2	2
	8	Y	1.5[1]	2
	15	Y	2	2
	16	Y	1.5[1]	1
	21	Y	2	2
GROUP B W/O own library	4	N	2	1
	11	N	2	1
	13	N	2	1
	14	N	2	1
	17	N	2	1.5[1]
	18	N		2
	19	N	2	1
GROUP C *Own library, not willing to donate*	5	Y	3	1
	6	Y	1	1
	9	Y	1	1.5[1]
	10	Y	1	2
	12	Y	1	1
	20	Y	1	3[2]
	22	Y	1	1

1. Indicated that they were equally split between choice 1 & 2.
2. Indicated that they would prefer a BBS style library service.

Questions 3 and 5 are represented in the Analysis table in the same fashion as in table 1. Questions 3 and 5 are listed below:

- Question 3. Do you currently have a library of reusable components of your own? (Y/N)

- Question 5. Would you prefer to maintain your own library system allowing others to have access, or turn your library over to a centralized library.

  1) Maintain your own library with all maintenance responsibilities.

  2) Turn over reusable software assets to a centralized repository, with the library assuming the storage and maintenance responsibilities.

  3) Would not consider either

Question 6 was added to Table 8 to identify a unique trait of library owners. Survey Question is presented below:

- Question 6. Assuming a centralized library system, what primary mode of access would you prefer? An access mode where the user would primarily access the library via remote logon or primarily via a CD-ROM generated by the library. For the CD mode, the CDs would be distributed to the subscribers on a scheduled basis (quarterly / annually). The CDs would be targeted towards a particular domain so as to minimize the number of irrelevant assets.

  1) Remote Logon
  2) CD access
  3) Neither, would prefer (please specify)

2. Analysis

Core Question 4 has addressed the motivators/incentives that work best for the groups with libraries. For this analysis we will direct our attention towards Survey Question # 6.

Group A had six of the eight responses that indicated that they would prefer to receive a CD with the RSCs on them instead of an on-line service. It would appear that this group might use the CDs as a means to augment their own library. This group clearly displays support for a CD subscription service.

Group C, respondents with a library but did not want to donate their RSCs, did not show a strong support for the CD distribution concept. We concluded that offering a CD distribution service would not be enough to convince the people within this group to hand over their RSCs to the NSRS. Group B had only two respondents indicate that they were interested in the idea of the CD access. This group has less involvement with reuse in general and it is not surprising that they did not show much interest in receiving a CD with RSCs on them. Given the results of Groups A and C, offering a CD distribution service could be a service offered along with an on-line service that could attract additional users.

IV. CONCLUSION

A. SUMMARY OF CORE QUESTIONS

We were able to ascertain a clear conclusion for seven of the eight core questions. These conclusions lead us to recommendations that for the most part are completely within the control of NCTS Washington. This section is subdivided into eight summary conclusions for each of the Core Questions.

1. *Core Question 1*

The MIS domain as a whole would be highly likely to consider the services of the NSRS but they would probably be less likely to become heavy users. The NSRS will need to adjust its operating practices in order to lure this group into becoming substantial customers. We feel that the CC/Tactical domain will need to be taken on a more case by case basis. There is support within this group for donating software components, but they are divided as far as their level of reuse involvement. It appears that each activity within this domain would need to be approached separately. Training in the field of reuse would need to offered to each activity and would probably be required to make them viable users. We recommend that the NSRS focus on one of the domains and not attempt to please all of them.

2. Core Question 2

Our data did not show a majority of support for either a centralized library system or a more networked one. The overhead involved in linking up many libraries would be more extensive than incorporating various components into one central system. If you factor in the overhead costs, then the centralized concept would probably hold a slight edge. The significant portion of the software development community that already has libraries of their own will need some additional incentives if they are going to donate their software assets.

3. Core Question 3

We analyzed the data by domain to determine that, if the repository was to focus on a particular domain, which language should be included into the library. For the MIS domain, we recommended that the programming language C should be included into the repository. The group that developed applications in both domains paralleled the MIS domain. We made the same recommendation for this group as the MIS domain. The CC/Tactical domain showed strong use of FORTRAN in addition to Ada. If the NSRS is going to focus on this domain, we recommended that the repository include FORTRAN into the repository.

4. Core Question 4

The advantage of gaining exposure to other software development activities proved to draw the highest overall response. Along with having the

highest score, providing exposure would also be the easiest for the NSRS to implement.

Royalties being paid to the donor of the RSC got the second highest score overall. The analysis showed that people generally felt good about it, but it was not a key motivator or incentive. The third runner up was the mandated policy that would require all DoD software developers to donate RSCs to the repository. The data indicated that a mandated policy is a controversial idea and would need to be carefully considered before it was implemented.

5. Core Question 5

Further research into this subject area after the survey was constructed revealed that many more factors significantly affect the level of interaction with and participation with a reuse facility. It would take individual interviews with activity representatives and a more detailed analysis of their practices to arrive at an accurate level.

6. Core Question 6

The data indicates that the library is best served by populating the library with RSCs that meet level 2 certification or higher. We realize that as a library is starting out it may have to settle for RSCs that are only level 1. As the library matures it should focus on weeding these out in favor of level 2 or higher. We do not feel that there is adequate support for additional effort for bringing

assets up to level 4 from level 3. The added documentation provided by this higher level does not seem to be of great importance to the reuse community.

7. Core Question 7

If a fee for service is instituted at the NSRS, then the fee that is charged is going to have to be a low percentage of the projected development costs. We feel that it should not be any higher than 5%. From Core Question 4 we learned that customers want a clear policy concerning reuse and this would apply to the subject of the fee structure. NCTS will need to go to great lengths to ensure that their policy for charging and collecting is clearly understood by all the users. The policy must also be easy to understand, since a complicated policy would serve to hinder the emerging concept of reuse. Programmers will not spend a lot of time trying to figure out what something will cost if they can go to a relatively free BBS style repository and get a similar product.

8. Core Question 8

Since Core Question 4 had already addressed the aspect of motivators and incentives, we concentrated on the concept of CD-ROM distribution service. This is where the RSCs would be distributed to the users via a CD. We concluded that offering a CD distribution service should be a service offered along with an on-line service. There is not enough wide spread support to completely replace the on-line method of RSC retrieval and library

interaction. There was enough interest in the CD distribution idea that it could add significant value to the library services to make it a worthwhile investment.

B. SUMMARY COMMENTS

The NSRS needs to advertise in as many government software related periodicals as possible. The previously mentioned recommendations will have an effect only if the NSRS is known to the general development community. Articles to publications such as Federal Computer Weekly and CHIPS should be submitted at least quarterly. Subject matter for the articles could range from discussions of services offered to recent experience with a particular user.

The NSRS has had some exposure already and has recently completed a cooperative effort with the Marine Corps Tactical Systems Support Activity (MCTSSA). The program was successful and reuse was an integral part of the development [Ref. 9]. The NSRS should make the most of this initial experience. Every facet of this project should be studied and a comprehensive set of lessons learned should be formulated. The Lessons learned should be derived from the combined input of the entire NSRS staff and key representatives from the MCTSSA. Software reuse is in its initial stages of understanding and it should be expected that some mistakes will be made. These mistakes along with the desires of software developers concerning software reuse need to be identified and dealt with before software reuse can truly mature as an accepted practice.

APPENDIX A

Software Repository Market Survey

1.) Do you or your organization have a policy for utilizing reusable software components in development projects?

O Yes
O No (go to question 5)

2.) Is this policy practiced by you and your staff?

O Yes
O No

3.) Do you currently have a library of reusable components of your own?

O Yes
O No

4.) What is the software repository system(s) that you are utilizing?

O ASSET	O NTSC	O CRSS
O DSRS	O SIMTEL 20	O COSMIC
O CARDS	O Ada Net	O Ada Software Repository
O Public Ada Library	O AdaSAGE	
O Other _____		O Do not utilize a repository sys.

5.) Would you prefer to maintain your own library system allowing others to have access, or turn your library over to a centralized library.

O Maintain your own library with all maintenance responsibilities.

O Turn over reusable software assets to a centralized repository, with the library assuming the storage and maintenance responsibilities.

O Would not consider either

6.) Assuming a centralized library system, what primary mode of access would you prefer? An access mode where the user would primarily access the library via remote logon or primarily via CDs generated by the library. For the CD mode, the CDs would be distributed to the subscribers on a scheduled basis (quarterly / annually). The CDs would be targeted towards a particular domain so as to minimize the number of irrelevant assets.

- O Remote Logon
- O CD access
- O Neither, would prefer (please specify) _____

_____

_____

7.) In your opinion what would be the most effective means or incentives that would ensure a sufficiently populated software repository system. Please rank with a 6 being the highest and 1 being the lowest.

___ Incentive credits towards free access to the library and customer support with respect to the amount donated. (*i.e. For a large donation, unlimited access for a year, or, one-for-one credit).*

___ A mandated DoD policy requiring all government software developers to donate their software components to a repository.

___ Feedback from library customers regarding your donated RSCs. (*i.e. ways they have improved upon your RSC)*

___ Donors gaining exposure to other development activities. *(i.e. If a development activity sees that you have done a large amount of work in a particular area they may subcontract out to you instead of attempting to build from your components.)*

___ Royalties paid to the donor activity when the RSC is used.

___ Free extraction of re-engineered components derived from your donated RSC.

7A.) Please list any other incentives or policies that are not presented in the previous question, that would significantly motivate developers to donate components to the library system.

_____

_____

8.) A module within the library will be classified at one of four levels. How would the level of classification affect whether or not you would consider using an RSC? Please use the table below to indicate your answer. An explanation of each level is listed below the table.

Levels	Would not consider	Unlikely	May consider	Strongly consider
1				
2				
3				
4				

Level 1: As-is; immediate demand components; no additional testing or documentation; may not be complete or correct.
Level 2: Reviewed for quality; Metrics reported; Completeness has been determined; Has been compiled.
Level 3: Complies with CSRO Certification criteria and documentation guidelines; Approved test suites are provided.
Level 4: Complies with CSRO Certification criteria and documentation guidelines; Approved test suites and documentation.

9.) What percentage of your software development projects would you categorize as being in the Information Systems domain? (see attached domain chart)

- O 100%
- O 70% to 99%
- O 50% to 69%
- O 20% to 49%
- O Less than 20%
- O 0%

10.) What percentage of your software development projects would you categorize as being in the Command and Control or Tactical domain? (see attached domain chart)

- O 100%
- O 70% to 99%
- O 50% to 69%
- O 20% to 49%
- O Less than 20%
- O 0%

11.) Please indicate below the respective percentages of software development programs your organization has developed, or are in the process of developing in the last 24 months.

__% Ada
__% C++
__% C
__% FORTRAN
__% COBOL
__% Other _____

12.) What are the respective lines of code (LOC.) for the software programs listed above? Check the appropriate level using the key provided below:

key: [A] = 1 to 10 KLOC
[B] = 11 to 100 KLOC
[C] = 101 to 1000 KLOC
[D] = Greater than 1000 KLOC

[A] [B] [C] [D] Ada
[A] [B] [C] [D] C ++
[A] [B] [C] [D] C
[A] [B] [C] [D] FORTRAN
[A] [B] [C] [D] COBOL
[A] [B] [C] [D] Other _____

13.) Are you familiar with Fee for Service? ____yes ____no
If no see attached sheet title "Fee for Service"

14.) In a few years a fee for service program may be instituted for all Software Repository Systems. Under the fee for service structure what percentage of the projected development costs would you be willing to pay for a component? For example. (If a module is projected to take 2 months to develop, test and document at an estimated cost of $20,000, I would only be willing to pay a maximum of 10% or $2,000.)

Note: For all cases assume a level 3 component and it would require only minor modifications to meet the module requirements.

O 1%
O 3%
O 5%
O 7%
O 10%
O 12%
O 15%
O 18%
O 20%
O 25%
O 30%
O 35%
O 40%
O 50%
O 75%

15.) Assuming that you have donated a level three module to a reuse library, what would be the minimum royalty that you would be willing to accept for the use of the module by another party? The fee would need to offset the added costs that you would need to incur in order to prepare the module for level three certification.
The fee would not however need to cover all of the development costs since the module was developed as a result of an earlier effort.

O 1%	O 12%	O 30%
O 3%	O 15%	O 35%
O 5%	O 18%	O 40%
O 7%	O 20%	O 50%
O 10%	O 25%	O 75%

APPENDIX B

Tabulated survey results.

	Survey Questions with short answers											
No	Agency	Q1	Q2	Q3	Q5	Q6A	neither	Q9	Q10	Q14 [%]	Q15 [%]	Comment
1	NCTS	1	1	1	2	2		5	1	1	1	
2	NAWC	0	1	1	2	1		1	2	5		
3	FNOC	1	1	1	2	2		0	5			
4	FNOC	0	0	0	2	1		0	5	10	10	
5		1	1	1	3	1		5	0	1	10	Have library take care of all fees
6		1	1	1	1	1		5	0	5	5	
7	DISA	0	0	1	2	2		4	1			
8	FNOC	1	1	1	1.5	2		1	4	1	1	
9	NCTS	0	1	1	1	1.5		4	2			
10	NCCOS	1	1	1	1	2		0	5	20	75	
11	TELOG	0	0	0	2	1		1	4	25	25	
12	Mntn. Net	1	1	1	1	1		2	1	10	30	
13	OASD	1	1	0	2	1		2	2			
14	Soft. Prod.	0	0	0	2	1		0	0	5	5	
15	U of Tenn	1	1	1	2	2		0	0	25	25	
16	DSR	1	1	1	1.5	1		1	2	15[a]	15[a]	
17	SPAWAR	0	0	0	2	1.5		0	5	7	0	
18	NCTS	1	1	2		2		4	1	20	20	
19	NCTS	1	1	0	2	1		3	3			
20	NCTS	1	1	1	1	3	BBS	4	2	50	10	
21	NCTS	1	1	1	2	2		5	3	50	10	
22	NCTS	1	1	1	1	1		5	2	10	3	

a. Actual answer given was a range of 5% to 25%, a middle value of 15% was used as the answer.

	Question # 4									
No	ASSET	DSRS	PAL	NTSC	ADA NET	ADA SAGE	COSMIC	ASR	OTHER	NONE
1		1		1		1				
2									RAPID	
3		1	1		1	1			CRSS	
4										1
5										1
6										1
7		1								
8		1				1			Internal	
9					1	1		1		
10									Internal	
11										1
12					1					
13		1								
14										1
15										1
16	1	1				1	1			
17										1
18						1				
19						1				
20						1				
21			1			1		1		
22									Share Net	

	Question #7						
No	No Ans	Incentive	policy	Feedback	Exposure	Royalties	Free extraction
1		6	1	4	5	3	2
2	1						
3		1	6	1	5	1	1
4		5	6	1	3	4	2
5		2	6	1	5	3	4
6		3	1	4	6	5	2
7		5	6	2	1	3	4
8		2	1	4	3	6	5
9		0	0	0	0	0	0
10		2	1	3	6	5	4
11		5	4	2	1	6	3
12		4	4	6	5	4	5
13		4	1	2	6	5	3
14		3	6	4	2	5	1
15		1	6	2	5	4	3
16		3	2	4	5	5	2
17		5	6	1	2	4	3
18		1	6	3	4	5	2
19		5	1	2	6	3	4
20		1	1	4	6	6	3
21		3	3	6	6	4	3
22		3	6	5	6	4	3

Answers to Question 7A

Survey

#	Suggestions

#5

- Reduced IRM project funding as penalty for not using repository system(s).
- Need clear policy for contractors on who owns RSC - contractor or Gov..

#6

- Designation that is clear on (1) who is the central repository for a specific business area and (2) an enforcement of use/sharing.

#7

- Yearly award for the "most reused asset".
- Quarterly reports on where the assets were used - by. When and in what systems and at what dollar savings.
- Quarterly reports on how one agency's / individuals donations compared in the total number of donated assets for the period.

#8

- An easy to use access to the system.
- An easy to find S/W method employed in the system.
- Knowledge that all NAVY was using this system.
- Knowledge that all NAVY agencies that were producing domain specific S/W were also using the system (using = contributing to the repository).

#9

- Ease of access
- Newsletters that describe new and old RSCs. The Army has a newsletter called "The Army Reuse Center News".
- Free!

#10

-Sorry I view my library as my competitive edge and I have no intention on donating it. Jobs are at stake.

	Question #8				
No	No Ans	Level 1	Level 2	Level 3	Level 4
1		3	4	4	4
2		1	2	3	4
3		3	3	4	4
4		2	3	4	4
5		1	2	3	4
6		2	2	3	4
7		1	1	3	4
8	1				
9		1	3	4	4
10		3	3	4	4
11		1	2	3	4
12		3	3	4	4
13		3	3	3	3
14		3	3	3	3
15		2	3	4	4
16		2	3	4	4
17		3	3	4	4
18		1	3	3	4
19		1	3	4	4
20		1	2.5	3	3.5
21		1	4	4	4
22		1	3	4	4

	Question #11							
No	No Ans	ADA	C++	C	FRTRN	COBOL	OTHER	BRAND
1		25		20			55	
2							90	Assembly
3		0.5		3	96.5			
4		1			99			
5							100	XBASE
6							100	BASIC+2(90%),ORACLE,PL/SQL,
7	1							
8				5	90		5	Assembler, Pascal, Basic, PL/M
9		30	5	5		10	50	XBASE, 4GL
10		90		10				
11		40		20	40			
12		50		50				
13	1							
14				50			50	Pascal
15				100				
16		80	10	10				
17	1							
18	1							
19		60					40	FOXPRO
20		100						
21		100						
22			30	30	1	20	19	Dbase/Clipper, Paradox, Quick Basic

Question #12							
No	No Ans.	ADA	C++	C	FORTRAN	COBOL	OTHER
1		3		1			3
2	1						
3		1		1	4		
4		1			4		
5							4
6							3
7	1						
8				1	4		2
9	1						
10		4		2			
11		2		1	2		
12		1		1			
13	1						
14				1			1
15				2			
16		2	1	1			
17	1						
18	1						
19		2					1
20		3					
21		4					
22			3	3	2	2	3

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