Software Reuse Issues Affecting AdaNET

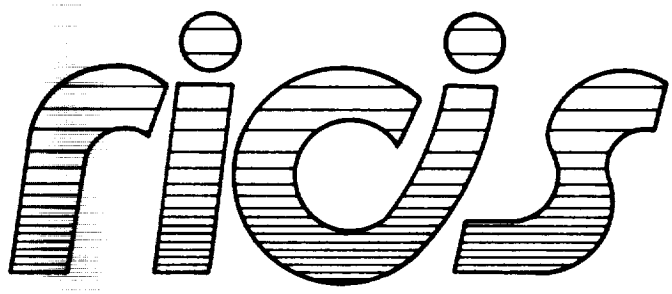
John G. McBride

SofTech, Inc.

July 14, 1989

Cooperative Agreement NCC 9-16
Research Activity No. IM.14

NASA Headquarters
NASA Technology Utilization Program



Research Institute for Computing and Information Systems
University of Houston - Clear Lake

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The RICIS Concept

The University of Houston-Clear Lake established the Research Institute for Computing and Information systems in 1986 to encourage NASA Johnson Space Center and local industry to actively support research in the computing and information sciences. As part of this endeavor, UH-Clear Lake proposed a partnership with JSC to jointly define and manage an integrated program of research in advanced data processing technology needed for JSC's main missions, including administrative, engineering and science responsibilities. JSC agreed and entered into a three-year cooperative agreement with UH-Clear Lake beginning in May, 1986, to jointly plan and execute such research through RICIS. Additionally, under Cooperative Agreement NCC 9-16, computing and educational facilities are shared by the two institutions to conduct the research.

The mission of RICIS is to conduct, coordinate and disseminate research on computing and information systems among researchers, sponsors and users from UH-Clear Lake, NASA/JSC, and other research organizations. Within UH-Clear Lake, the mission is being implemented through interdisciplinary involvement of faculty and students from each of the four schools: Business, Education, Human Sciences and Humanities, and Natural and Applied Sciences.

Other research organizations are involved via the "gateway" concept. UH-Clear Lake establishes relationships with other universities and research organizations, having common research interests, to provide additional sources of expertise to conduct needed research.

A major role of RICIS is to find the best match of sponsors, researchers and research objectives to advance knowledge in the computing and information sciences. Working jointly with NASA/JSC, RICIS advises on research needs, recommends principals for conducting the research, provides technical and administrative support to coordinate the research, and integrates technical results into the cooperative goals of UH-Clear Lake and NASA/JSC.

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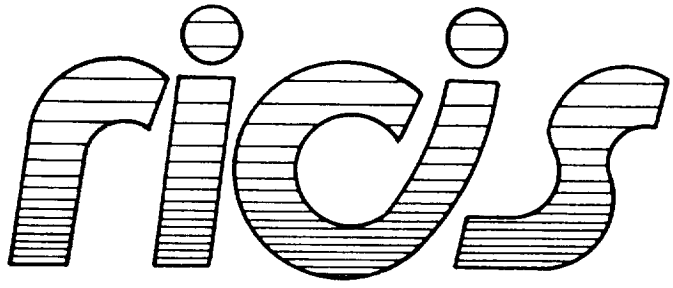

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Preface

This research was conducted under auspices of the Research Institute for Computing and Information Systems by John G. McBride of SofTech, Inc. Dr. Peter C. Bishop, Director of the Space Business Research Center, UHCL, served as RICIS technical representative.

Funding has been provided by the NASA Technology Utilization Program, NASA/JSC through Cooperative Agreement NCC 9-16 between NASA Johnson Space Center and the University of Houston-Clear Lake. The NASA technical monitor for this activity was Robert B. MacDonald, Assistant for Research, Education & University Programs for the Mission Support Directorate, NASA/JSC.

The views and conclusions contained in this report are those of the author and should not be interpreted as representative of the official policies, either express or implied, of NASA or the United States Government.

SOFTECH

SOFTWARE REUSE ISSUES AFFECTING AdaNET

July 14, 1989

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Introduction

The AdaNet program is reviewing its long-term goals and strategies. A significant concern is whether current AdaNet plans adequately address the major strategic issues of software reuse technology. This report identifies and summarizes the major reuse issues of providing AdaNet services that should be addressed as part of future AdaNet development.

Section 2

Approach to Issue Definition

Many issues deal with software reuse. The method used in this report organized these issues into a framework to facilitate an understanding of their relationship and importance to the AdaNet mission. The framework is based on a Structured Analysis and Design Technique (SADT) diagram (Figure 1). Using this modeling method the AdaNet system is represented as an activity box with arrows representing inputs, outputs, controls/constraints, and mechanisms. The activity box represents what AdaNet is accomplishing, while the arrows represent its environment. With this type of representation, the issues of software reuse are classified, detailed, and discussed with respect to the arrows on the diagram. Within the discussion of each issue, a specific statement or question that captures the issue is printed in *italics*.

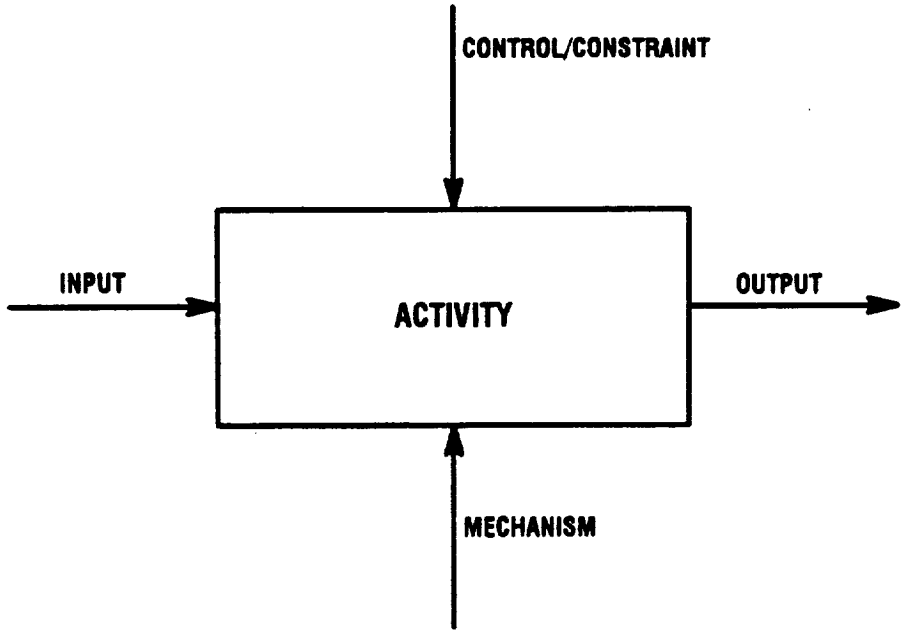

Figure 1. Basic Modeling Component

Section 3

Analysis of AdaNet Reusability Issues

The objective of AdaNet is to provide a facility to transfer federally funded software engineering and Ada technology to the commercial industrial sector. Figure 2 represents this activity with AdaNet providing the support to offer policy and publicity, technical guidance, reusable software component (RSC) descriptions and products, and histories. AdaNet must provide these services and products within the constraints of its sponsoring organizations and the needs of its users. AdaNet services and products will evolve as new and enhanced RSCs and RSC user experience are acquired and software life cycle cost benefits are better understood. Strategic software reuse issues are indicated by the arrows of Figure 2.

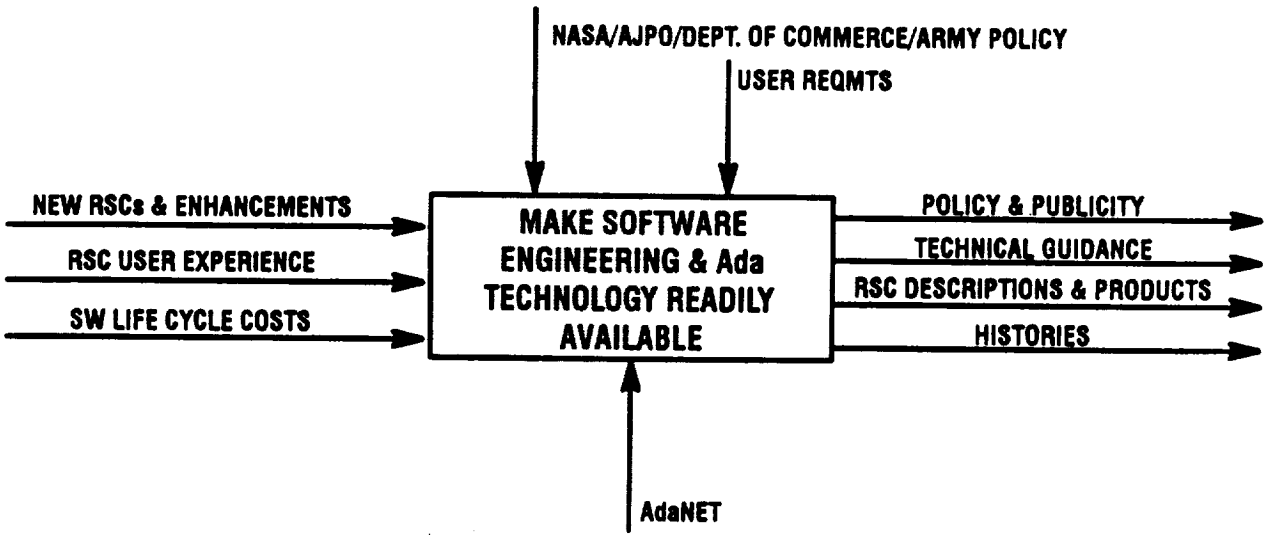

Figure 2. AdaNet Objective

3.1 User Requirements Issues

The capability to provide viable services and products depends on the ability to understand the needs of prospective users. User requirements issues are modeled as constraints and are divided into four major areas including types of RSCs, methodology, software engineering environment, and incorporation. Issues within these areas are discussed below.

3.1.1 Types of Reusable Software Components

Market analysis is needed to determine what types of RSCs are needed, how they are selected, their appropriate level of granularity, and their consistency of quality. Merely populating the AdaNet with RSCs does not ensure that they are useful to the user. They must help to satisfy system capabilities which the user is trying to develop. The type of RSCs that will populate the system may be general purpose, domain, or project specific. General purpose RSCs may have wide applicability, but

typically have low payoff since they only provide a small amount of capability. Domain specific RSCs can have a higher payoff within an application domain, but if the domain is not chosen carefully few users will benefit. Project specific RSCs are relatively easy to acquire, but are of limited use if they are not well classified according to capability. There are also tradeoffs concerning the granularity of the RSC. An RSC with large granularity is less likely to meet the specific requirements of a user, but if it does there is a large payoff. Depending on the domain and capability there may be wide variation in the granularity of RSCs.

3.1.2 Methodology

Current system development methods do not adequately address the potential for software reuse. The availability of a reuse library does not necessarily make reuse happen. System design approaches must be incorporated into the development process to consider using RSCs that help satisfy system requirements. *To what extent will the AdaNet program participate in the development of these approaches to improve RSC utilization?*

3.1.3 Software Engineering Environment

Maximum effectiveness of a reuse library may require it to be integrated with the software engineering environment. Tools for reuse would facilitate the development of RSCs, thus adding more to the library. Also, tools may be necessary to "glue" together RSCs to form a system application (composition), or tools may be required to generate software automatically based on reusable specifications and templates. *How much support should AdaNet provide to assist users in integrating RSCs into their applications?*

3.1.4 Incorporation

The ability to incorporate an RSC efficiently is a significant issue even if the user has already acquired it. Understanding just what the RSC does and evaluating how well and under what conditions it performs its functions can often take as long as it would to develop the RSC from scratch. Even if the RSC does meet all of the functional requirements, the degree of actual reuse may depend on whether it is written in an appropriate computer language, runs on the same computer, and meets performance goals. Also, the quality standards of the RSC may not be compliant with the development standards of the user. The interfaces of the RSC with the rest of its software environment may not match well, since RSCs may have hidden dependencies on their environment that are not explicit in terms of the input and output parameters. *How should AdaNet describe RSCs to facilitate their incorporation?*

3.2 Policy and Publicity Issues

The policies that govern the operation of AdaNet should be clearly stated so that users, RSC providers, and AdaNet personnel understand the type and quality of services to be expected. These

policies should address the quality standards for developing RSCs and the guidelines for using RSCs. The policy on data rights should explicitly state who owns the RSCs once they are used in an application. If an application fails, product liability must also be addressed where RSCs are used to specify culpability in the event of product failure. Related to liability is the question of warranty of the RSC and who will pay to correct RSC deficiencies. *Policies should be defined prior to operational use of AdaNet.*

Effective publicity of AdaNet is important to convey realistic expectations to the user community. The user should understand the benefits of AdaNet. This publicity requires quantitative information to assist a user in determining the cost and competitive value of specific services and products. *The benefits of RSCs should be determined and a promotional strategy should be prepared prior to operational use.*

3.3 Technical Guidance Issues

Technical guidance consists of providing assistance to RSC developers to produce RSCs that meet AdaNet standards. Technical support is also needed to help users incorporate reuse into the system design process and to assist users in locating candidate RSCs for consideration in an application design. *To what extent will technical guidance be provided?*

3.4 Reusable Software Component Descriptions and Products Issues

The nature and definition of the RSCs must be clearly defined. The contents of RSCs may include requirements specifications, designs, code, and test programs. The ability to understand what services are provided by an RSC, how it performs, and under what conditions it operates needs to be described in some type of abstract that is readily understood. The best methods to distribute RSCs and their descriptions may be dependent upon the types of RSCs AdaNet provides. These methods may be as simple as a centralized electronic bulletin board, with or without technical support, or mail order type CD-ROM catalogues for products with high information content such as graphics. *What types of RSC descriptions will be available?*

3.5 New Reusable Software Components and Enhancements Issues

The viability of AdaNet depends on the initial population of its library with high quality RSCs, acquiring new RSCs, and enhancing and maintaining RSCs. It will be important to stay abreast of opportunities — present and forthcoming applications for sources of new or enhanced RSCs. Also, as new or enhanced RSCs are acquired, they must be classified and evaluated in accordance with AdaNet standards. Finally, the qualification process to ensure AdaNet standards are being met must be consistently applied. *What type of procedures will be employed to support the acquisition of RSCs?*

3.6 AdaNet System Issues

The AdaNet system provides the mechanism in Figure 2 to support the principle activities of AdaNet. A number of reuse issues have been classified as system issues since they deal more with the

capabilities and implementation of the system rather than how the system is used. *A critical issue in any library management system is "how to catalogue items so they can be easily located and retrieved." Another issue is "how many RSCs are needed in the system to achieve a "critical mass."* The architecture of the system also affects the overall performance of the system. *What type of architecture should be used to provide reasonable responsiveness and availability?* These issues are discussed in greater detail below.

3.6.1 Cataloguing/Retrieval Methods

The three principle techniques commonly used in information retrieval systems are the hierarchical, key word, and facets techniques. *Which technique(s) of RSC retrieval will be used?*

The hierarchical technique classifies each item into one higher level class, similar to the public library's Dewey Decimal System. This technique is familiar to most people, but the classification of each item must be performed by experts in library science since the subject matter of many items could easily fit into more than one class. The key word technique is common for document retrieval systems. This technique is used to partially overcome the limitations of classifying documents in a hierarchical system. This method searches for combinations of key words to identify documents containing those key words. Further refinement is then performed by the researcher who imposes more restrictive combinations of key words and reviews the material. The facets technique employs a set of descriptive attributes for each item. With this search method the system retrieves items that match the attribute descriptions. This technique is very flexible and powerful; however, to be effective a common set of attributes meaningful to the user must exist. The set of attributes may need to be tailored to the application domain. Thus, there may be a standard set of attributes such as creation date, author, and language, and then a variant set that is domain specific. Another related issue is whether to employ controlled or uncontrolled search vocabulary. A controlled vocabulary is much easier to maintain, but shifts the burden to the user who must be precise in his descriptions of the items to be searched. Such descriptions may be meaningful in one domain but not another. The uncontrolled vocabulary may employ a thesaurus to allow more flexibility in search descriptions, but greater effort is needed to maintain the vocabulary list.

3.6.2 Reusable Software Component Critical Mass

The AdaNet system must provide a sufficient number of RSCs, with adequate quality and in relevant domains, for users to make repeated requests for services and products. As with any distribution service, if customers make the effort to search for an item and repeatedly fail to find it, they will discontinue to use that service. *A plan to populate and enhance the AdaNet system should be developed to determine if adequate resources exist before attempting to offer reuse services to the general public.*

3.6.3 Architecture

The early implementations of AdaNet have been based on a centralized system accessed via long haul telecommunications networks. Not only has this system suffered response problems, but its

availability is also limited. Additionally, future needs of distribution may dictate wider bandwidth access to information. *A better understanding of the types of RSC information is needed to assess the merits of a distributed vs. centralized system, and telecommunications vs. electronic catalogue distribution methods.*

3.6.4 Performance

The concept of using RSCs in the development of new systems is not new, but the effective widespread application of RSCs has yet to be realized. Significant obstacles will remain even if AdaNet is able to provide useful RSCs. Since one of the major problems is the assessment of RSCs, it is imperative that users can browse through the library and evaluate them with reasonable responsiveness and high system availability. *Prior to developing new versions of AdaNet, performance requirements should be established.*

Section 4

Recommendation

Before significant development proceeds, a plan should be developed to resolve the aforementioned issues. This plan should also specify a detailed approach to develop AdaNet. A three phased strategy is recommended. The first phase would consist of requirements analysis and produce an AdaNet system requirements specification. It would consider the requirements of AdaNet in terms of mission needs, commercial realities, and administrative policies affecting development, and the experience of AdaNet and other projects promoting the transfer software engineering technology. Specifically, requirements analysis would be performed to better understand the requirements for AdaNet functions. The second phase would provide a detailed design of the system. The AdaNet should be designed with emphasis on the use of existing technology readily available to the AdaNet program. A number of reuse products are available upon which AdaNet could be based. This would significantly reduce the risk and cost of providing an AdaNet system. Once a design was developed, implementation would proceed in the third phase.