WISR'95: 7th Annual Workshop on Software Reuse Summary and Working Group Reports

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The Seventh Annual Workshop on Institutionalizing Software Reuse (WISR '95), hosted by Andersen Consulting, took place August 28-30, 1995 in St. Charles, Illinois. Almost 50 experts representing an international group of industry, academic and government organizations gathered to discuss both the state of the art and state of the practice in adopting software reuse. As in past workshops, work began with an introductory session in which participants presented current and critical issues based on position papers they submitted to the workshop. Attendees then divided into eight working groups (two combined and one "virtual") covering a wide range of topics including:

- *The Organization* (or *Software Reuse in a Business Environment*): led by Kevin Benner (Andersen Consulting)
- *Domain Processes and Engineering:* led by Sid Bailin (CTA)
- *Domain Modeling Representation Strategies: Towards a Comparative Framework:* led by Mark Simos (Organon Motives, Inc)
- *The Reuse of Processes:* led by Bill Frakes (Virginia Tech)
- *Micro-Architecture of Software Components* and The Need For Good Mental Models of Software Subsystems: a joint working group led by Steve Edwards (The Ohio State University), Joe Hollingsworth (Indiana University Southeast), Larry Latour (The University of Maine) and Bruce W. Weide (The Ohio State University)
- *Systematic OO Reuse - A Tale Of Two Cultures:* led by Martin L. Griss (Hewlett-Packard Laboratories)
- *Barriers to Institutionalizing Reuse Using Current Tools and Environments:* led by Margaret (Maggie) J. Davis (Boeing Defense and Space Group), and Rebecca Joos (Motorola)

The Tools and Environments group decided very early in the workshop to become a "virtual" working group, sending envoys throughout the workshop and meeting periodically to collect and discuss different perspectives on their problem. The envoy concept was also used successfully by the Systematic OO Reuse group. Envoys were again sent to other groups to pull in different perspectives on the Systematic Software Reuse/OO "two cultures" issue. This allowed the working groups to exchange ideas much more quickly and in greater detail than they could via the plenary sessions.

A number of innovative ideas came out of this year's workshop. Along with the highly successful envoy concept, two groups used the case study approach to get a different "holistic" perspective on their problem. Kevin Benner's "The Organization" working group brought in domain experts from Andersen Consulting to study a fictitious organization not unlike Andersen in many respects, and Sid Bailin's "Domain Processes and Engineering" working group adopted the metaphor of theatrical criticism to analyze the key scenes of an organization. Borrowing a page from C.P Snow's critique of the "Two Cultures" of science and the humanities, Martin Griss led his group in an analysis of "Systematic OO Reuse - A Tale of Two Cultures". Mark Simos formed and led his domain model representations group under the premise that much could be learned by attempting to develop a framework of representation strategies. The group's use of Kiviat diagrams was innovative and thought provoking. Steve Edwards and Larry Latour found it very worthwhile to discuss mental models of software within the very pragmatic context of Joe Hollingsworth and Bruce Weide's Micro-architectures group. Finally, Bill Frakes found it useful to consider issues of manipulating the reuse process as product, applying concepts of form and parameterization typically applied to more "standard" artifacts. These innovative working group approaches led to an extremely interesting and productive 2 1/2 days.

This report contains an edited version of the individual working group reports. Complete versions, along with current and past proceedings and past working group reports, are available from the WISR archive listed at the end of this summary.

"The Organization" (or Software Reuse in a Business Environment)

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Between the learning of the basic concepts of systematic software reuse and their application in a commercial environment there is a difficult transition between sterile concepts and the prickly issues associated with real-world reuse. Simple tradeoffs become multi-variable equations as competing issues com-

pete for priority. The purpose of this working group was to look at these issues in the context of a real example. The case study is based on analysis of Andersen Consulting's software assets called "Customer/1" and its use in the development of custom solutions for utility companies. The general situation is that AC has developed a customer service package most appropriate for gas and electric utility companies. There are in fact various distinct versions of Customer/1. The study focuses principally on the version called Customer/1 IP. Some of the basic functionality includes billing, invoicing, service orders, customer contacts, and etcetera. The study spans the last six years as Andersen Consulting has built approximately 25 of the last 30 customer care systems for gas and/or electric utility companies across the United States.

The goal of the working group was to understand the basic business environment in which Customer/1 is used, understand the current reuse plan, and then critique and provide recommendations on how to improve the overall reuse strategy for Customer/1 within this business environment. The STARS developed Conceptual Framework for Reusable Processes (CFRP) is used as a framework for characterizing the current reuse practices. Given an understanding of these practices, recommendations for how to improve the current practices are presented.

The Case Study

Though AC has been reusing Customer /1 for many years, neither an explicit statement of their business environment in which they operate nor an explicit reuse plan exists at this time. In lieu of this, I have used the STARS developed CFRP as an outline into which I have characterized AC's reuse practices regarding Customer /1.

The strategy activities necessary for a comprehensive reuse strategy are reuse planning, reuse infrastructure development, and reuse continuous improvement. The tactical activities needed are asset creation and improvement, asset management, and asset utilization.

The following sections will describe what each of the these activities are and describe to what degree they are being performed by the Customer/1 IP program.

The Evaluation

Strategic Reuse Activities

Reuse Planning

Reuse Planning consists of four phases: Assessment of business environment, Direction setting and scoping of reusable asset generations, Reuse infrastructure planning, and Project planning.

Assessment of business environment:

Before putting in place a reuse plan, one must first assess whether the current business environment is conducive to reuse. Assuming there exists a common set of capabilities across some target market, one must ensure that there exists a sufficiently large body of potential clients over a sufficiently long period of time so as to justify the investment. How broad and stable this client base is drives how big an investment to make in reusable assets, as well as over what period of time.

The target clients for Customer /1 IP are utilities in the US who are most concerned with low risk solutions for customer service software. These potential clients already are running mainframe IT operations and/or are planning to upgrade to a new mainframe IT operation. The target market is entering a period of transition. There is mounting pressure for utilities to pursue client-server solutions as that technology platform matures. However, due to the uncertainty associated with client-server (e.g., costs, technical issues, etc.), many utilities still favor mainframe solutions.

The application functionality of Customer /1 includes energy services, products, etc., credit/collection, payment processing, service orders, meter reading, meter history (e.g., purchase/inventory/tracking), service delivery, marketing, customer contact, and financial/non-financial controls.

The customer/1 IP software was designed to provide a high degree of variability across client sites. Within the common functional areas described above, some areas have been built to support a high degree of variability. Those areas are: (1) Billing, (2) Credit/Collections, (3) Financial/Non-Financial controls, (4) Revenue/Non-Revenue reporting, (5) Letter generation, (6) Customer Contact, and (7) Purge/Archive. The primary method of obtaining this variability was through the use of parameterization in the functional areas.

An example of the use of parameterization is in the bill calculation function of customer/1 IP. The "core" billing calculation process architecture contains generic calculations that utilize user maintained (i.e., non-technical personnel) data which make up the tariff structures (e.g., customer charges, energy charges, etc.) that are common across electric and gas utilities. This enables a utility to change the data within the parameter tables to support their specific tariffs. Additionally, the billing architecture utilizes a compartmentalized approach to the software (e.g., individual sub-routines performing specific functions - calculate demand charges, etc.).

Currently, Andersen Consulting has three Utility CIS software solutions: (1) customer/1 IP (Illinois Power), (2) customer/1 ENTERPRISE, and (3) customer/1 COOPERATIVE. All three of these solutions have some overlapping functionality (e.g., basic data model, base functionality, etc.). customer/1 IP operates in a mainframe environment while the other two are client/server applications.

1. customer/1 ENTERPRISE is a UNIX client/server solution being developed from the customer/1 IP software with modifications being added to support the client's business environment/needs.

2. customer/1 COOPERATIVE is a client/server solution that was developed from the original customer/1 software site (Baltimore Gas & Electric). The software in its current state contains electric only functionality.

The primary differences between the two client server applications are that customer/1 ENTERPRISE is intended as a business solution operated by Andersen, whereas customer/1 COOPERATIVE is a client/server CIS.

Direction setting and scoping:

Relative to Customer /1 IP, the general direction setting and scoping has already been put in place. This direction is to leverage the current asset as much as possible. Currently there is no plan to localize solution delivery into a single site (i.e., a solution center).

Another part of scoping is selecting a specific asset packaging approach. An asset is packaged via some combination of people with specific knowledge, deliverables (i.e., any sort of work product which is to be reused), tools for effectively manipulating or modifying the deliverables, and formalized processes on how to employ the reusable asset. This decision is ultimately driven by a trade-off between often competing solution delivery values. Some of these solution delivery values are: flexibility, productivity, speed of delivery, cost of delivery, investment cost, evolvability over time, and developer learning curve.

While all of the above solution delivery values are important, in the real- world one must strike the right balance for the targeted audience. For the utilities industry that AC is targeting, the three most important solution delivery values are: (1) cost of delivery, (2) speed of delivery, (3) flexibility. Another delivery value often mention by customers is the evolvability, but exactly what this means to them is difficult to quantify.

Driven by the above solution delivery values, AC has evolved toward a packaging strategy encompassing all of the above packaging elements, but with a distinct reliance on people. In particular, the Customer/1 asset has not been packaged as a stand alone asset. Rather, effective use of the asset can really only be done by a select group of people who understand the deliverable well enough to be able to customize it for new clients. This approach has the advantage of flexibility and minimal up front investment, but has the disadvantage of making people the limiting resource.

Reuse Infrastructure Planning:

Reuse infrastructure planning is naturally an important part of any reuse plan. It is concerned with the organizational, educational, and technology infrastructure specifically constructed to facilitate reuse. In general, there has not been any sort of strategic planning in this area.

Project Planning:

Project planning refers to a plan which spans multiple projects concerning which projects will create and improve both the reuse infrastructure and the reusable assets. For Customer /1, there is no plan which looks beyond the current set of engagements under way. Efforts to coordinate projects and share results are done informally.

The closest example of project planning was the creation of the Customer/1 IP asset. This though was a mixture of good luck and some planning. In this case Illinois Power was a particularly sophisticated client who appreciated the need to design their customer information system to be evolvable. The engagement was staffed with several fairly senior developers who had previously worked on multiple customer information systems. Because of this seniority, the vision of the client, and the "reuse rule of three", a well designed reusable asset was created— Customer/1 IP.

Reuse Infrastructure Development

Reuse infrastructure development refers to the creation and maintenance of organizational, educational, and technology infrastructure to support reuse.

Organizational infrastructure includes three critical elements: people, processes, and organizations tailored for reuse. People with the necessary reuse training are the most critical element. The necessary reuse knowledge includes both knowledge of general reuse practices, as well as specific knowledge on how to use particular reusable assets. Within the "Customer /1 IP team", knowledge of how to utilize the asset is concentrated in a small number of people. Training of additional people is done as part of engagements using the asset.

Ideally, the organizational element should be configured to maximize effective reuse. This is best achieved by separating the creation and enhancement portions of the organization from the utilization portions. Though this may not always be achievable it is at least important that individuals understands what role they are performing at any given time.

Educational Infrastructure

Educational infrastructure refers to the capability to train people in the necessary skills for building and using reusable assets, as well as the overall reuse center development process. Customer /1 IP only addresses the later as part of on the job training while working within an engagement using the asset.

Technology Infrastructure

Technology infrastructure includes various technologies which can aid reuse. This often includes: a repository of some sort, technology for packaging assets (e.g., ways of representing deliverables, specific tools, and process formalizations). Within Customer/1 IP, there is no special reuse technology infrastructure. Of particular note, the repository in which Customer/1 is delivered is the same one used in its initial creation. This has the advantage of bundling all of the various work- objects generated as part of the initial engagement. The disadvantage of this repository is that it is a repository intended only to support the development of a single system.

Reuse Continuous Improvement

Reuse continuous improvement, as the name implies, is con-

cerned with the continual improvement of the reuse process. Relative to Customer /1 IP, there is no explicit continuous improvement program. On the other hand, business market forces are a strong incentive to evolve what you are doing in response to the competition and the needs of your clients or go out of business. It was in response to market forces that Customer/1 Enterprise and Cooperative were created.

Tactical Reuse Activities

Asset Creation and Improvement

Experience has shown that large grained reuse can provide significant advantages over small grained approaches. This approach relies on shared, well understood domain models, architectures, and components. Customer /1 IP is a large grained asset consisting of the following assets: (1) a set of 14 binders of design documentation outlining both functional information (e.g., billing binder) and technical information (e.g., data model), (2) Installation documentation, (3) customer/1 software, (4) utility software (e.g., testing software), (5) test data for installation testing, and (6) a design repository of all of the above plus additional more detailed work objects. The software has a distinct functional architecture facilitating customization. Some modules are parameterized to enable specific classes of customization.

There is no official mechanism for improving the above assets. Improvements that are made in the context of an engagement remain with that engagement. Sharing of new and improved assets is done informally between managers. At this point there is almost a standard set of diskettes which are passed along with the repository which contain standard modifications/improvements to the Customer/1 IP baseline.

In general, one can think of this reuse approach as being exemplar based. Relative to Customer/1 IP, the delivered customer information system for Illinois Power was recognized as being particularly good. It was declared the baseline (or exemplar) from which subsequent utilizers would start. This exemplar plus its immediate derivatives define a generation of solutions. The problem/challenge with the market driven approach is that it can result in an unnecessarily large number of asset generations. Discipline needs be exercised.

Asset Management

Asset management activities fall into two broad categories: maintaining the repository and the assets in it, and facilitating better communications between asset creators and utilizers. Regarding the Customer /1 IP assets, no one does either of these roles. The repository is frozen. Communication is done informally.

Asset Utilization

Asset utilization is development-with-reuse. The principle steps to development with reuse is identification of the potentially reusable asset(s), evaluation and hopefully selection of the appropriate asset(s), tailoring of the asset (if this is part of the specific utilization process of this specific asset), and integration of this asset into the total solution. For Customer /1 IP, this activity is performed by comparing the requirements of the client to Customer /1 IP. The resulting Gap Analysis determines the feasibility and cost of leveraging this asset. The development process for Customer /1 has been streamlined to: install, convert, then customize.

Knowledge of which portions of Customer /1 can be tailored, as well as how to perform this tailoring, is known by managers and staff who have extensive experience with the asset. This knowledge is the single greatest limiting factor to our capacity to build Customer /1 IP solutions.

The Recommendations

The above description should have given the reader some understanding of the type of reuse currently being performed within Andersen Consulting's Utilities Industry Group. This section will summarize the recommendations of our working group. The basic thrust of the recommendations was toward incremental improvements on what was already in place.

Deliverables

In general the current utilization process consists of evaluating the appropriateness of each module. The goal is to reuse, without modification, 60-80% of Customer/1's modules. Though this goal is meet, there are cases where the same customizations are done in multiple projects thus missing opportunities for additional reuse. None of these improvements are rolled back into the baseline and few of these improvements become part of the "delta" disks which are passed as adjuncts to the baseline repository. We recommend creating an additional repository into which alternative module implementations can be saved.

Tools

A specific repository, called Design/1, is the principle tool to facilitate reuse within typical AC engagements. Though very effective at managing the work objects of an engagement, it is less then ideal for facilitating reuse. The repository is really a design repository organized around the design and its architecture. If one does not know the design and architecture of Customer/1 it is very difficult to find things. Also, the repository does not support versioning. Alternative versions are only supported via user imposed naming conventions. Traceability links are quite limited. Improvement to each of the above features would allow people not familiar with Customer/1 to browse it and become more familiar with it, thus lowering the learning curve associated with using the Customer/1 repository.

Process

The customization of the Andersen Consulting methodology to install, convert, and customize has realized significant time savings. It was clearly the right thing to do given the high degree of commonality among clients and the high degree of reuse employed in the construction of custom systems. This sort of customization needs to be carried further. Within the customization process, what modules are always customized? What are the issues that drive the customization? What are the key decision points? This knowledge needs to be harvested and made more accessible.

People

The people of an organization is where reuse must originate. The individuals who have and are now involved with Customer/1 clearly understand the advantages of reuse and strive to maximize it. This is done in spite of various limitations of their environment. Steps need to be taken to ensure that new people have a similar commitment. Andersen Consulting has an extensive initial training and continuing education program. Reuse needs to be integrated into these programs at the lowest and highest levels. Additionally, career maps which describe the various positions within Andersen Consulting and the areas of expertise for each level need to be augment to include criteria which are reuse based.

Summary

In summary, we were able to come to a sufficient understanding of the case example on the first day. Over the remaining day and a half we characterized many of the essential elements of a reuse plan. With that in hand we evaluated the current reuse practices regarding Customer/1. Finally, we made a series of concrete recommendations on how to improve these reuse practices.

Domain Processes and Engineering

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The objective of this working group was to identify key patterns and choices that can impact a Domain Engineering effort for better or worse, and characterize these patterns/choices at a more specific, lower level of granularity than is obtained with conventional process description languages. Of particular interest was to identify patterns of interaction among stakeholders that could postively or adversely impact the effort.

Rather than using the traditional techniques such as brainstorming, cause/effect diagrams (also known as fishbone or Ishikawa diagrams), affinity diagrams (also known as the KJ method), etc., we adopted a novel approach using the metaphors of theater [11, 15]. This method attempts to uncover and analyze some of the key "scenes" in the theatrical drama of domain engineering.

The "theatrical script" technique provided for a logical sequence of documented events that led to the conclusions, as well as the identification of key decision points (or issues) that may have altered the final conclusions. This technique does require more effort than the traditional techniques to traverse and document the alternative paths in a tree of script scenarios.

In this report, we present the resulting drama in terms of its characters, their relationships in the organization, and a succession of scenes that represent one path for a domain engineering effort. This particular path represents a series of choices that are close to the borderline between success and failure. We did this in order to surface as many issues as possible. Interactions between characters that indicate significant risks are flagged with an asterisk (*), and for each such risk we identify potential alternative responses that might increase the chances of success.

The Characters

General Manager (GM), Ross, age 50, is the senior manager in this drama. His main responsibility, as he sees it, is to ensure annual profitability. To accomplish this he needs timely and accurate information, good advice from his Director of Technology, and good employee morale. He dislikes lack of "ownership" by his employees, the attitude that this is just a job, apathy, and low standards. Ross has at his disposal some excellent staff at various levels of the organization. He knows that his budget is inadequate for all of the technology base and infrastructure needs that his people articulate. His dilemma in this drama is the perennial question: where to put the money?

Director of Technology (DT), Paul, age 49, is expected to make unbiased technical decisions and to stay out of the "budget swirl." In order to do this, he must stay up to date technically as well as maintain a good understanding of all projects in the organization. He expects the projects to provide him with technical data, and he expects his boss, the General Manager, to bless his decisions and mandate them to the projects or back them up when necessary. Paul is happy when he believes he has made sound decisions. He therefore tries to get concensus from others, and if this is not forthcoming he stalls on making decisions, effectively deadlocking the decision process.

Portfolio Manager (PfM), Jim, age 51, is responsible for profit and loss in an organization spanning several projects. He is expected to ensure that the projects under him are completed on time and within budget, and more generally to meet any goals set by his boss, the General Manager. In order to do this, Jim needs a competent accounting person and the relevant accounting and project data, including project met-