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KNOWLEDGE-BASED REUSABLE SOFTWARE SYNTHESIS SYSTEM

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The Eli system, a knowledge-based reusable software synthesis system, is being developed for NASA Langley under a Phase II SBIR contract. Named after Eli Whitney, the inventor of interchangeable parts, Eli assists engineers of large-scale software systems in reusing components while they are composing their software specifications or designs. Eli will identify reuse potential, search for components, select component variants, and synthesize components into the developer's specifications. The Eli project began as a Phase I SBIR to define a reusable software synthesis methodology that integrates reusability into the top-down development process and to develop an approach for an expert system to promote and accomplish reuse. The objectives of the Eli Phase II work are to integrate advanced technologies to automate the development of reusable components and the use of reusable components within the context of large system developments, to integrate with user development methodologies without significant changes in method or learning of special languages, and to make reuse the easiest operation to perform. Eli will try to address a number of reuse problems including developing software with reusable components, managing reusable components, identifying reusable components, and transitioning reuse technology. Eli is both a library facility for classifying, storing, and retrieving reusable components and a design environment that emphasizes, encourages, and supports reuse. Eli is being developed incrementally and will be released in a series of builds with progressively more functionality. A related issue, not being addressed by the Eli project, is how to implement reuse within an organization.

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Outline of Presentation

- Eli Project Background
- Problems that Eli Will Solve
- Overview of Eli Build Plan
- Some Eli Operational Issues

Eli Project Background

- Phase I completed in Fall 1987, objectives were to:
  - Define reusable software synthesis methodology that integrates reusability into the top-down development process
  - Investigate formal languages for specifying reusable component interfaces, operations and requirements
  - Investigate knowledge and database representations for organizing and storing both components and knowledge of the application domain and development process
  - Develop approach for expert system to promote and accomplish reuse

Eli Project Background (Conc)

- Phase II started in July 1988; objectives are to:
  - Integrate advanced technologies to automate the development of reusable components and the use of reusable components within the context of large system developments
  - Integrate with user development methodologies without significant changes in method or learning of special languages
  - Make reuse the easiest operation to perform

Problems That Eli Will Solve

What Reuse Problems Must Eli Address?

- Developing software with reusable components
- Managing reusable components
- Identifying reusable components
- Transitioning reuse technology

What is Eli?

- Library facilities for classifying, storing and retrieving reusable components
- Design environment that emphasizes, encourages and supports reuse

User Roles

- Eli will support the following user roles:
  - Classifier
  - Searcher
  - Promoter
  - System Administrator

Key Qualities of Eli

- Adaptability
- Performance
- Ease of Use

• • *Make reuse the easiest operation to perform* • •

How Will Eli Solve Reuse Problems?

Identifying Reusable Components

- Flexible component classification facilities
- Flexible browsing and querying facilities

Managing Reusable Components

- Efficient storage and retrieval of large component inventories
- Open architecture to support integration with user environment
- Facilities for tracking and promoting reuse activities

Developing Software With Reusable Components

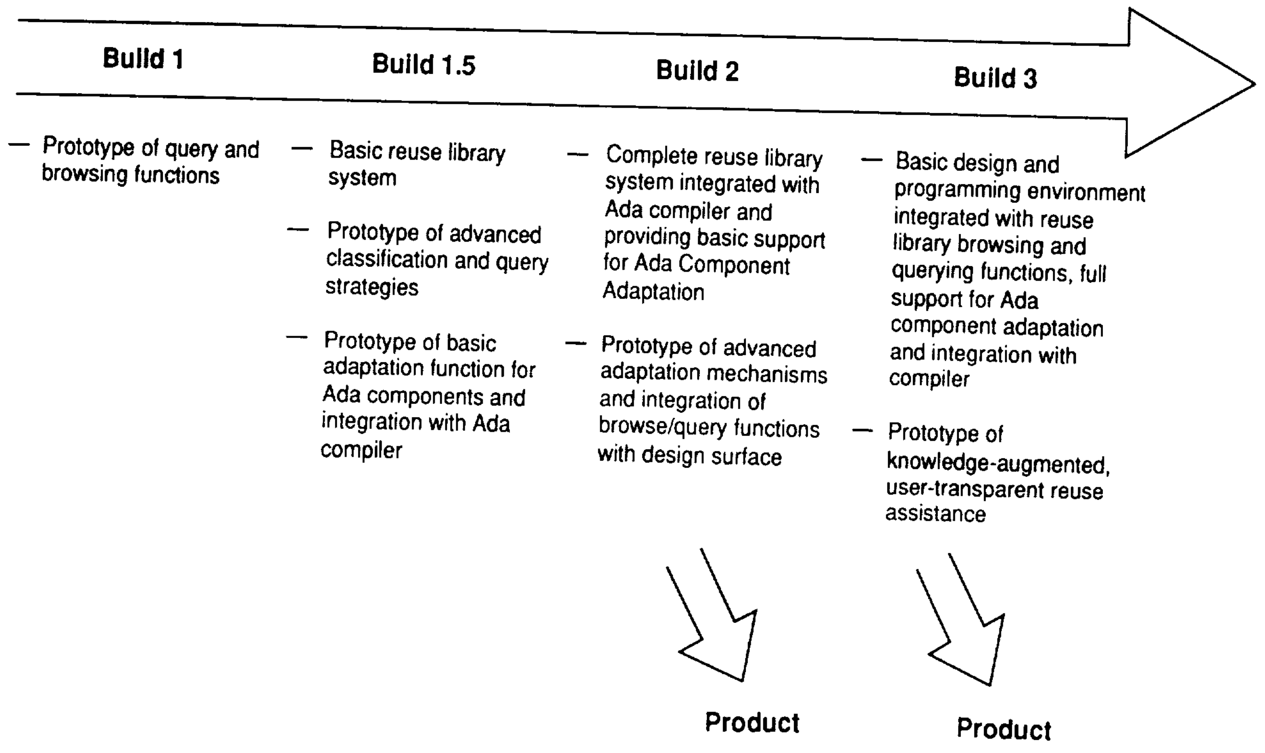
- Direct support for Ada components, including adaptation and integration
- Support for object-oriented design and programming
- Integration of design surface with library facilities

Transitioning Reuse Technology

- Support for defining new types of components, new component characteristics and new component relationships
- Loose and tight integration capabilities to transition existing tools and information

Overview of Eli Build Plan

Build Plan

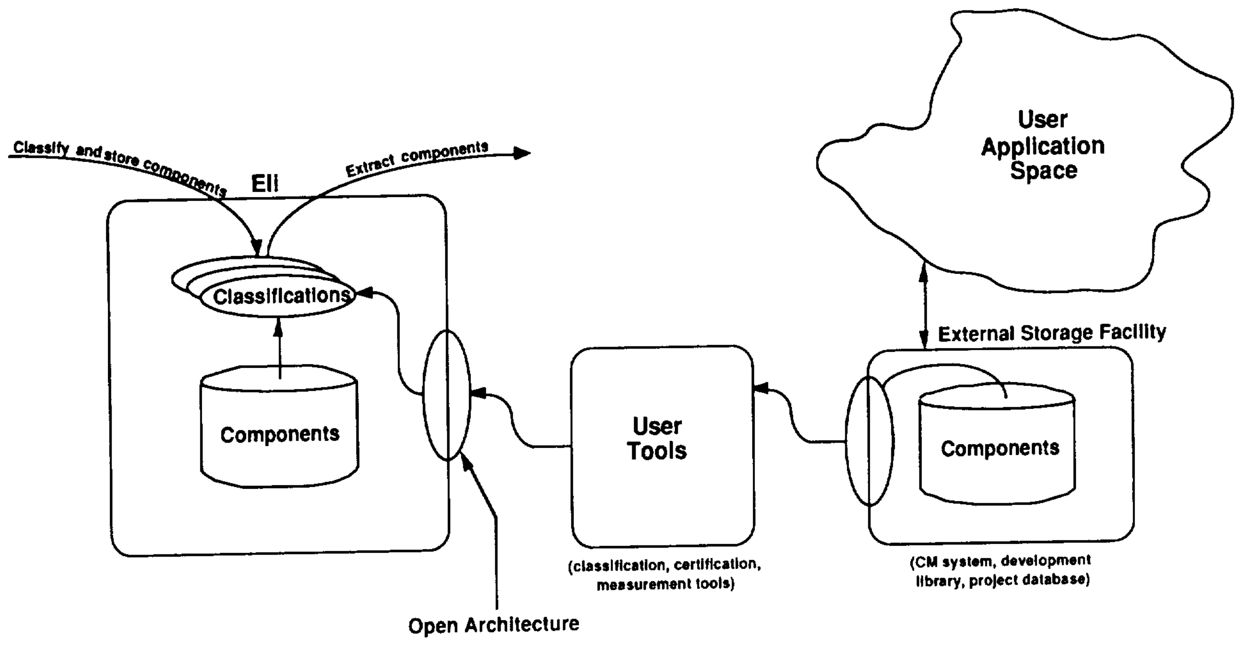


Build 1	Build 1.5	Build 2	Build 3
— Prototype of query and browsing functions	— Basic reuse library system — Prototype of advanced classification and query strategies — Prototype of basic adaptation function for Ada components and integration with Ada compiler	— Complete reuse library system integrated with Ada compiler and providing basic support for Ada Component Adaptation — Prototype of advanced adaptation mechanisms and integration of browse/query functions with design surface	— Basic design and programming environment integrated with reuse library browsing and querying functions, full support for Ada component adaptation and integration with compiler — Prototype of knowledge-augmented, user-transparent reuse assistance

Build 1.5

- This build will provide basic library capabilities:
  - Creation and maintenance of libraries
  - Creation and maintenance of classification schemes for library components
  - Classification and storage of components
  - Browsing of libraries to find/identify components
  - Querying on libraries to find/identify components
  - Extraction of classification schemes, components and component information
  - Integration of component classification, storage, query and extraction functions through a program interface

Build 1.5/2


Classify and store components
Eli
Extract components
Classifications
Components
User Tools
(classification, certification, measurement tools)
User Application Space
External Storage Facility
Components
(CM system, development library, project database)
Open Architecture

Build 2

- This build will provide a complete, sophisticated library system:
  - Import/export of libraries and classification schemes
  - Enhanced manipulation of classification schemes and component classifications
  - Semi-automated derivation of Ada component characteristics
  - Classification support for Classic-Ada components
  - Clustering of components and support for "like this" querying
  - Enhanced and additional forms of interactive browsing and querying on component characteristics
  - Storage, retrieval and modification of query sessions, including batch submittal of queries and query sessions

Build 2 (Conc)

- Version control on libraries, classification schemes, components and component information
- Access control to libraries, classification schemes, components and component information
- Adaptation and integration of reusable Ada components with user application
- Collection and reporting on library and classification scheme usage, and component submittal and extraction
- Customization and tailoring capabilities

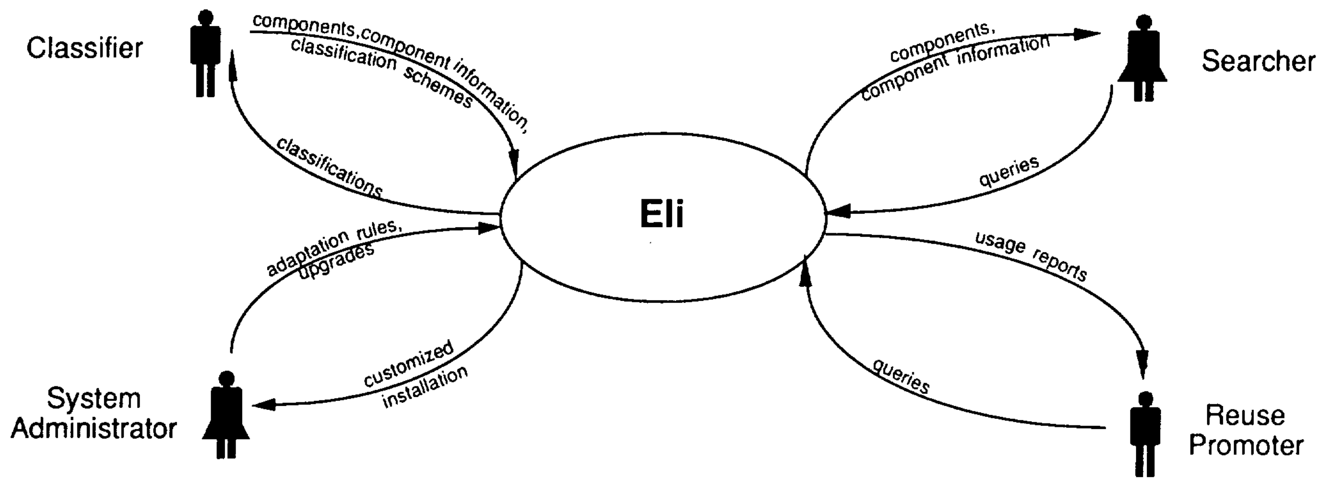
Build 3

This build will provide an object-oriented design surface with the following capabilities:

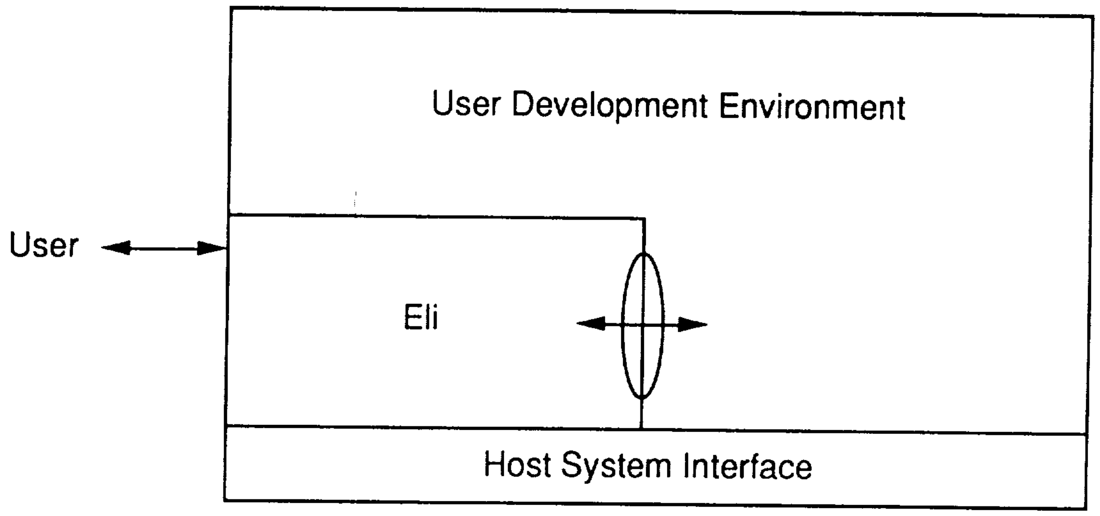
- Integration with Eli library facilities for design-time reuse assistance
- More automated derivation of component characteristics and classification of components
- Ordered assessments of components identified as result of queries
- Advanced support for Ada component adaptation and integration

Some Eli Operational Issues

User Roles



Eli "Black Box" View



Eli Interface Requirements

Interface Area	Principal Eli Focus
• Host Operating System	Transportability
• User's Development Environment Framework	Interoperability
• User's Development Environment Tools	Interoperability
• User's Development Environment Policies, Procedures and Methods	Adaptability

Eli Host Operating System Interfaces

Approach: Establish localized internal interfaces and utilize industry standards (e.g. Unix, XWindows, TCP/IP, Postscript) for transportability

- Device management
- Process Management
- File Management
- Communications

Eli Interfaces to User's Development Environment Framework

Approach: Support many levels of interaction including an open architecture - - procedural access to internal Eli facilities, published information schemas/structures, and an ASCII import/export interchange mechanism.

- Eli invocation
- Import of environment roles, access rights, procedures, etc.
- Configuration management of components
- Ada library manager
- Environment information management facilities
- Invocation of other environment tools/facilities

Eli Interfaces to User's Development Environment Tools

Approach: Provide open architecture - - procedural access and ASCII import/export facilities to allow users to exchange information with other tools

- Ada compilation system
- Documentation tools
- Other CASE (i.e. design surface) tools
- Other reuse systems (e.g. libraries, domain analysis tools)
- Project management tools

Eli Interfaces to User's Development Environment Policies, Procedures and Methods

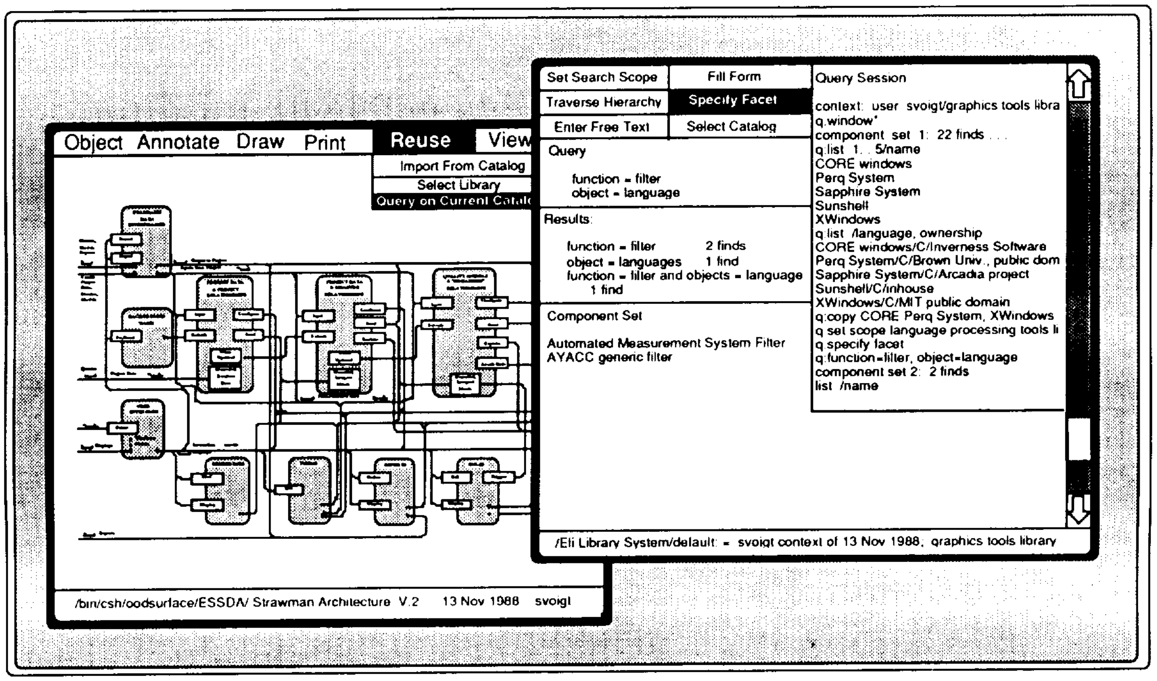
Approach: Make Eli facilities adaptable to accommodate a wide spectrum of usage

- User roles and access rights
- Usage scenarios/sequences/work flows
- Configuration management procedures
- Component certification procedures
- Custom component attributes/facets
- Custom classification schemes
- Site/library installations

Eli Distribution Options

	Classification Update (Library Control)	Component Classification & Storage	Library Access
Non-distributed library model	Local	Local	Local only
Interaction of remote, separately controlled libraries (e.g., interlibrary loan)	Local	Local	Local plus protocol or accessing remote libraries
Master/branch library (e.g. , bookmobile)	Local to master library	Local to master library	Accessible across affiliated branches
Partitioned library (e.g., library system)	Single point or negotiated	Partitioned	Accessible across library sites
Cooperating, distributed libraries	Distributed	Distributed	All libraries accessible transparently from any site

Library Interaction Through Design Surface



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Query

    function = filter
    object = language

Results:

    function = filter          2 finds
    object = languages         1 find
    function = filter and objects = language
        1 find

Component Set

Automated Measurement System Filter
AYACC generic filter
```

```
Query Session

context: user svoigt/graphics tools libra
q.window*
component set 1: 22 finds . . .
q:list 1. . 5/name
CORE windows
Perq System
Sapphire System
Sunshell
XWindows
q:list /language, ownership
CORE windows/C/Inverness Software
Perq System/C/Brown Univ., public dom
Sapphire System/C/Arcadia project
Sunshell/C/inhouse
XWindows/C/MIT public domain
q:copy CORE Perq System, XWindows
q set scope language processing tools li
q specify facet
q:function=filter, object=language
component set 2: 2 finds
list /name
```

```
/Eli Library System/default: = svoigt context of 13 Nov 1988; graphics tools library
```

```
/bin/csh/oodsurface/ESSDA/ Strawman Architecture V.2    13 Nov 1988    svoigt
```

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