Adoption Centric Software Engineering

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Leveraging Cognitive Support and Modern Platforms for Adoption-Centric Reverse Engineering (ACRE)

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Problem

Research tools in software engineering often fail to be adopted and deployed in industry. Important barriers to adopting these tools include their unfamiliarity with users, their unpolished user interfaces, their poor interoperability with existing development tools and practices, and their limited support for the complex work products required by industrial software development.

Approach

Office suites, by contrast, are capable, mature, flexible, extensible, and familiar to many developers. For example, common office suites are used daily to browse Web content, produce multimedia documents, prepare presentations, and maintain budgets. These suites and other middleware-based environments can be extended and leveraged to provide familiar support for software engineering tasks. Developing and deploying innovative research tools and ideas as extensions to modern, commonly used desktop environments may ease the barriers to adoption. Users will more likely adopt tools that work in an environment they use daily and know intimately. That is, tool adoption will be improved if we specifically address the issues of cognitive support and interoperability.

The ***cognitive support*** of Software Engineering tools can be improved by exploiting the deep familiarity and expertise that users already have with their favorite applications and environments. We believe that building software engineering tools on top of these platforms will address the issue of cognitive support effectively.

Also, the ***interoperability*** of these tools can be improved significantly by leveraging recently developed middleware technologies. By exploiting technologies, such as plug-in or model-driven architectures and data exchange standards, we can address the issue of interoperability. Recently, tool builders and standards bodies have invented effective standards and interfaces for tool extension and customization.

These advances have opened new research avenues on how innovations in software engineering tools can be made more easily adopted by inserting them as extensions to commonly used office suites (e.g., Microsoft Office XP, Lotus SmartSuite, Sun StarOffice, and Corel WordPerfect Office) and middleware platforms (e.g., XML standards, SVG, scripting languages, model-driven architectures, and plug-in platforms). Our project aims to explore these avenues. Our main hypothesis is that in order for new tools to be adopted successfully, they must be compatible with both existing users and other tools. To validate this hypothesis, we will build prototype software engineering tools using open standards, popular office suites, and common middleware technology. Using these, we will conduct industrial case studies and structured tool experiments. The experience gained will be beneficial for both academic research and industrial practice.

Benefits

Developing effective techniques and strategies to overcome the software engineering tool adoption problem will have great value to the software and information technology sectors. Injecting more of the great software engineering research results into industrial practice has potentially a significant impact on the production of quality software. Thus, this research addresses two diverse markets: the software developers, who need to understand and document existing software systems, but also the researchers, who want to inject and validate their research tools in industrial development processes.

ACRE V1.0

ACRE V1.0 consists of several software visualization engines on top of various office products, including Lotus Notes, Excel, PowerPoint, and Visio. The software engineering tools in this ACRE environment interoperate using the ACRE persistence engine and SVG (Scaleable Vector Graphics). The ACRE persistence engine is implemented using IBM Websphere software platform [http://www-3.ibm.com/software/info1/websphere/], the OMG's Model Driven Architecture (MDA) [http://www.omg.org/mda/], and OTI's universal tool platform Eclipse [http://www.eclipse.org/]. SVG is a W3C XML standard and an effective solution for smart cross-platform graphics.

Towards Live Documents for Software Engineering Documentation

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An ACRE Live Document is

- a static document with a state
- data-driven and interactive
- adapts automatically and intelligently to its context
- is implemented on top of standard office platforms

Live documents can be used to

- synchronize code and documentation automatically (e.g., keep diagrams in line with the source code)
- produce multiple output versions from one source consistently (e.g., for print, online and audio use)
- address different audience needs (e.g., user manuals for novice and expert users)
- explore the system without leaving the document
- support group collaboration

Meeting reverse engineering requirements with MS Excel, PowerPoint and Visio

RE requirement	Excel	PowerPoint	Visio
Visualize program information artefacts and architecture	Drawing tools	Custom presentations and animation	Templates for diagrams, e.g. UML and Web sites
Statistical data analysis and metrics	Built-in statistical functions and charts		
Re-document system	Report builder Synchronize with data sources	Custom presentations and animation	Synchronize with data sources
Repository based	OBDC support Excel sheets as data sources,		
Collaboration features	Protect and share workbook Track changes	Track changes and merge documents	
	Meeting scheduling and sending documents via email		
Robust	Standard functionalities to build upon; e.g. “undo”		
Data-driven and net-centric	Web services, Smart Tags, and Dashboards, Web publishing Integrate with databases (e.g., Access) and MS server environments		
Interoperability	Active X/OLE support Support for XML and SVG objects		
End-user programmable and Office automation	Macro recording, playing, and editing, Scripting with VB script (Com) Add-Ins with VBA, Dynamic Libraries with .Net		
Leverage cognitive support	Large user base: according to Microsoft more than 250,000,000 users for Office		

Towards a Live Manual

- Keeping documentation up-to-date
  - synchronize graph analysis and vMSisualization using Excel built-in statistical functions and charts
  - synchronize visualization of statistical data using Excel charts
- Enhancing documentation capabilities of the Rigi reverse engineering system
  - different views on the graph data and statistics in Excel within one workbook
  - copy Excel views to PowerPoint for advanced presentations features
- Keeping source code and documentation in sync
  - capture Rigi graphs and display in Excel, PowerPoint and Visio
  - edit Rigi graphs in Excel, PowerPoint and Visio

ACRENotes—Leveraging Cognitive Support in Lotus Notes to build ACRE tools

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What is ACRENotes?

ACRENotes is an adoption-centric reverse engineering (ACRE) tool that is developed with the popular groupware product Lotus Notes. It has the following components:

- Data Repository
- Data Visualization
- End-User Programming
- Team Cooperation

Why Lotus Notes?

- Leverage GUI and metaphors familiar to users

As a successful groupware product, Lotus Notes has been used by millions of users all over the world. Consequently, Lotus Notes users have become familiar with its GUI, metaphors, and operation processes. Building on Lotus Notes, ACRENotes can save users a lot of time and effort compared to learning a stand-alone software egineering tool.

- Utilize built-in document database to efficiently manage data

Both documents and data in Lotus Notes are managed in its own document database. Documents can be easily selected, browsed, filtered, and categorized. Furthermore, they can be handled by predefined Agents and Actions. ACRE leverages Lotus Notes' database: By converting reverse engineering data (e.g., from GXL) into documents, the users' capability to directly manipulate reverse engineering data can be maximized. Moreover, all kinds of artifacts generated by the development team can be managed easily in this database.

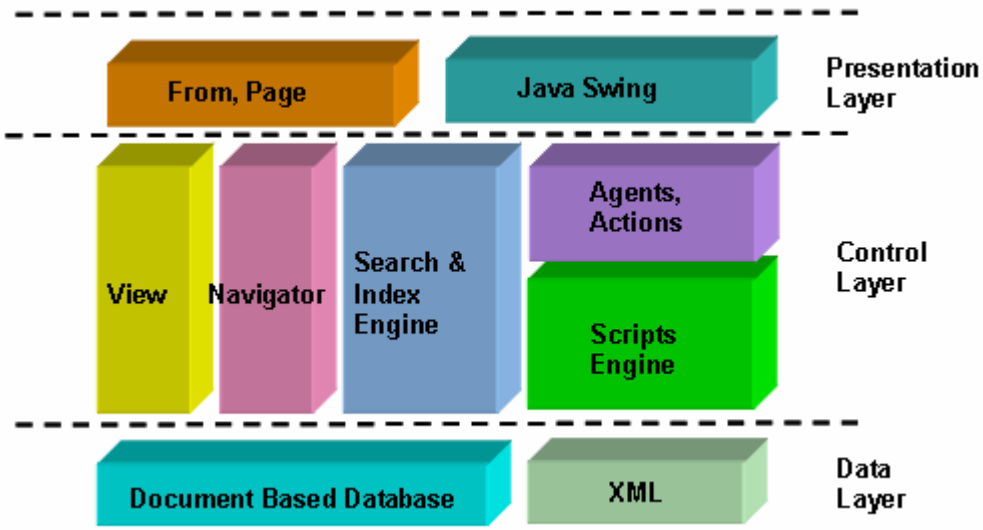
- Integrate CSCW support in reverse engineering tools

Lotus Notes' groupware features facilitate cooperation between team members. They can easily exchange project information in the form of Lotus Notes documents. Project managers can access information to coordinate and direct the team's effort. Therefore, people can work on a large reverse engineering project effectively and efficiently.

- Enable end-user programming

Users can access and manipulate their data with the help of scripting languages embedded in Lotus Notes (e.g., JavaScript). Therefore, tedious and complex tasks can be efficiently automated.

The ACRENotes Architecture



The ACRE SVG Visualization Engine (ASVE)

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What is ASVE?

- A graph visualization engine for exploring and annotating software artifacts
- Built exclusively with SVG and ECMAScript
- Embeddable into "host" applications such as Web browsers and office tools (e.g. PowerPoint, Excel, Word)
- A live document component
- A client for the ACRE Persistence Engine

Why SVG?

Scalable Vector Graphics (SVG) is an XML grammar for Web graphics from the W3C. Advantages of SVG over other image formats are:

- infinite zooming with crisp edges (i.e., no “jaggies”)
- embeddable in office applications, web pages, and XML documents
- (open source) viewers for common platforms
- XML-based format that is non-proprietary, human-readable, and searchable
- wide selection of tools available to edit and transform (XSLT, XQuery, etc.)
- small file sizes for high resolution graphics
- easy manipulation through standard APIs, such as the DOM API

What makes ASVE a good ACRE tool?

- Embeddable

Since ASVE is built using pure SVG it can easily be embedded into project documentation: PowerPoint for presentations, HTML pages for on-line browsing, Word documents for hard-copy documentation, and XML documents for further post-processing.

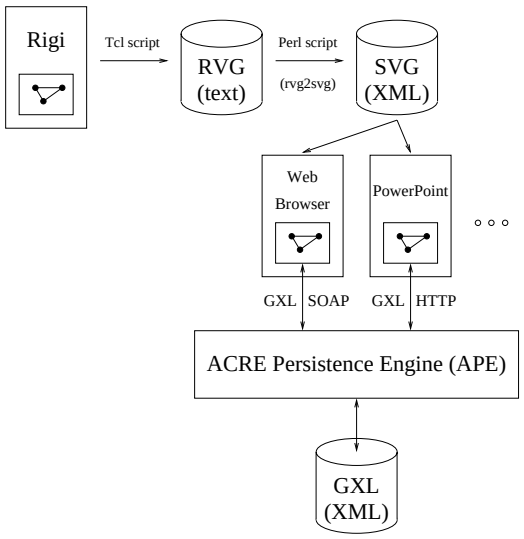
- Live and Interoperable

ASVE can act as a lightweight, platform independent client of the ACRE Persistance Engine. Regardless of the "hosting" application, ASVE can alway connect to its data in the ACSE repository.

- Rich Knowledge Store

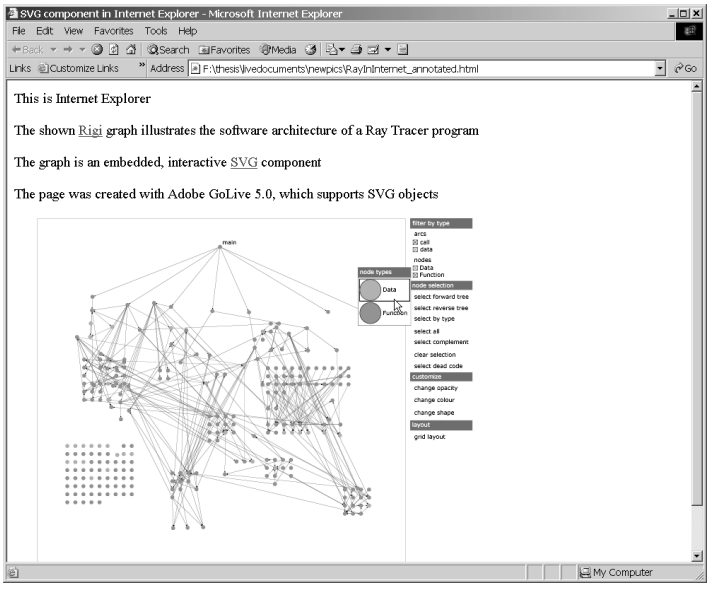
With ASVE, a single file encapsulates a snapshot of a Rigi reverse engineering view along with all the graph manipulation functionality needed for further exploration (see "ASVE Architecture").

ASVE Architecture



ASVE in Internet Explorer

The illustration below shows an extracted Rigi view—a call-graph of a ray-tracer application—in ASVE. Here, ASVE is "hosted" by Internet Explorer. The user can filter, rearrange, layout, annotate, display attributes, and change the visual characteristics of nodes and arcs in order to better understand the architecture of the software system.



The ACRE Persistence Engine

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What is it?

- A feature-rich, and extensible middleware system upon which to develop software engineering tools.
- Software engineering tool developers can build their custom applications on the Engine.
- Build on what is already in place – re-use!

An Example – Software Requirements Engineering

Some of the features that may be found in a Requirements Toolkit include:

- Data Repository processing
  - Requirements docs
  - Import/export docs
  - Dictionaries, glossaries
- Views
  - Graphic output
  - User-defined
- Requirements processing
  - Support standards
  - Requirements tracing
  - Sort/analyze metrics
- Integration
  - with popular IDEs
  - with popular SE tools
- Version control/change mgmt
- Secure access control
- Extras
  - Whiteboarding
  - On-line discussion
  - Custom calculations

Before the ACRE Persistence Engine

Developers have to write code for all aspects of the tool—from the basic infrastructure, such as client interfaces, the repository access, to the code which makes the tool unique. The lack of a standards-based design leads to more one-of-a-kind implementations.

With the the ACRE Persistence Engine

Tool developers can focus on creating custom code for new required features, as the Engine provides the basic components. Designers and developers can focus on creating code in support of the cognitive principles behind ACRE.

Architecture of the ACRE Persistence Engine

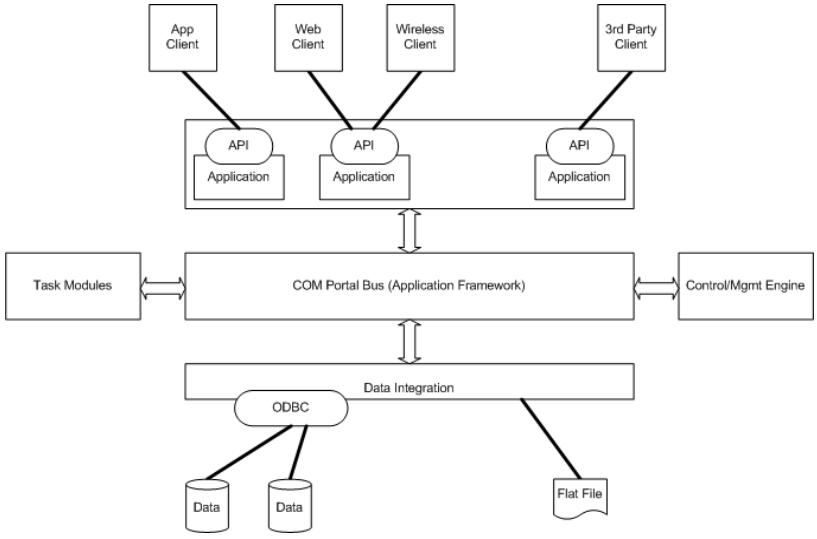
The ACRE Engine can be extended to provide the functionality needed in the Software Engineering tool/ application you are developing.

The architecture utilizes

- International standards (e.g., MDA, WSDL, SOAP, ODBC)
- Common data format (SVG/GXL/XML) for 3rd party integration
- IBM's WebSphere Application Server

The architecture provides

- Multiple perspectives/views
- Data repository control
- Version control
- Web and e-mail services;
- Web authoring toolkit
- XML data interchange
- Java interface
- Debugging and profiling
- End-user programmability
- API for multi-client applications
- Scripting



Adoption-Centric Software Engineering in Scenarios

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Scenario1: Live Documents with SVG components and the ACRE engine

Documents that synchronize with their changing context automatically

Scenario 2: Live Documents with MS Office Automation

Documents that synchronize with their changing context automatically and support collaboration

Scenario 3: Towards a Live Manual

Automatically Updated Graph Analysis in MS Excel

Integrated Workflow of Rigi tool with MS Excel and PowerPoint

Scenario 4: ACRE Web Site Reverse Engineering

Scenario 5: ACRE UML Editor

Scenario 6: ACRE Prototyping: Office Automation versus SVG

Scenario1: Live Documents with SVG Components and the ACRE Engine

Documents that synchronize with their changing context automatically (see Figure 1 and 2)

A reverse engineer has worked with the SVG implementation of the Rigi tool in Internet Explorer and developed a call-graph for a ray tracer program that shows the main modules for dead code in the program. The reverse engineer needs to capture the view to integrate it in the online documentation as well as in a PowerPoint presentation for an upcoming group meeting of the software developers group. While the additions to the online manual are due immediately, the PowerPoint presentation is not due before another couple of days during which the reverse engineer is still working on the architecture and is expecting some important changes.

Instead of repeatedly generating time-consuming screenshots, the reverse engineer embeds the SVG component in the online documentation (in fact, the reverse engineer could work directly in the documentation pages) as well as in the PowerPoint presentation. In this way, the online documentation as well as the PowerPoint presentation are up-to-date and synchronized. People attending the presentation will be able to visit the online documentation later, look at the graph and even explore new views of the system by themselves.

During the presentation, the reverse engineer can interactively change the graph to demonstrate evolution processes or reveal more detailed insights of the software architecture. As the SVG components in the PowerPoint presentation and in the online documentation are both referencing the same data sources, any changes made during the presentation will be automatically reflected in the online documentation. Figure 1, 2, and 3 illustrate the above described scenario.

before

- while explaining the scenario, the reverse engineer shows an example of the Rigi user manual with a sequence of screenshots
- for example, the reverse engineer would take screenshots for the manual, then later on for the presentation (because the tool has evolved) and again much later to include it in a tutorial

→ manual and presentation are out-of-date and out-of-sync with each other and with the source code

after

- the reverse engineer embeds the SVG component in PPT and Internet Explorer

→ manual, presentation, and source code are up-to-date and in-sync
The ACRE engine facilitates to keep the graphs and views linked: changes in the graph during the presentation will be reflected in the online manual upon loading the Web page with the SVG component

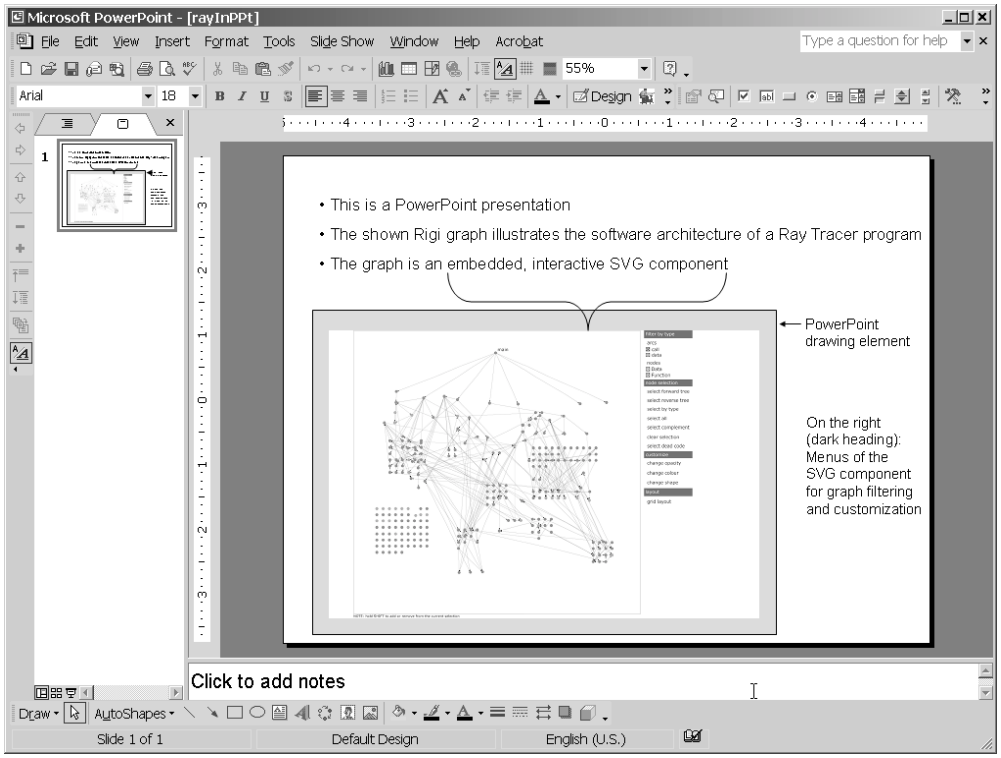


Figure 1. The SVG component, which implements the Rigi tool, is embedded in a MS PowerPoint slide and can be annotated using the PowerPoint editing tools.

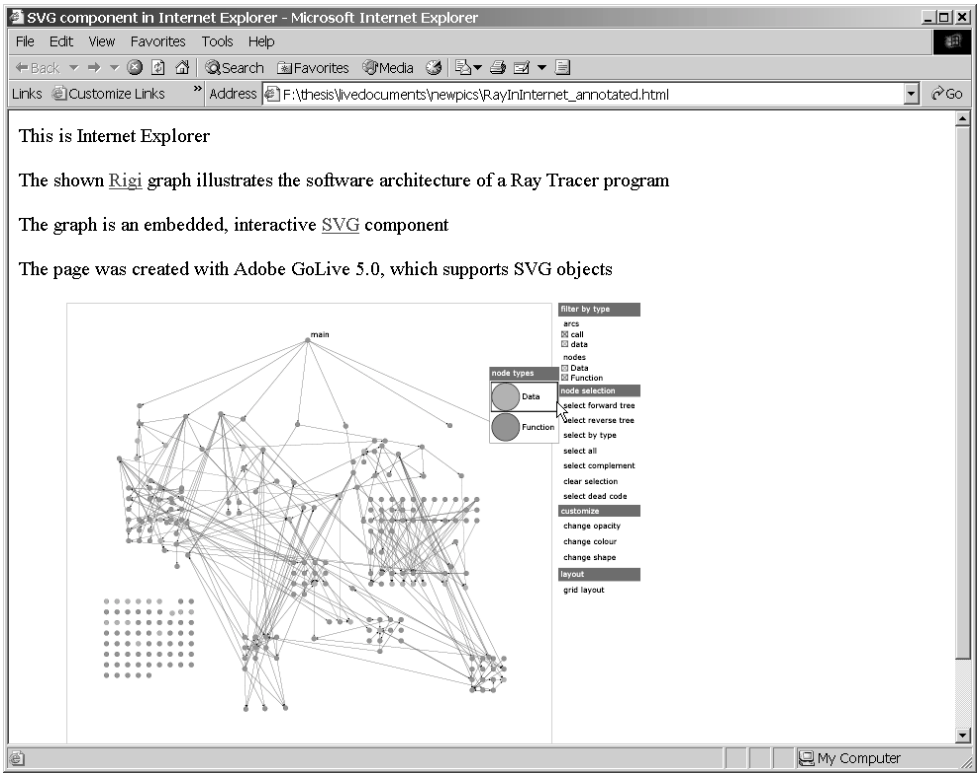


Figure 2. The SVG component, which implements the Rigi tool, is embedded in MS Internet Explorer. The SVG component is interactive: the user can drag nodes, select nodes with the mouse, and choose filtering, customization, and layout functions from the menus on the right. In this figure, the user has selected filtering according to node types and can now choose a node type from a sub menu. The SVG component provides the same interactive behavior in the MS PowerPoint slide show.

Scenario 2: Live Documents with MS Office Automation

Documents that synchronize with their changing context automatically and support collaboration (see Figure 5)

The reverse engineer has worked with the implementation of the Rigi tool that is implemented on top of PowerPoint and developed a graph view of a ray tracer program that shows the main modules for dead code in the program. However, the next steps will be performed by a colleague, who is more experienced with the further steps of exploring the architecture and who will also do the presentation during the upcoming software developer's meeting.
Consequently, the reverse engineer annotates the obtained view in PowerPoint and checks it into the company-wide version management tool. The colleague checks out the PowerPoint presentation, changes the graph and adds annotations at the same time. After the presentation the PowerPoint file is checked back to the version management tool.

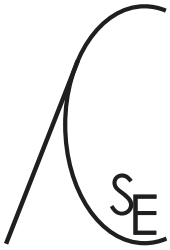
A couple of weeks after the presentation, the technical communicators check out the PowerPoint presentation and turn it into a tutorial by adding some slides and applying the layout according to the corporate standards. As the documentation and the reverse engineering application reside in the same tool, documentation and source code have never been separated and they are both in sync.

before

- reverse engineer produces screenshots of the view, adds it to PPT, and annotates it with explanations and sends it to a colleague
- colleague reproduces the view from scratch in Rigi and modifies the graph. He/she produces new screenshot(s) and modifies PPT slide accordingly for the presentation
- colleague does presentation with static screenshots
- technical communicators might need instructions for reproducing the Rigi view, need to produce new screenshots and update explanations in dependence of project progress (or they request these documents from the reverse engineer)

after

- reverse engineer works directly in PPT, changes in the graph can be annotated immediately
- colleague checks out the PPT file, starts from the produced view, modifies it
- colleague performs the presentation interactively, insights from discussion are directly fed back into the graph view
- technical communicators check out the file, apply corporate layout and might add additional instructions (in communication with reverse engineers) to target a novice audience



Scenario 3: Towards a Live Manual

Automatically Updated Graph Analysis in MS Excel (see Figure 4 and 5 below)

Rigi provides graph analysis reports for documentation purposes. However, these reports are more byproducts than documentation tools in their own right. Our implementation aims at enhancing the documentation features of the Rigi tool with a statistical analysis, a slide show of the analysis results, and consecutive "shots" of Rigi graph views for their automatic inclusion in a PowerPoint slideshow.

For the statistical analysis, we apply built-in functionality of standard office tools to Rigi graphs. For example, we programmed Excel XP to import a Rigi graph and to perform a statistical analysis, which measures the complexity of the graph (e.g., the number of nodes and graphs with respect to their different types such as data and function types). We visualized the statistical results with Excel charts. Excel automatically updates the analysis results and charts when the graph changes:

Integrated Workflow of Rigi tool with MS Excel and PowerPoint (see Figure 4 and 5 below)

before

- Rigi graph reports: just text, no graphics, not connected to current view

after:

- Integrated Workflow of Rigi tool with MS Excel and PowerPoint (see Figure 4 and 5 below)
- Statistical analysis in Excel, which is automatically updated when the graph changes
- Capturing of Rigi graph views in MS PowerPoint for further editing:

  "Slide" button in Rigi starts MS PowerPoint automatically and captures the current graph in the Rigi tool. The captured graph view is drawn in a new MS PowerPoint slide. The nodes and arcs of these graph views are MS PowerPoint objects. This functionality allows the reverse engineer to capture consecutive views of the graph to document continuous insights in a professional slideshow environment. The author can further enhance the slideshow of the graph views with annotations, additional graphics, and even animations by using the original MS PowerPoint functionality.

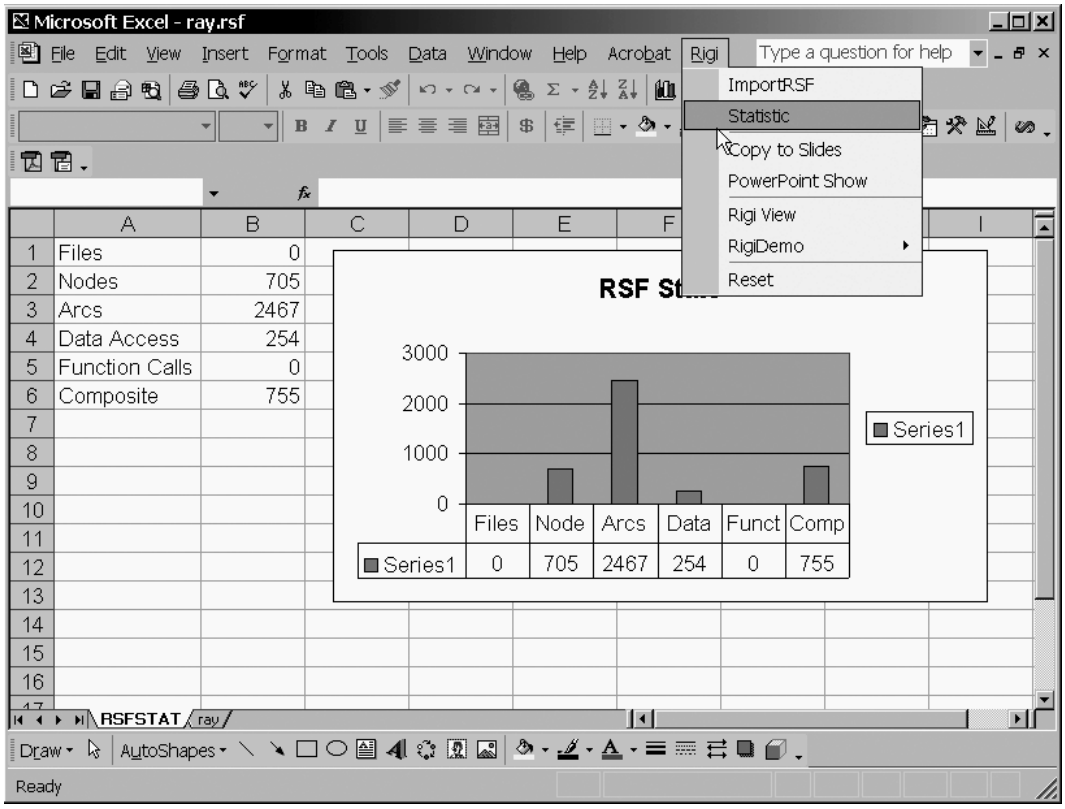


Figure 4. Analysis report for a Rigi graph in MS Excel that updates automatically when the data source (the graph information) changes

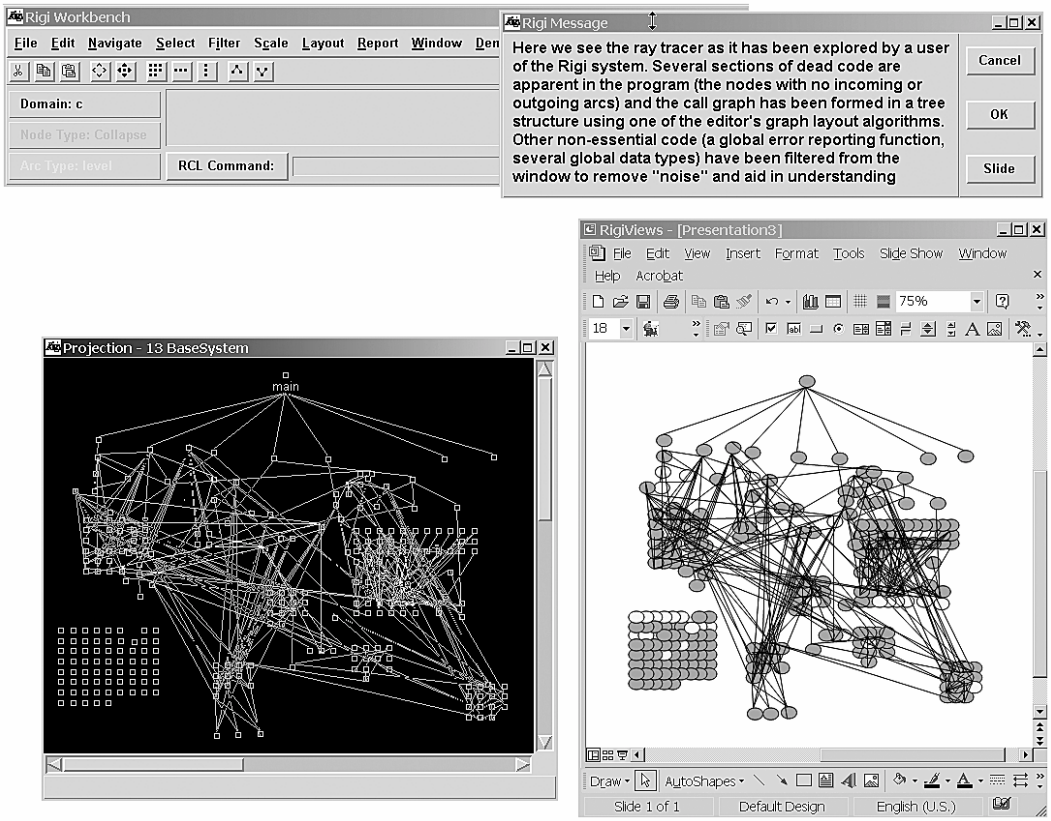
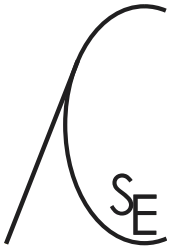


Figure 5 Rigi graph in the original tool (left) and as a MS PowerPoint drawing (right bottom window)



Scenario 4: ACRE Web Site Reverse Engineering

Reverse engineering of Web sites requires the adequate visualization of site maps, site architecture, linked document. For example, even Adobe GoLive, which is a standard tool for Web site development, does the visualization of site hierarchies very badly. One point is that it visualizes way too much information and that the hierarchy is difficult to navigate. Furthermore, broken links only appear in one special window, not in the hierarchy visualization.

The target tool for Web site visulation using ACRE is Visio. Visio can parse web sites and supports some web site visualization already. These are still rudimentary but the parser seems to be able to visualize applications within Web pages, such as Javascript, ASP pages, etc.

Furthermore, Viso supports lost of shapes and diagrams in Visio. We could therefore implement different visualizations for Web site architectures (according to different RE problems) and synchronize them by programming Visio. Rigi (implemented in Visio) could be one of these visualizations. Another possibility are UML diagrams for the site architecture based on Visio UML diagrams. The UML editor would be specifically targeted to Web site evolution.

In a further step, it would be worthwhile to integrate the visualization with Excel features (e.g. for metrics on web sites or statistics).

Scenario 5: ACRE UML Editor

Visio provides advanced features for building UML diagrams. This includes building static diagrams for Visual C++ and VB code. However, it does not yet consider the relationship between class models. The idea here is to build on these features and provide an advanced and easy to adopt UML editor as a case study for a comparison with professional tools.

Scenario 6: ACRE Prototyping: Office Automation versus SVG

Protyping a Metrics tool

Idea/Problem

We want to run metrics on a lot of different platforms, even on a PDA. While Excel offers a lot of built-in functionality to perform statistical analysis and visualize the results, it does not run on all platforms.

Solution

develop the metrics tool in Excel using all the built-in analysis and calculation functionality

Prototyping Rigi Graphs

Idea/Problem

Develop it with what you know (e.g., PowerPoint, Excel) – run it everywhere with SVG

Solution

- develop the Rigi graphs in PPT to work within a familiar tool and to exploit presentation features (e.g., document what you're doing and exploit collaboration)
- export the final tool to SVG