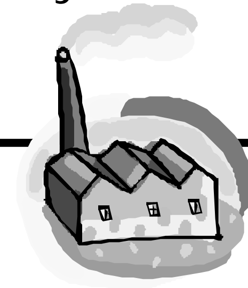
Universities and Industry

- Existing problems with teaching Scientific Software
- Experience of the Software Industry
- Current Developments in the Software Industry



Student Training in Scientific Software Problems

- **Scientific computation** at universities is currently being driven by **procedural** techniques

- **Scientific computation** at universities is currently implementation centric, without following good **software engineering** practices of requirements capture, analysis, design, testing, and implementation

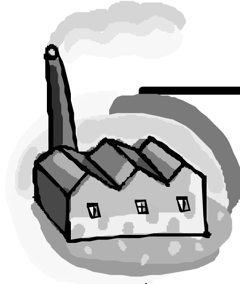
- Consequently, scientific software systems built by using practices are difficult to **maintain**, **extend**, and **reuse**. Such systems are difficult to decompose into **reusable components**

- This coding style leads to software systems which are **not robust under changes**, i.e. local changes often lead to global effects. This often leads to systems being **developed from scratch** whenever an old system needs to be modified or rebuilt, instead of **reusing** the **components** of already built systems

Problems (... continued)

- Students write code without considering the needs of users who are going to use the code in the future.

- New students can not understand this code and thus start **writing their own code from scratch**

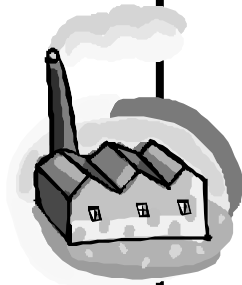


Experience of the Software Industry

- Software industry has recognized the problem of **maintaining** and **modifying** systems based on functional decomposition, and has largely shifted towards building systems based on **object technology**.

- Experience gained by industry has lead to **processes** and **tools** for building object oriented systems, which are more **robust to changes**, and easier to **maintain** and **upgrade**.

- The movement towards building systems of applications based on **reusable components** is also showing a greater amount of **reuse** in the software industry.



Experience of the Software Industry
(… continued)

- The promise of this technology was not realized overnight. There were **many false starts** and **failed projects**.

- The first generation of techniques did lead to code reuse, but also lead to systems, which were very **difficult to debug and modify**.

- Today, object technology is relatively mature and is using a **new generation** of techniques and processes, which are resulting into successful systems which are more **flexible**, and easier to **maintain, reuse** and **change**.

- **Simply using object technology, and a language which supports object orientation does not automatically lead to systems, which are robust and stable under changes.**

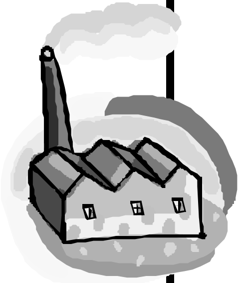
Current developments in the Software Industry

Patterns: Patterns are the result of a **grass root** movement, which originated in the **object software community**. The aim of this movement is to collect the **experience of successful software developers** in the form of patterns. (894U)

Iterative and Incremental Software Development Process: This is not a **top down** or **bottom up** approach. Instead, software is developed in well-defined **increments**. (894U)

Use Case Driven Processes: Modern processes start with modeling requirements in terms of **use cases**. All the activities of system building, i.e., analysis, design, implementation, and testing are **driven by use cases**. (894U)

Unified Modeling Language (UML): Recently, the **Object Management Group** (OMG) has standardized a modeling language, known as the **Unified Modeling Language** (UML). (694T, 894U)

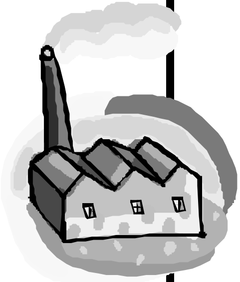


Current developments in the Software Industry (… continued)

Component Based Development: Components can be **reused**, and serve as **building blocks** to construct applications. **Standardized** component models have been adopted by the industry, such as **Java Beans, and CORBA components** (694T)

Computer Aided Software Engineering (CASE) tools: Newer generation of CASE tools, such as **Rational Rose** from Rational Corporation, support the incremental and iterative process of system development quite well. (894U)

Distributed Computing: Industry has shifted away from **two tier** client-server models to **three tier** and **n-tier** systems. The client side is getting **thinner**, requiring less computational resources. The **business logic** is implemented using **EJB** (Enterprise Java Beans) on the middle tier, and middleware like **Application Servers**, **TMs** (Transaction Monitors), **OMs** (Object Monitors), **CORBA** (Common Object Request Broker Architecture), **RMI** (Remote Message Invocation), and **Jini**. These architectures **scale** well as the size of the system increases. (894V)



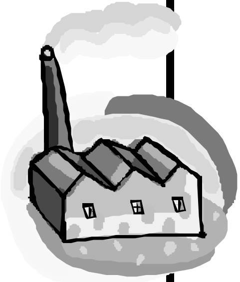
Current developments in the Software Industry (... continued)

Interoperability: Objects written in **different languages**, such as C++ and Java can communicate by using industry standard **CORBA** standardized by **OMG** (Object Management Group) or Java **JNI** (Java Native Interface) (894V)

Platform independence: Systems built by using **100% Java** can run on any modern operating system without the need for recompilation.

Mobile Code: Compiled **100% Java** byte code can execute on any operating system with a **JVM** (Java Virtual Machine) without a need for **recompilation**. Behavior of a remote application can be modified even after the application has been already deployed and activated. (694J)

XML (eXtensible Markup Language): This technology is causing a lot of excitement in the software industry. It presents the software community with a **standard** way to handle structure in data. (894V)



Current developments in the Software Industry (… continued)

Refactoring:

Refactoring is the process of changing a software system in such a way that it does not alter the external behavior of the code yet improves its internal structure. It is a disciplined way to clean up code that minimizes the chances of introducing bugs. In essence when you refactor you are “improving the design of the code after it has been written. “

That's an odd turn of phrase!

With refactoring you can take a bad design, chaos even, and rework it into well-designed code. Each step is simple, even simplistic. You move a field from one class to another, pull some code out of a method to make into its own method, and push some code up or down a hierarchy. Yet the cumulative effect of these small changes can radically improve the design. It is the exact reverse of the normal notion of software decay.

Quote from: “Refactoring : Improving the Design of Existing Code” 1999, Martin Fowler (Addison-Wesley Object Technology Series)