Software re-engineering

- Reorganising and modifying existing software systems to make them more maintainable

System re-engineering

- Re-structuring or re-writing part or all of a legacy system without changing its functionality
- Applicable where some but not all sub-systems of a larger system require frequent maintenance
- Re-engineering involves adding effort to make them easier to maintain. The system may be re-structured and re-documented

When to re-engineer

- When system changes are mostly confined to part of the system then re-engineer that part
- When hardware or software support becomes obsolete
- When tools to support re-structuring are available

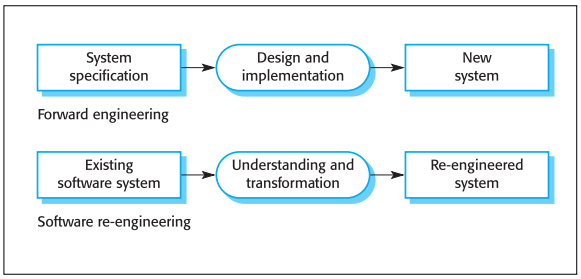
Re-engineering advantages

- Reduced risk
  - There is a high risk in new software development. There may be development problems, staffing problems and specification problems
- Reduced cost
  - The cost of re-engineering is often significantly less than the costs of developing new software

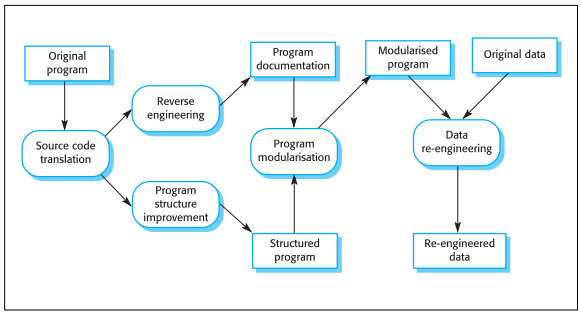
Business process re-engineering

- Concerned with re-designing business processes to make them more responsive and more efficient
- Often reliant on the introduction of new computer systems to support the revised processes
- May force software re-engineering as the legacy systems are designed to support existing processes

Forward and re-engineering



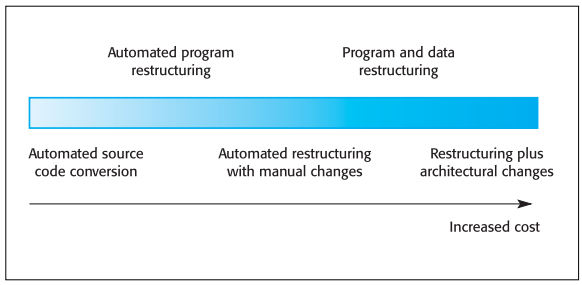
The re-engineering process



Re-engineering cost factors

- The quality of the software to be re-engineered
- The tool support available for re-engineering
- The extent of the data conversion which is required
- The availability of expert staff for re-engineering

Re-engineering approaches



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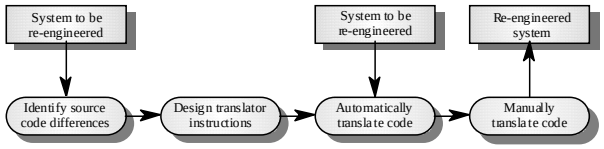
System measurement

- You may collect quantitative data to make an assessment of the quality of the application system
  - The number of system change requests;
  - The number of different user interfaces used by the system;
  - The volume of data used by the system.

Source code translation

- Involves converting the code from one language (or language version) to another e.g. FORTRAN to C
- May be necessary because of:
  - Hardware platform update
  - Staff skill shortages
  - Organisational policy changes
- Only realistic if an automatic translator is available

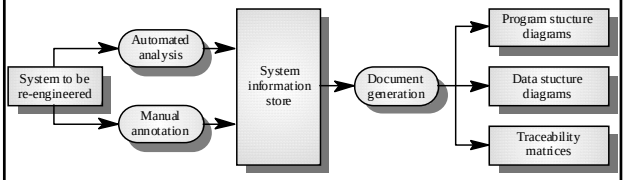
The program translation process



Reverse engineering

- Analysing software with a view to understanding its design and specification
- May be part of a re-engineering process but may also be used to re-specify a system for re-implementation
- Builds a program data base and generates information from this
- Program understanding tools (browsers, cross-reference generators, etc.) may be used in this process

The reverse engineering process



Reverse engineering

- Reverse engineering often precedes re-engineering but is sometimes worthwhile in its own right
  - The design and specification of a system may be reverse engineered so that they can be an input to the requirements specification process for the system's replacement
  - The design and specification may be reverse engineered to support program maintenance

Program structure improvement

- Maintenance tends to corrupt the structure of a program. It becomes harder and harder to understand
- The program may be automatically restructured to remove unconditional branches
- Conditions may be simplified to make them more readable

Spaghetti logic

```
Start:    Get (Time-on, Time-off, Time, Setting, Temp, Switch)
          if Switch = off goto off
          if Switch = on goto on
          goto Cntrld
off:  if Heating-status = on goto Sw-off
          goto loop
on:   if Heating-status = off goto Sw-on
          goto loop
Cntrld:   if Time = Time-on goto on
          if Time = Time-off goto off
          if Time < Time-on goto Start
          if Time > Time-off goto Start
          if Temp > Setting then goto off
          if Temp < Setting then goto on
Sw-off:   Heating-status := off
          goto Switch
Sw-on:    Heating-status := on
Switch:   Switch-heating
loop:     goto Start
```

Structured control logic

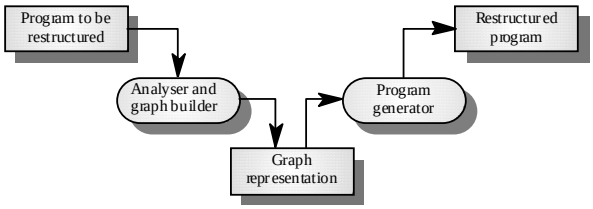
```
loop
    -- The Get statement finds values for the given variables from the system's
-- environment.
    Get (Time-on, Time-off, Time, Setting, Temp, Switch) ;
    case Switch of
        when On => if Heating-status = off then
                        Switch-heating ; Heating-status := on ;
                   end if ;
        when Off => if Heating-status = on then
                        Switch-heating ; Heating-status := off ;
                   end if;
        when Controlled =>
            if Time >= Time-on and Time < = Time-off then
                if Temp > Setting and Heating-status = on then
                    Switch-heating; Heating-status = off;
                elsif Temp < Setting and Heating-status = off then
                    Switch-heating; Heating-status := on ;
                end if;
            end if ;
    end case ;
end loop ;
```


Condition simplification

-- Complex condition
if not (A > B **and** (C < D **or not** (E > F)))...

-- Simplified condition
if (A <= B **and** (C>= D **or** E > F)...

Automatic program restructuring



Restructuring problems

- Problems with re-structuring are:
  - Loss of comments
  - Loss of documentation
  - Heavy computational demands
- Restructuring doesn't help with poor modularisation where related components are dispersed throughout the code
- The understandability of data-driven programs may not be improved by re-structuring

Program modularisation

- The process of re-organising a program so that related program parts are collected together in a single module
- Usually a manual process that is carried out by program inspection and re-organisation

Module types

- Data abstractions
  - Abstract data types where data structures and associated operations are grouped
- Hardware modules
  - All functions required to interface with a hardware unit
- Functional modules
  - Modules containing functions that carry out closely related tasks
- Process support modules
  - Modules where the functions support a business process or process fragment

Recovering data abstractions

- Many legacy systems use shared tables and global data to save memory space
- Causes problems because changes have a wide impact in the system
- Shared global data may be converted to objects or ADTs
  - Analyse common data areas to identify logical abstractions
  - Create an ADT or object for these abstractions
  - Use a browser to find all data references and replace with reference to the data abstraction

Data abstraction recovery

- Analyse common data areas to identify logical abstractions
- Create an abstract data type or object class for each of these abstractions
- Provide functions to access and update each field of the data abstraction
- Use a program browser to find calls to these data abstractions and replace these with the new defined functions

Data re-engineering

- Involves analysing and reorganising the data structures (and sometimes the data values) in a program
- May be part of the process of migrating from a file-based system to a DBMS-based system or changing from one DBMS to another
- Objective is to create a managed data environment

Approaches to data re-engineering

Approach	Description
Data cleanup	The data records and values are analysed to improve their quality. Duplicates are removed, redundant information is deleted and a consistent format applied to all records. This should not normally require any associated program changes.
Data extension	In this case, the data and associated programs are re-engineered to remove limits on the data processing. This may require changes to programs to increase field lengths, modify upper limits on the tables, etc. The data itself may then have to be rewritten and cleaned up to reflect the program changes.
Data migration	In this case, data is moved into the control of a modern database management system. The data may be stored in separate files or may be managed by an older type of DBMS.

The data re-engineering process