Software Re-engineering

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Objectives

- To explain why software re-engineering is a cost-effective option for system evolution
- To describe the activities involved in the software re-engineering process
- To distinguish between software and data re-engineering and to explain the problems of data re-engineering

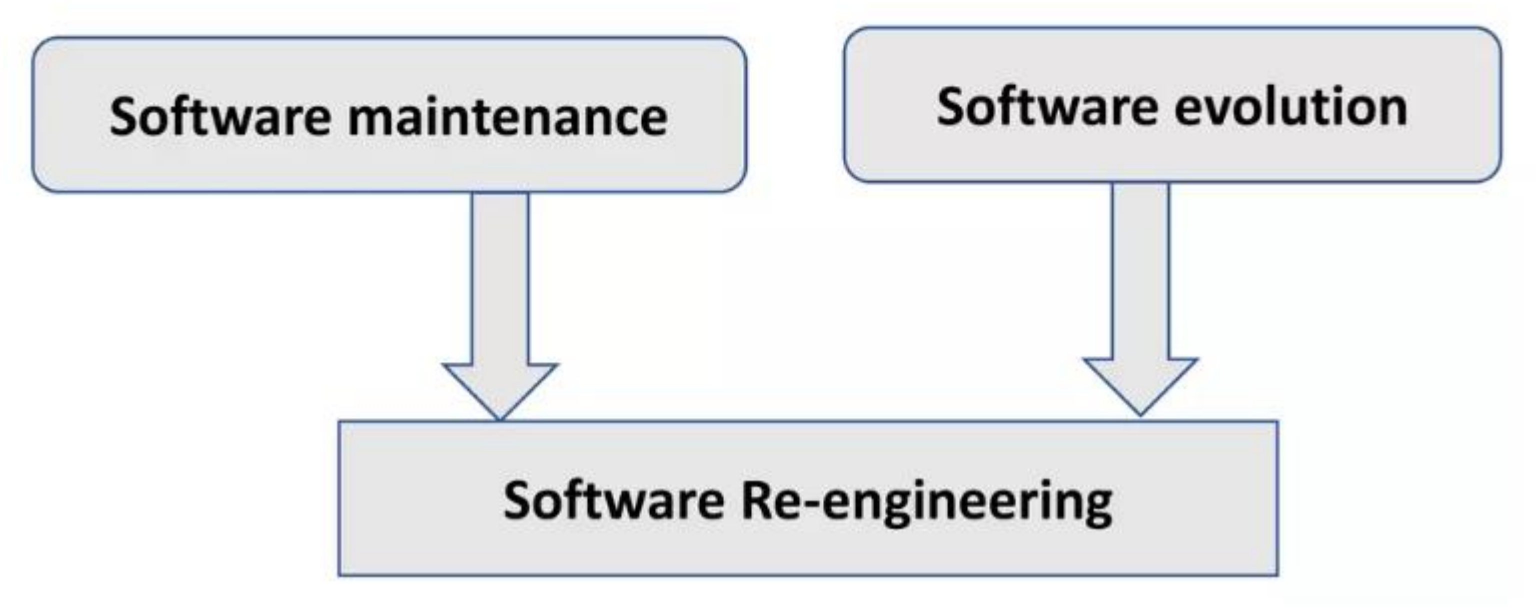
What is Software Reengineering

Software reengineering, often called "software renovation" or "software rejuvenation," refers to the process of analyzing, designing, and modifying, existing software systems to improve their quality, performance, and maintainability.

It involves restructuring the code, updating the design, and enhancing the overall quality of the software.

What is Software Reengineering

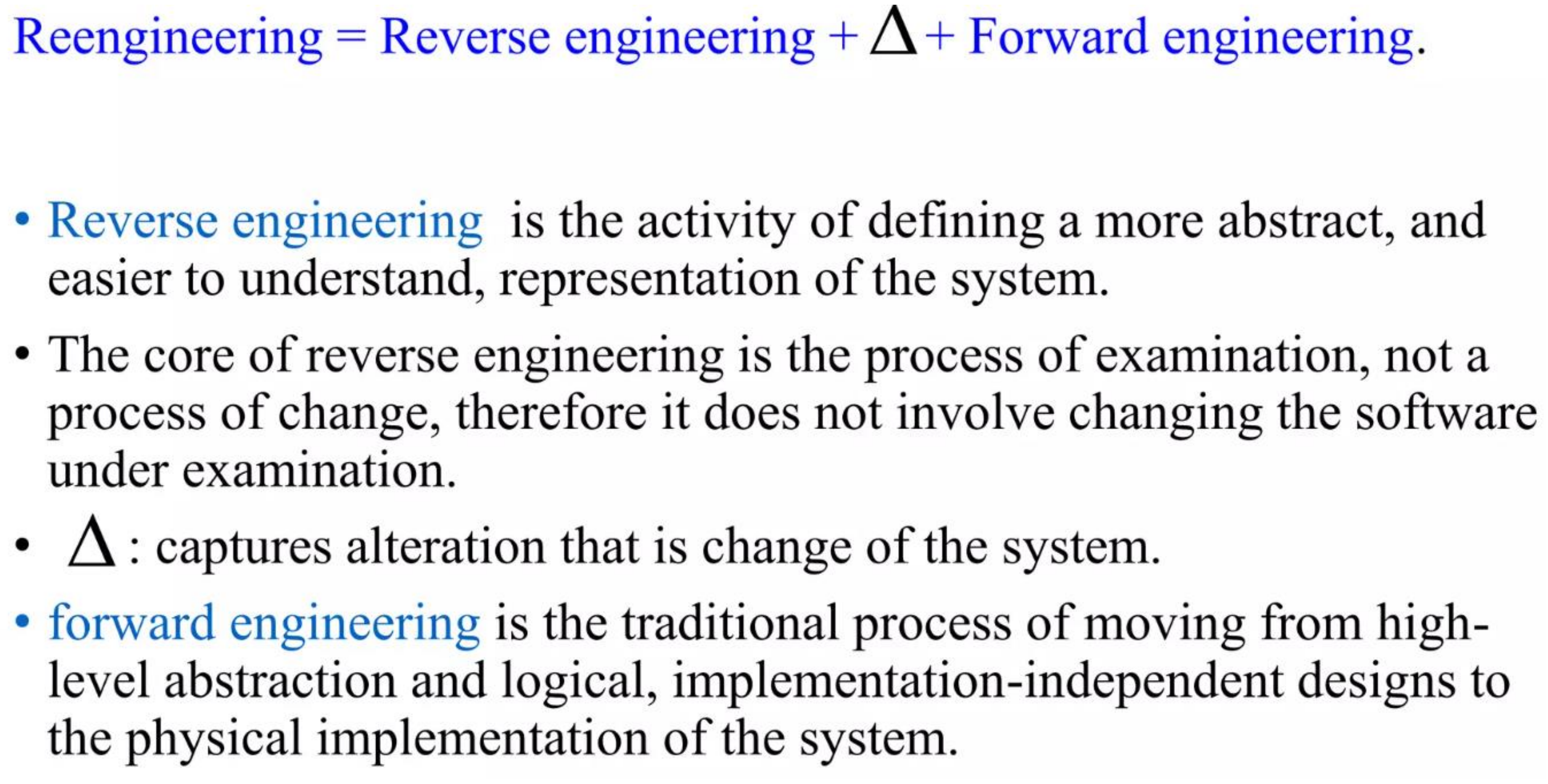
Software reengineering is a critical process in software development which is done to improve the maintainability of a software system.



Why Reengineer Software

- Evolving business requirements: As businesses change, software systems must adapt.
- Technological obsolescence: Aging technology can limit performance and security.
- Competitive pressure: To remain relevant, software must keep pace with competitors.
- Improving maintainability: Legacy code can be challenging to maintain, increasing costs.

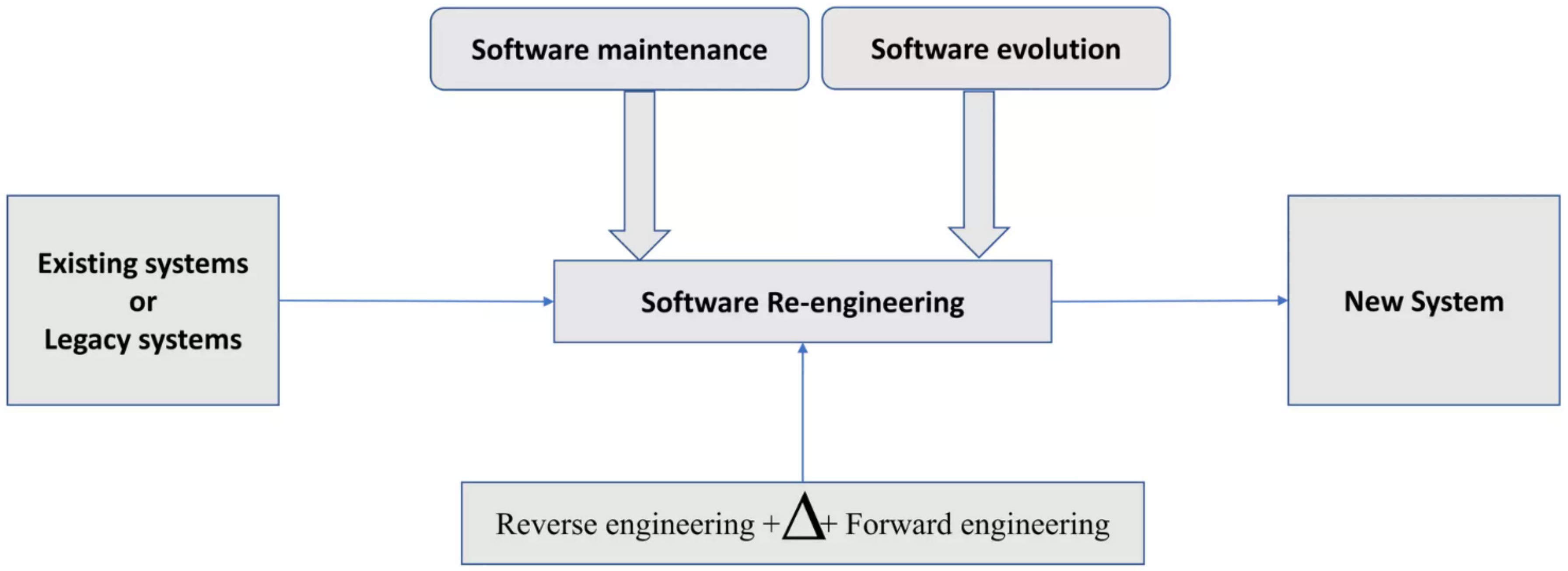
Software re-engineering



Reengineering = Reverse engineering + Δ + Forward engineering.

- Reverse engineering is the activity of defining a more abstract, and easier to understand, representation of the system.
- The core of reverse engineering is the process of examination, not a process of change, therefore it does not involve changing the software under examination.
- Δ : captures alteration that is change of the system.
- forward engineering is the traditional process of moving from high-level abstraction and logical, implementation-independent designs to the physical implementation of the system.

Software re-engineering


Software maintenance
Software evolution
Existing systems or Legacy systems
Software Re-engineering
New System
Reverse engineering + Δ + Forward engineering

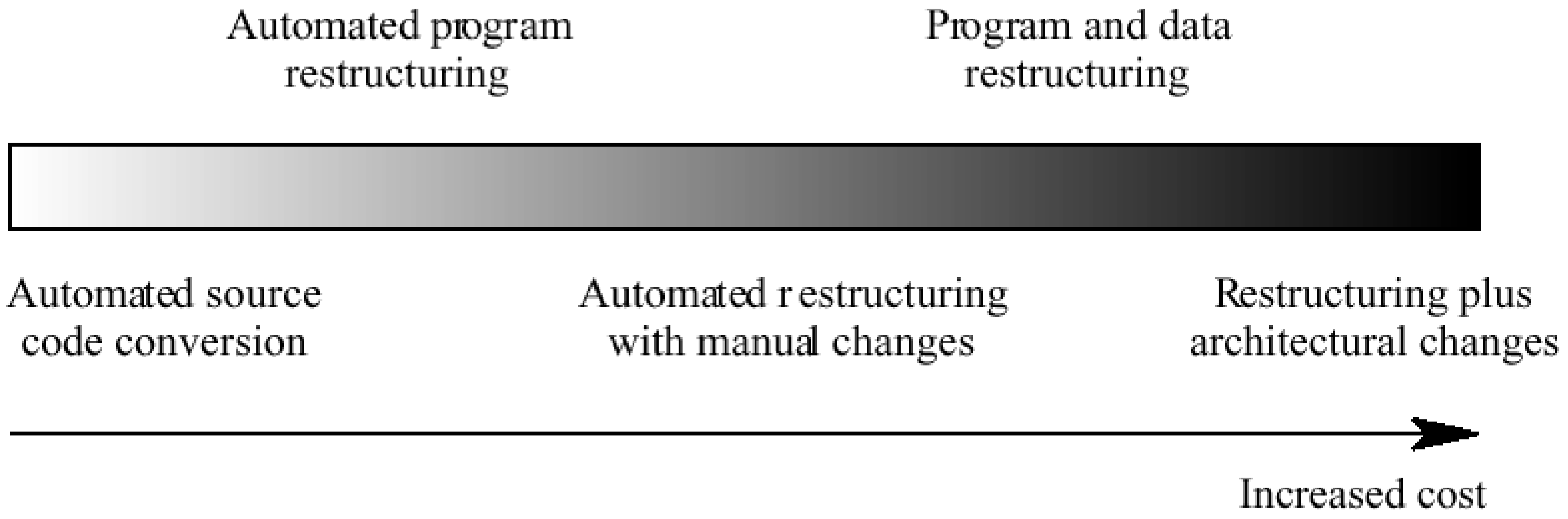
When to re-engineer

- 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.

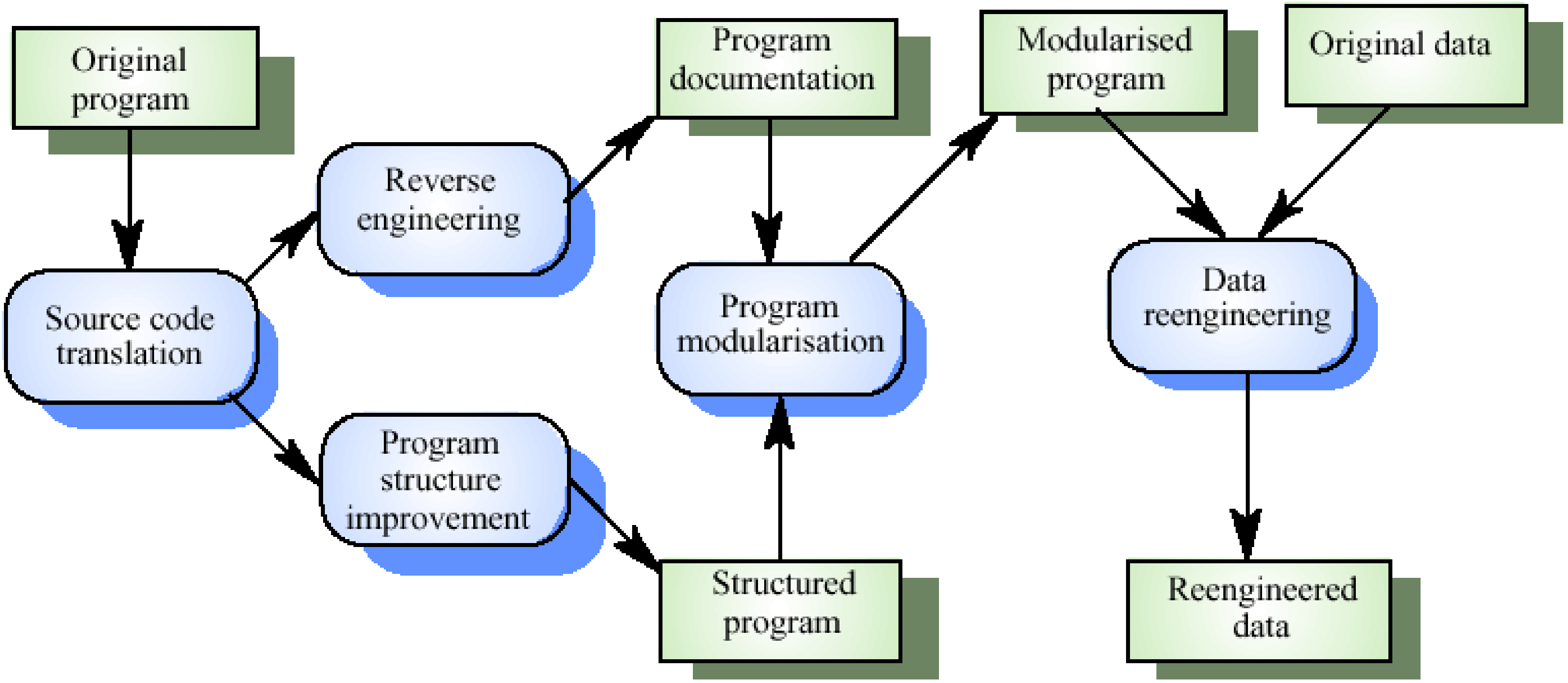
Re-engineering cost factors

- 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

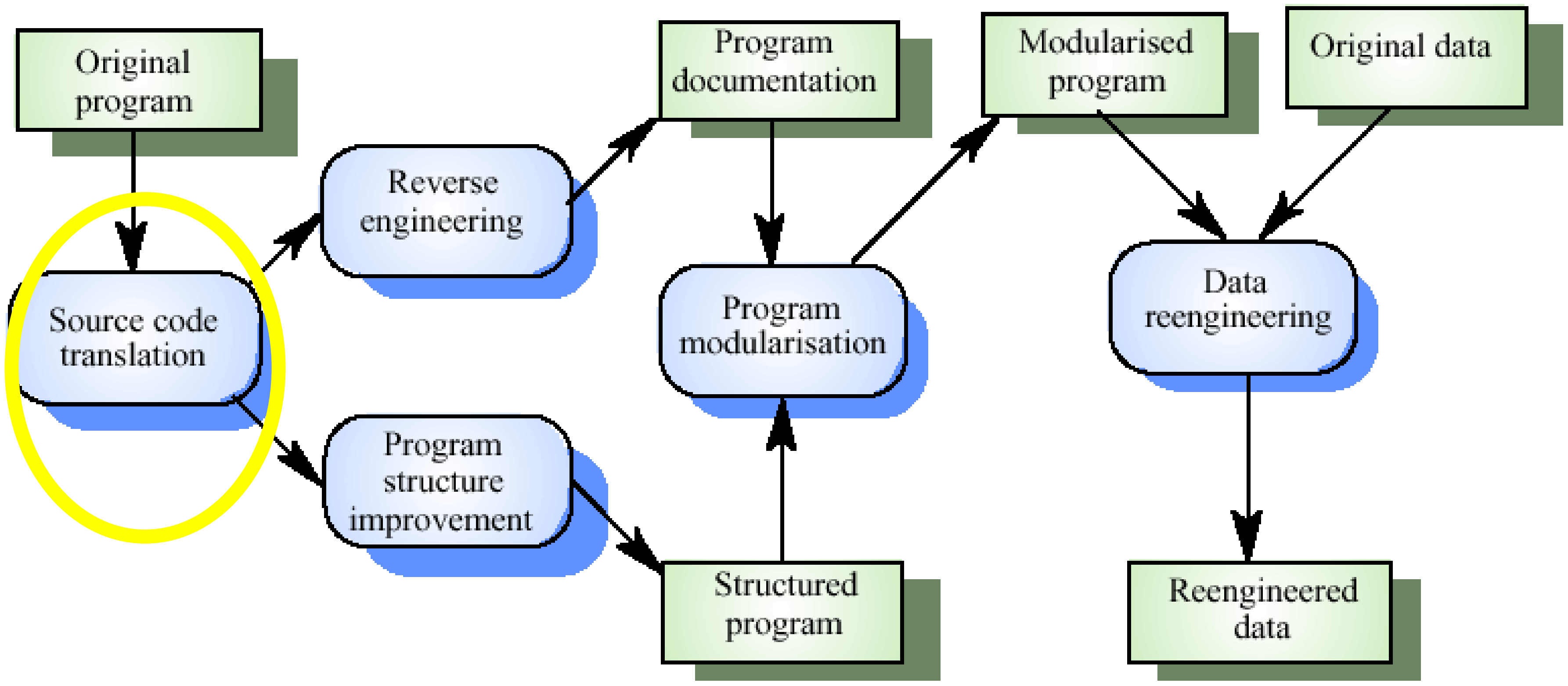
Re-engineering approaches


Automated program restructuring
Program and data restructuring
Automated source code conversion
Automated r estructuring with manual changes
Restructuring plus architectural changes
Increased cost

The re-engineering process



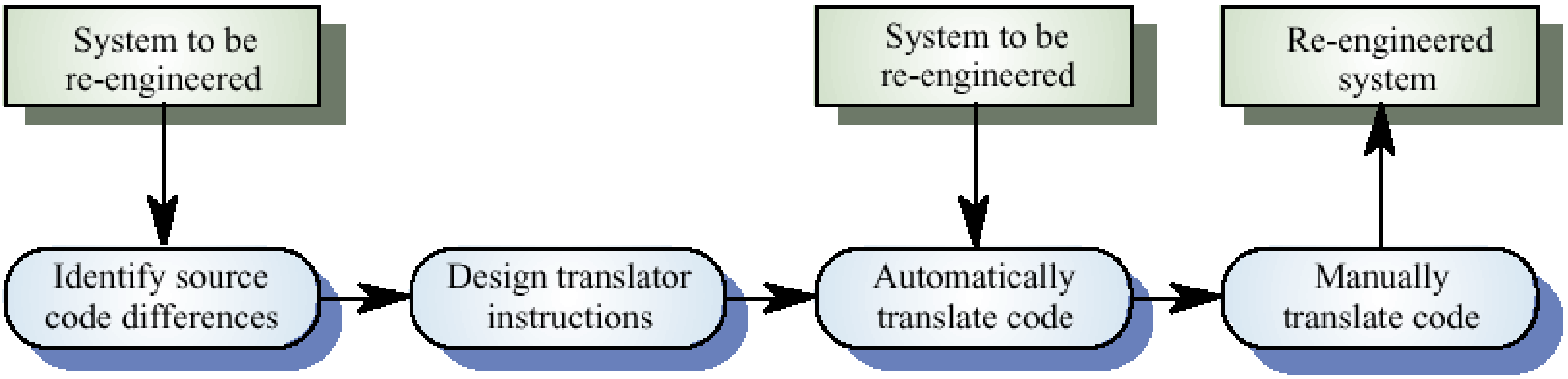
The re-engineering process



Source code translation

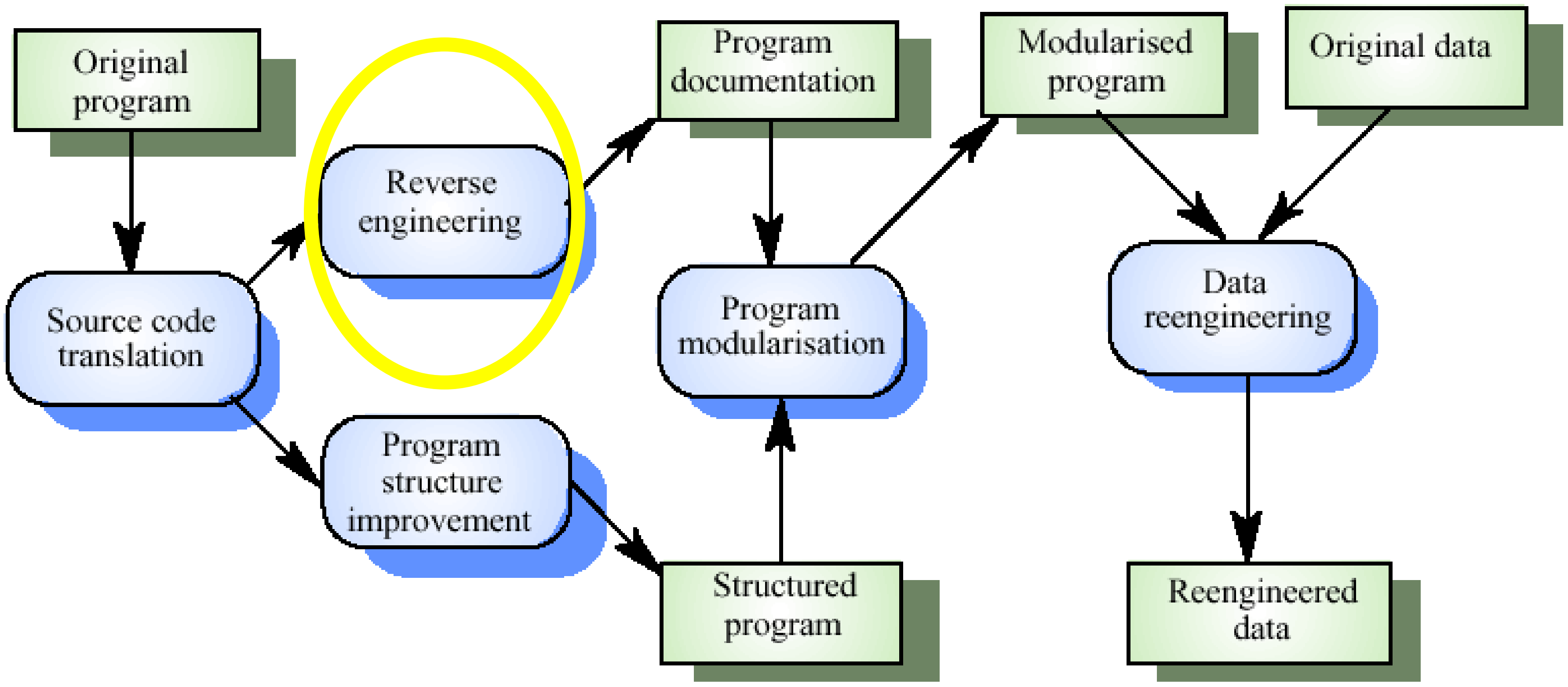
- Involves converting the code from one language (or language version) to another e.g. FORTRAN to C
- May be necessary because of:
  - Hardware platform update
  - Staff skill shortages
  - Organisational policy changes
- Only realistic if an automatic translator is available

The program translation process



System to be re-engineered
System to be re-engineered
Re-engineered system
Identify source code differences
Design translator instructions
Automatically translate code
Manually translate code

The re-engineering process



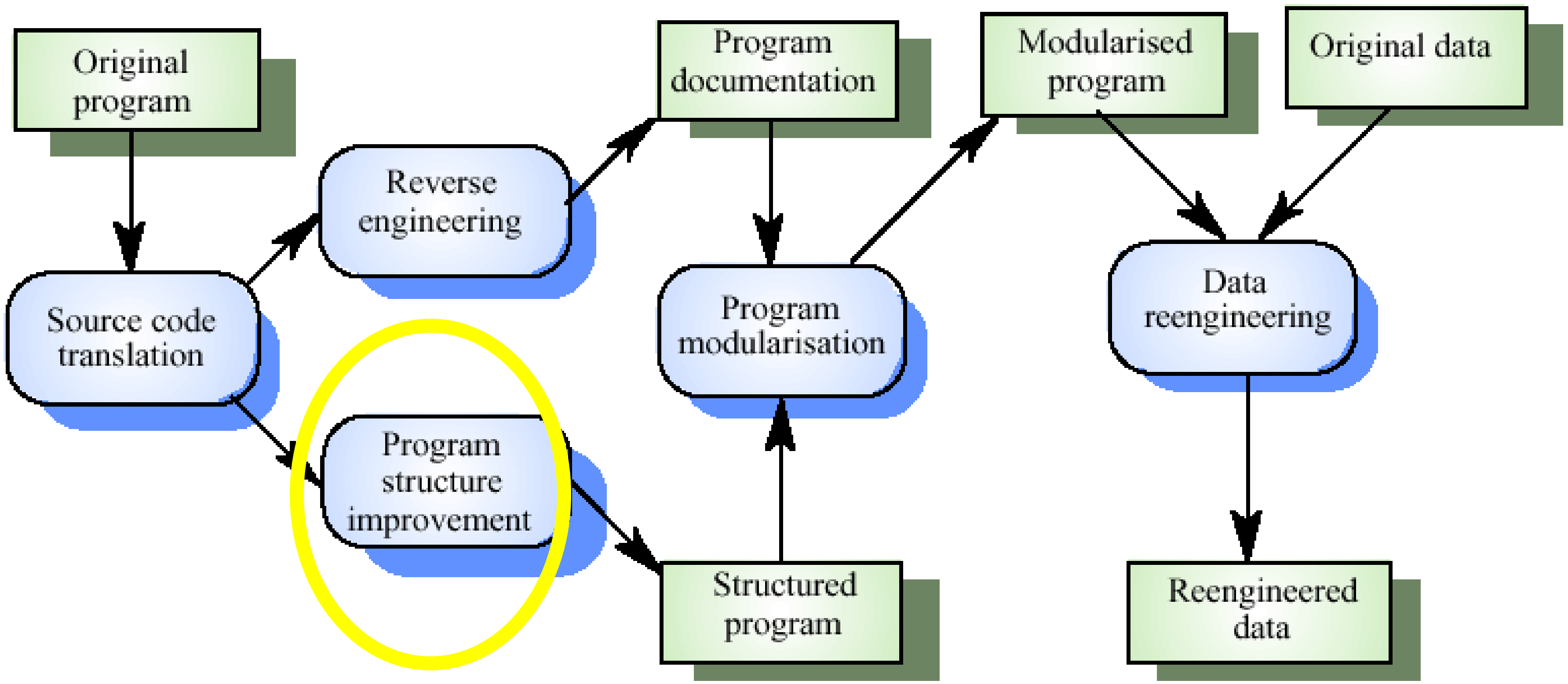
Reverse engineering

- 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

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

The re-engineering process



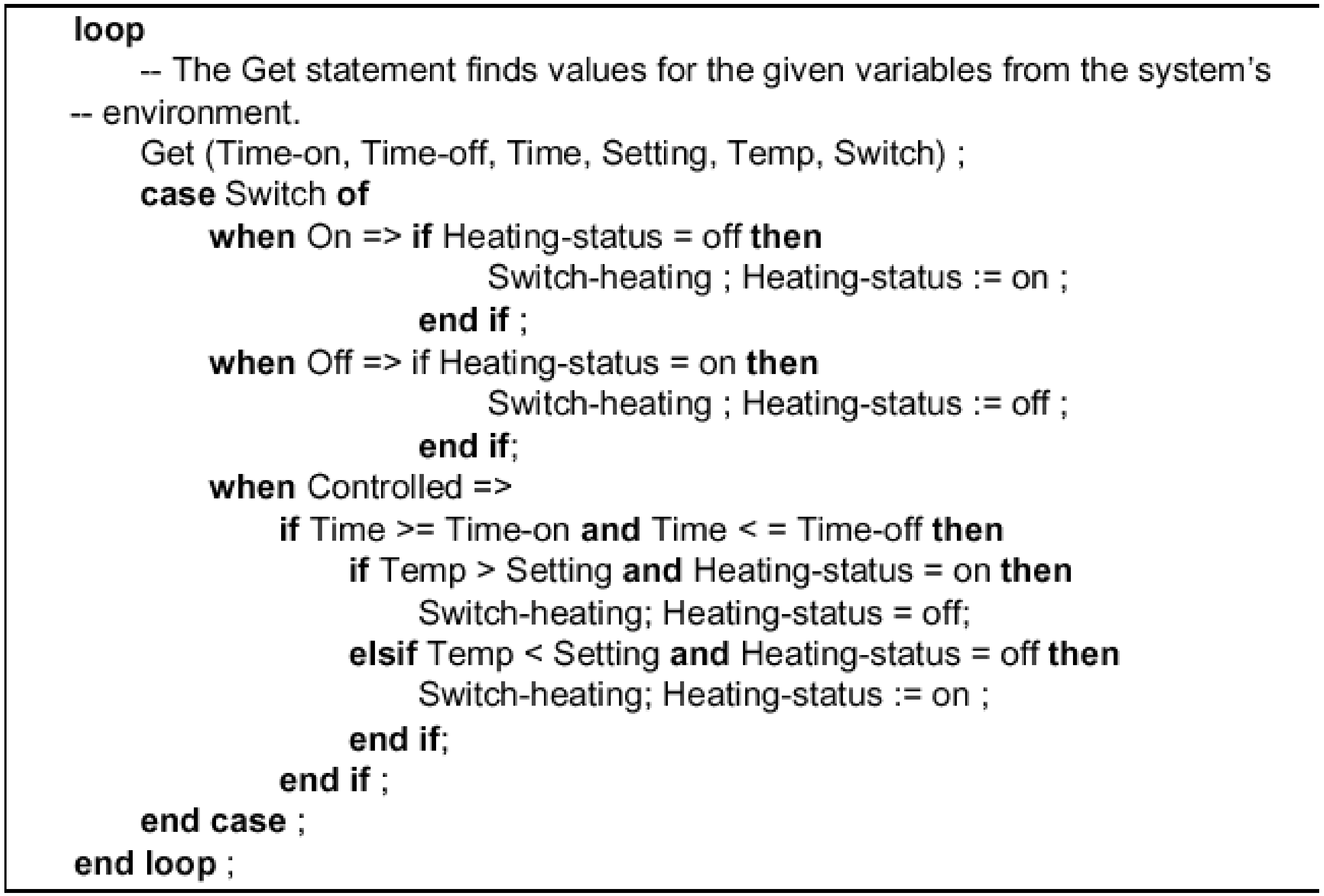
Program structure improvement

- 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

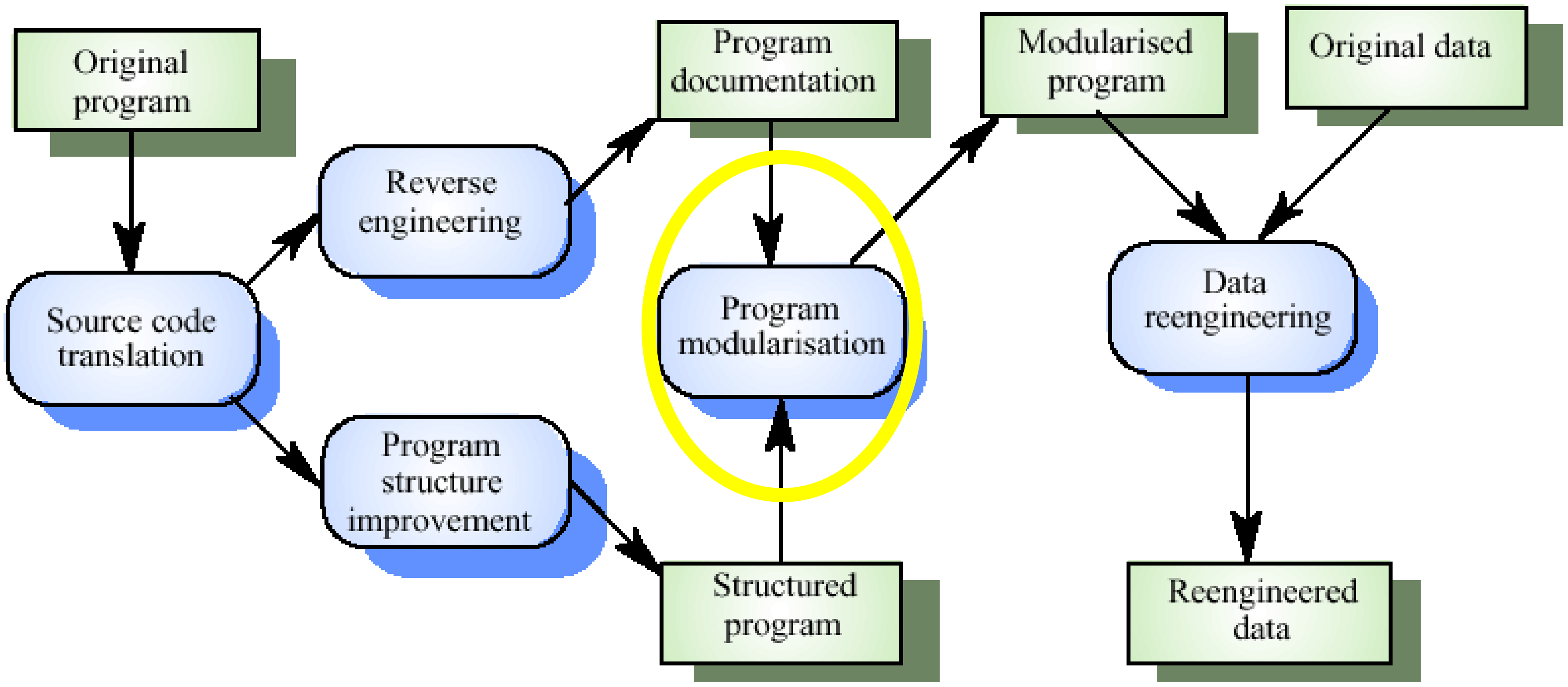
```
-- Complex condition
if not (A > B and (C < D or not ( E > F) ) )...

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

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

The re-engineering process



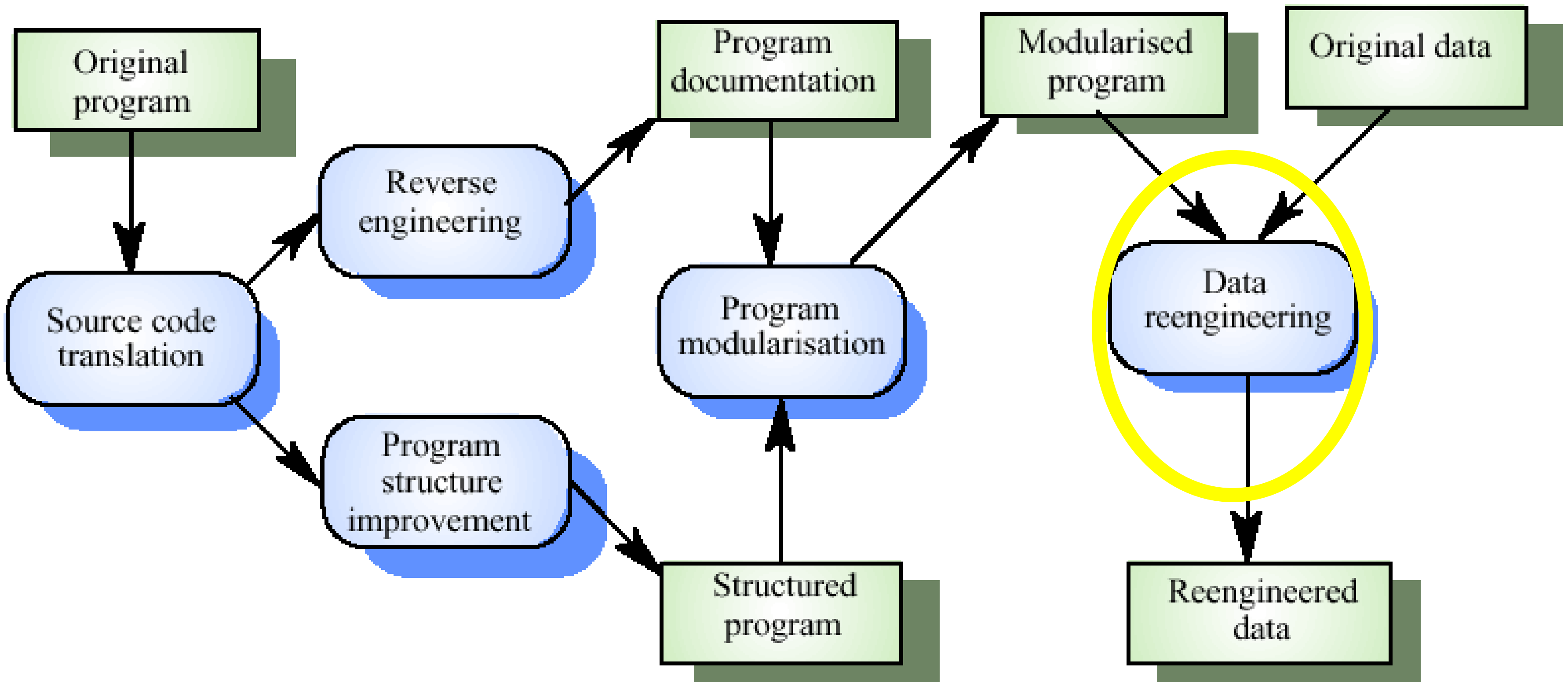
Program modularisation

- 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

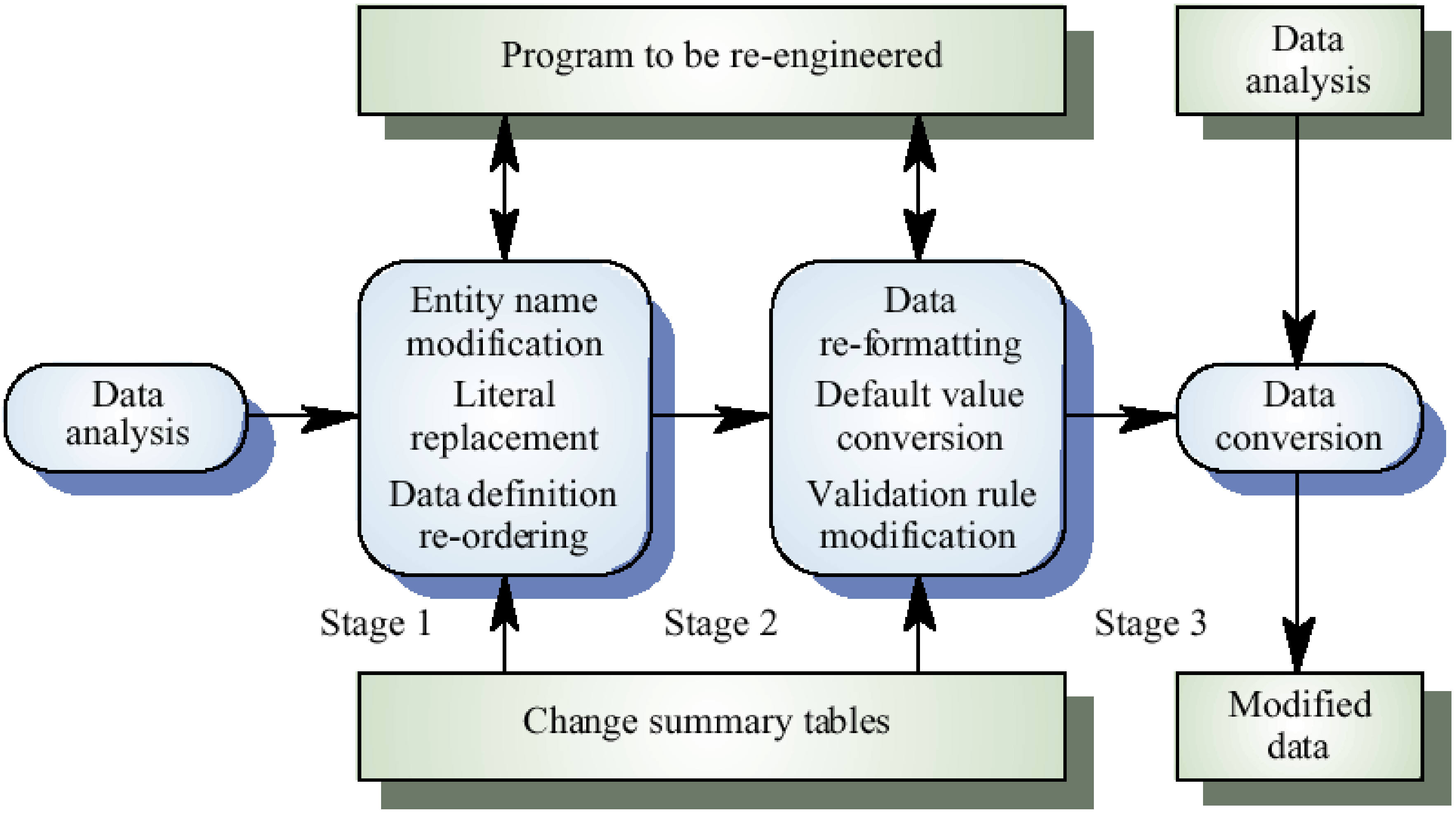
The re-engineering process



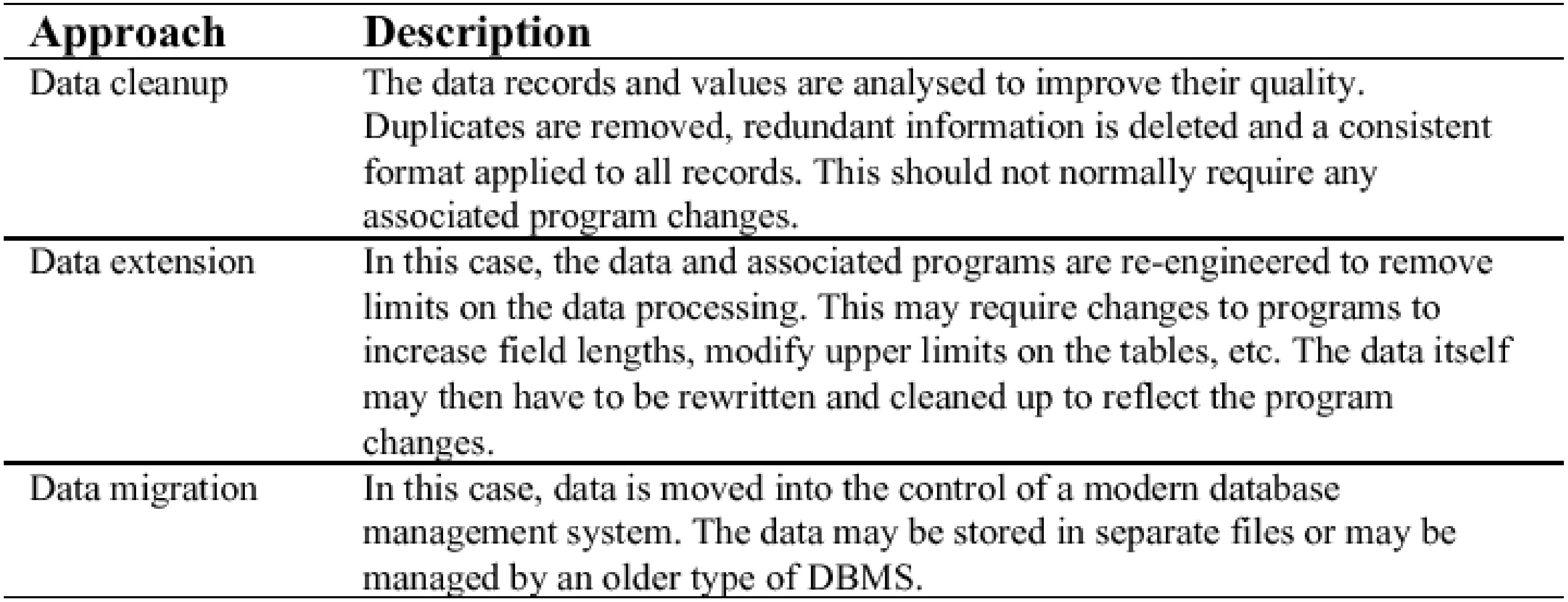
Data re-engineering

- 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

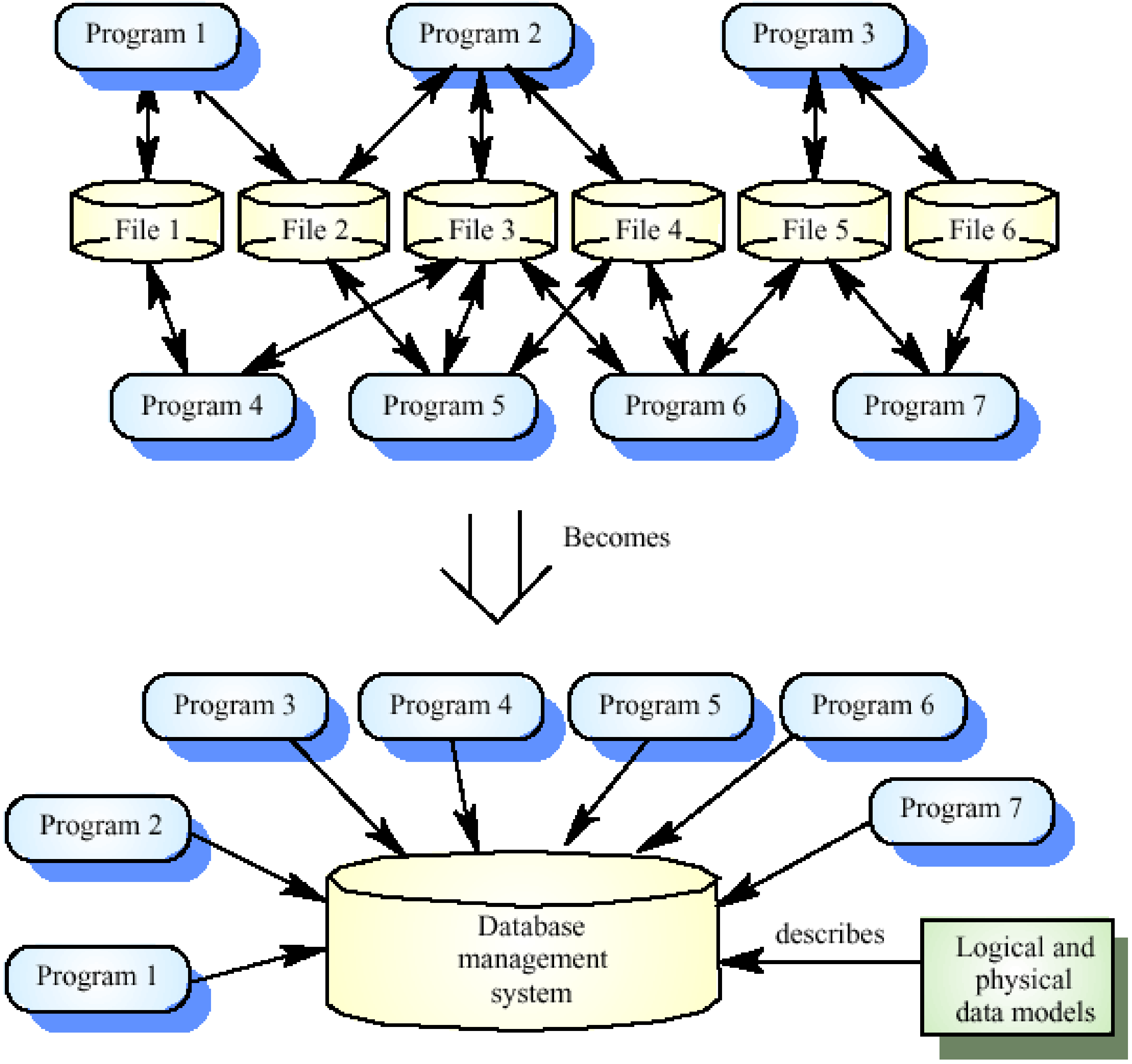
The data re-engineering process



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.



Data migration

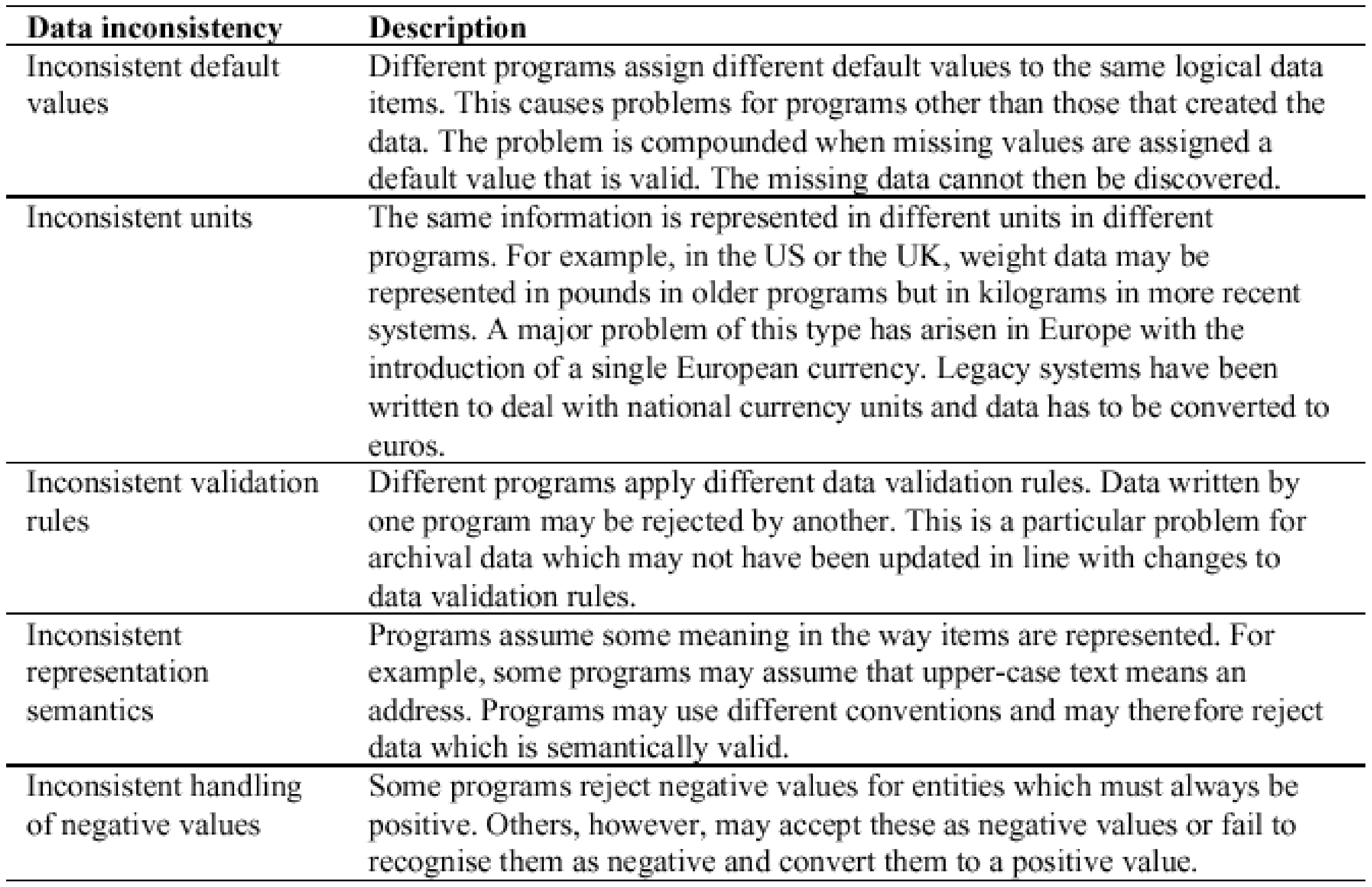
Data problems

- End-users want data on their desktop machines rather than in a file system. They need to be able to download this data from a DBMS
- Systems may have to process much more data than was originally intended by their designers
- Redundant data may be stored in different formats in different places in the system

Data problems

- Data naming problems
  - Names may be hard to understand. The same data may have different names in different programs
- Field length problems
  - The same item may be assigned different lengths in different programs
- Record organisation problems
  - Records representing the same entity may be organised differently in different programs
- Hard-coded literals
- No data dictionary

Data value inconsistencies



Data inconsistency	Description
Inconsistent default values	Different programs assign different default values to the same logical data items. This causes problems for programs other than those that created the data. The problem is compounded when missing values are assigned a default value that is valid. The missing data cannot then be discovered.
Inconsistent units	The same information is represented in different units in different programs. For example, in the US or the UK, weight data may be represented in pounds in older programs but in kilograms in more recent systems. A major problem of this type has arisen in Europe with the introduction of a single European currency. Legacy systems have been written to deal with national currency units and data has to be converted to euros.
Inconsistent validation rules	Different programs apply different data validation rules. Data written by one program may be rejected by another. This is a particular problem for archival data which may not have been updated in line with changes to data validation rules.
Inconsistent representation semantics	Programs assume some meaning in the way items are represented. For example, some programs may assume that upper-case text means an address. Programs may use different conventions and may therefore reject data which is semantically valid.
Inconsistent handling of negative values	Some programs reject negative values for entities which must always be positive. Others, however, may accept these as negative values or fail to recognise them as negative and convert them to a positive value.

Data conversion

- Data re-engineering may involve changing the data structure organisation without changing the data values
- Data value conversion is very expensive. Special-purpose programs have to be written to carry out the conversion

Advantages of Reengineering

- Improving software quality,
- Reducing maintenance costs,
- Extending the lifespan of systems,
- Enhancing overall functionality.
- It can rejuvenate aging software and make it competitive once again.

Challenges and Risks

- Dealing with legacy code,
- Managing resistance to change,
- Handling evolving requirements.
- Risks include budget overruns and project delays.

Key points

- The objective of re-engineering is to improve the system structure to make it easier to understand and maintain
- The re-engineering process involves source code translation, reverse engineering, program structure improvement, program modularisation and data re-engineering
- Source code translation is the automatic conversion of program in one language to another

Key points

- Reverse engineering is the process of deriving the system design and specification from its source code
- Program structure improvement replaces unstructured control constructs with while loops and simple conditionals
- Program modularisation involves reorganisation to group related items
- Data re-engineering may be necessary because of inconsistent data management

Conclusion

- Software reengineering plays a vital role in maintaining and rejuvenating software systems. It addresses the challenges of aging technology and evolving business needs. By understanding the process, techniques, and best practices, we can ensure the success of reengineering projects.