

Software Prototyping

- ◆ Animating and demonstrating system requirements

Objectives

- ◆ To describe the use of prototypes in requirements validation
- ◆ To discuss evolutionary and throw-away prototyping
- ◆ To introduce rapid prototyping techniques
- ◆ To explain the need for user interface prototyping

Topics covered

- ◆ Prototyping in the software process
- ◆ Prototyping techniques
- ◆ User interface prototyping

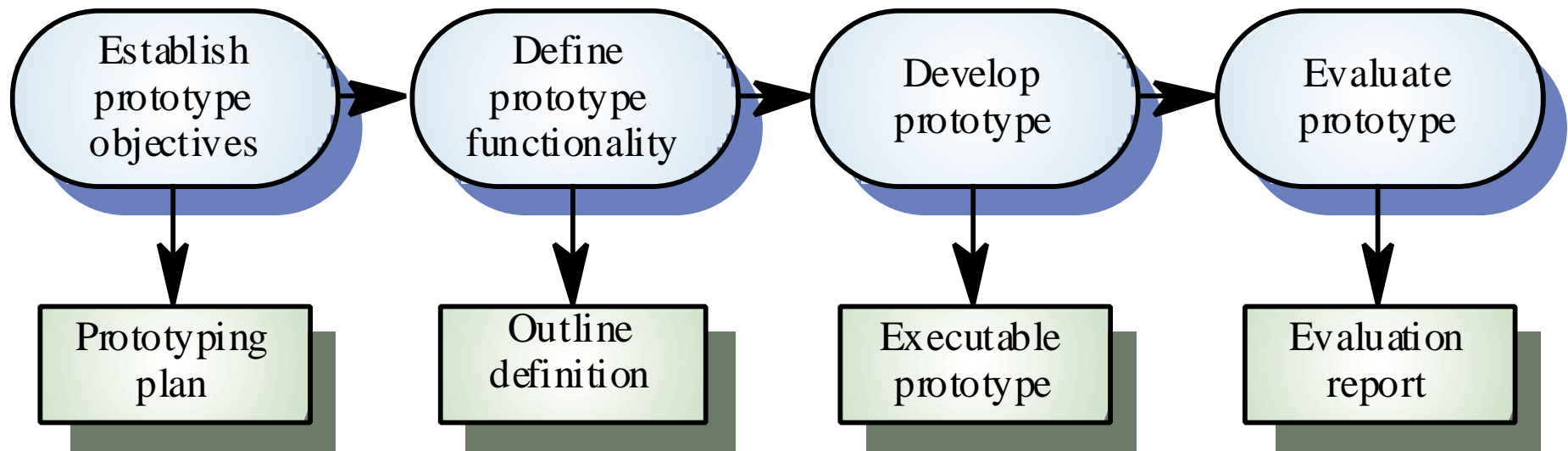
Uses of system prototypes

- ◆ The principal use is to help customers and developers understand the requirements for the system
- ◆ The prototype may be used for user training before a final system is delivered
- ◆ The prototype may be used for back-to-back testing

Prototyping benefits

- ◆ Misunderstandings between software users and developers are exposed
- ◆ Missing services may be detected
- ◆ Confusing services may be identified
- ◆ A working system is available early in the process
- ◆ The prototype may serve as a basis for deriving a system specification

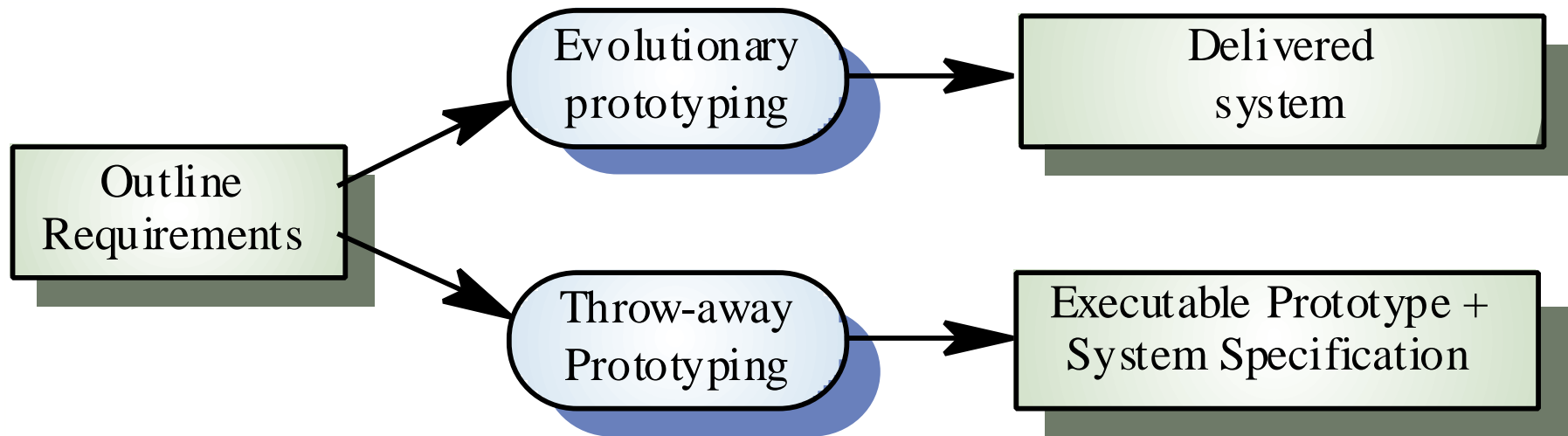
Prototyping process



Prototyping objectives

- ◆ The objective of *evolutionary prototyping* is to deliver a working system to end-users. The development starts with those requirements which are best understood.
- ◆ The objective of throw-away prototyping is to validate or derive the system requirements. The prototyping process starts with those requirements which are poorly understood

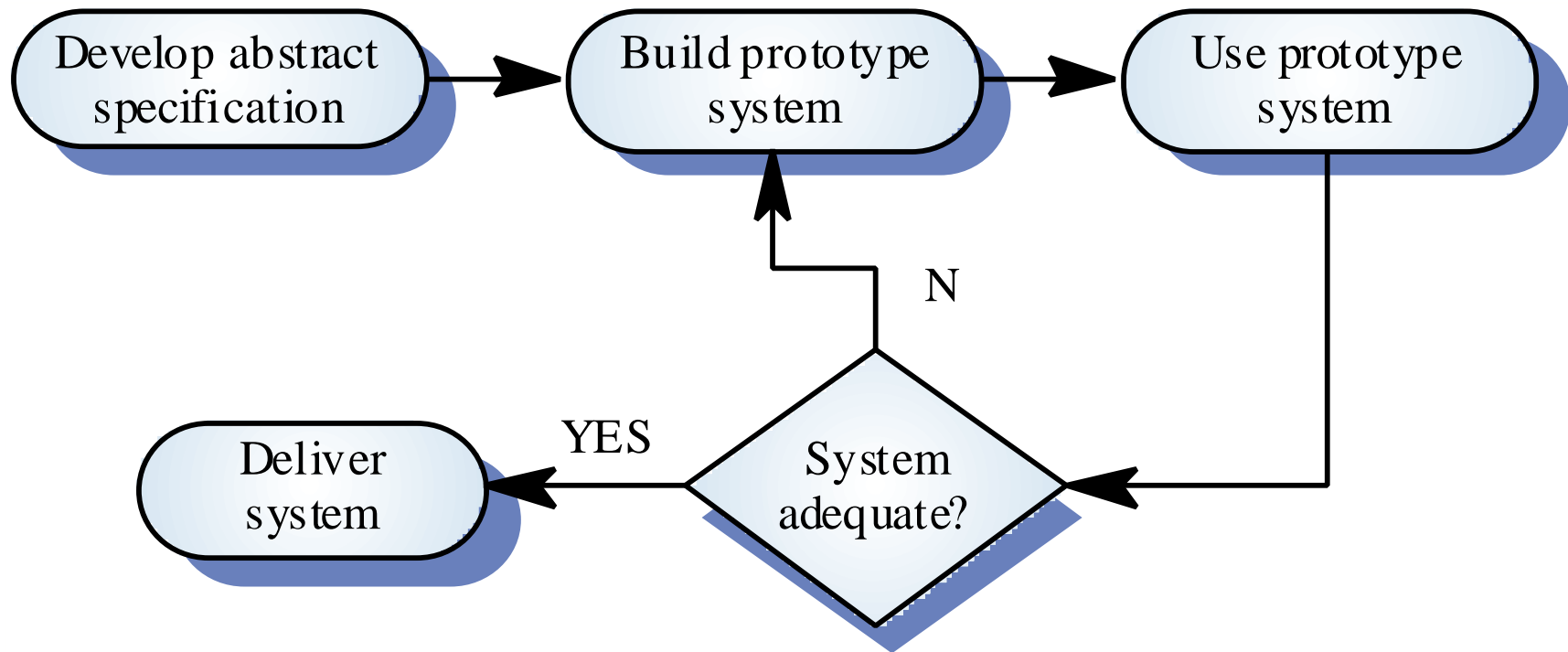
Approaches to prototyping



Evolutionary prototyping

- ◆ Must be used for systems where the specification cannot be developed in advance e.g. AI systems and user interface systems
- ◆ Based on techniques which allow rapid system iterations
- ◆ Verification is impossible as there is no specification. Validation means demonstrating the adequacy of the system

Evolutionary prototyping



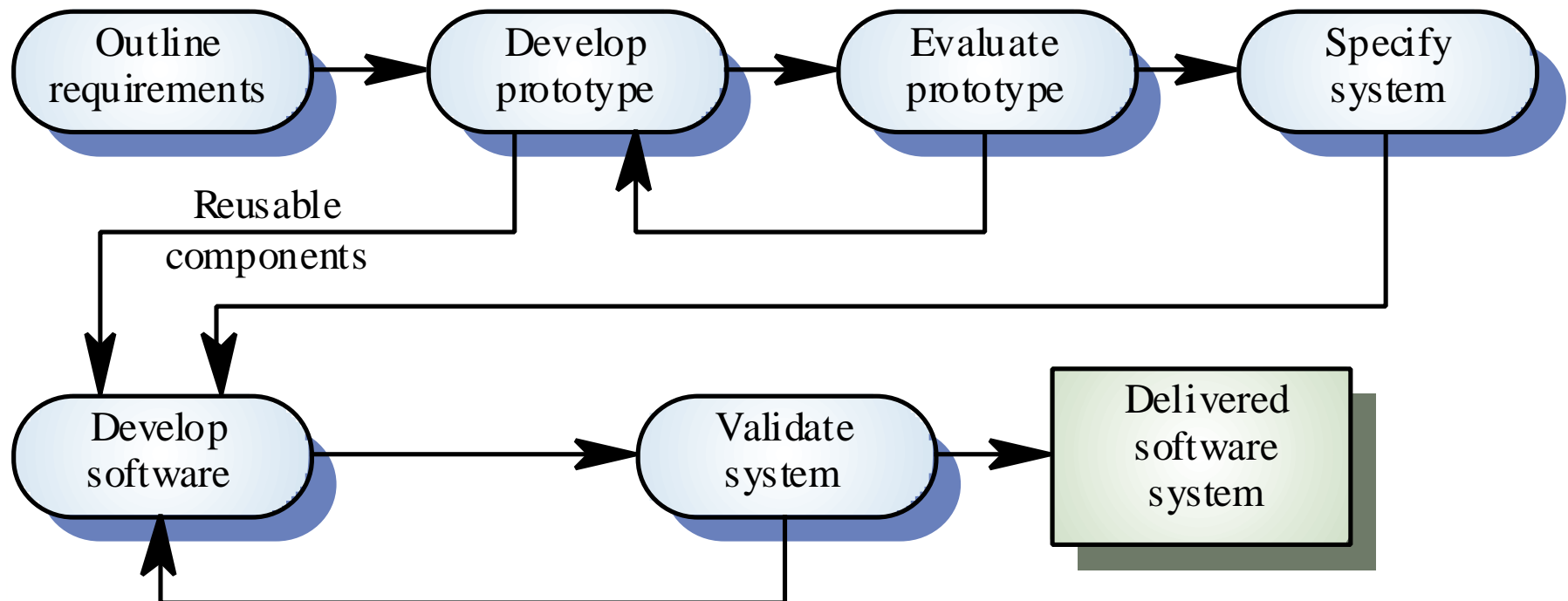
Evol. prototyping problems

- ◆ Existing management processes assume a waterfall model of development
- ◆ Continual change tends to corrupt system structure so long-term maintenance is expensive
- ◆ Specialist skills are required which may not be available in all development teams
- ◆ Organisations must accept that the lifetime of systems developed this way will inevitably be short

Throw-away prototyping

- ◆ Used to reduce requirements risk
- ◆ The prototype is developed from an initial specification, delivered for experiment then discarded
- ◆ The throw-away prototype should **NOT** be considered as a final system
 - Some system characteristics may have been left out
 - There is no specification for long-term maintenance
 - The system will be poorly structured and difficult to maintain

Throw-away prototyping



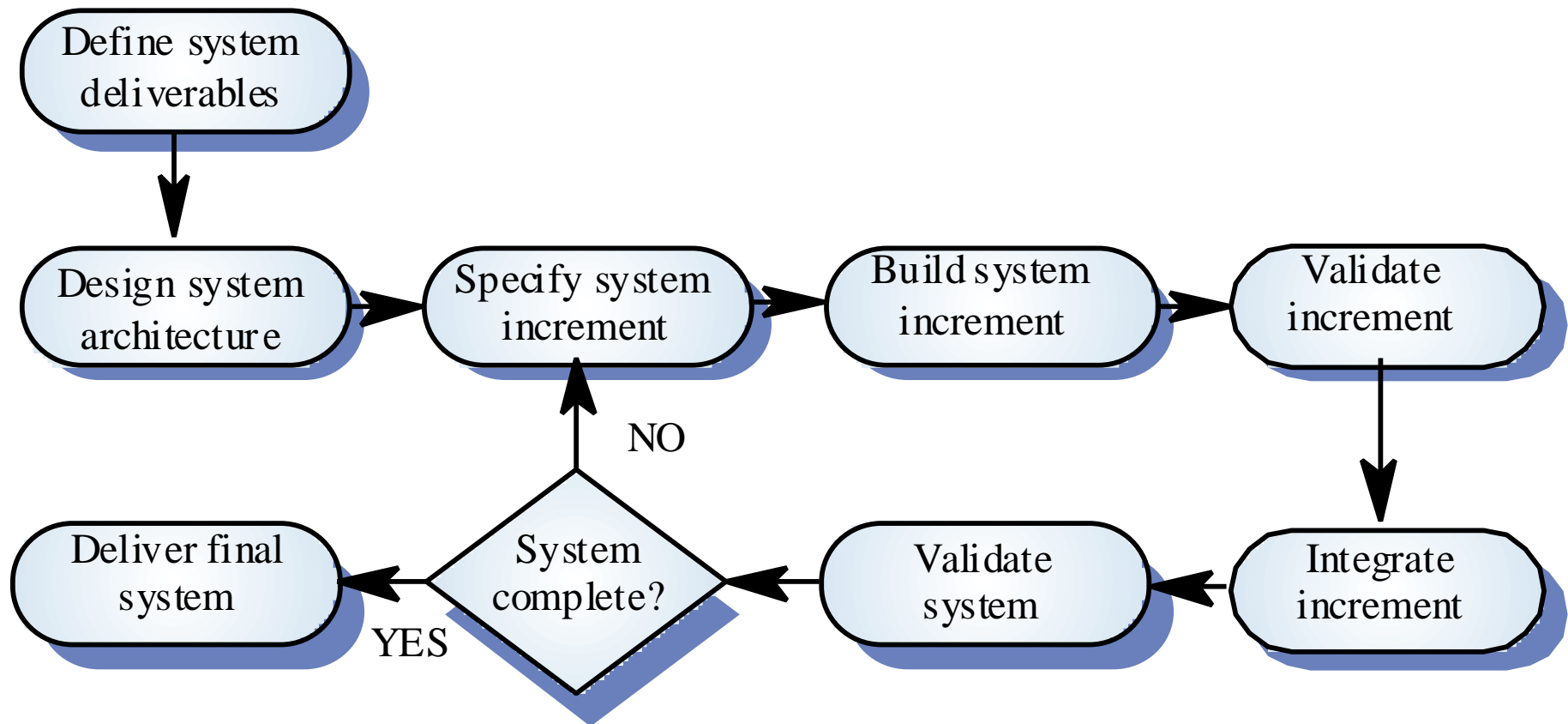
Prototypes as specifications

- ◆ Some parts of the requirements (e.g. safety-critical functions) may be impossible to prototype and so don't appear in the specification
- ◆ An implementation has no legal standing as a contract
- ◆ Non-functional requirements cannot be adequately tested in a system prototype

Incremental development

- ◆ System is developed and delivered in increments after establishing an overall architecture
- ◆ Users may experiment with delivered increments while others are being developed. therefore, these serve as a form of prototype system
- ◆ Intended to combine some of the advantages of prototyping but with a more manageable process and better system structure

Incremental development process



Prototyping techniques

- ◆ Executable specification languages
- ◆ Very high-level languages
- ◆ Application generators and 4GLs
- ◆ Composition of reusable components

Executable specification languages

- ◆ The system is specified in a formal language
- ◆ This specification is processed and an executable system is automatically generated
- ◆ At the end of the process, the specification may serve as a basis for a re-implementation of the system

Problems with this approach

- ◆ Graphical user interfaces cannot be prototyped
- ◆ Formal specification development is not a rapid process
- ◆ The executable system is usually slow and inefficient
- ◆ Executable specifications only allow functional requirements to be prototyped

Very high-level languages

- ◆ Languages which include powerful data management facilities
- ◆ Need a large run-time support system. Not normally used for large system development
- ◆ Some languages offer excellent UI development facilities
- ◆ Some languages have an integrated support environment whose facilities may be used in the prototype

Prototyping languages

Language	Type	Application domain
Smalltalk	Object-oriented	Interactive systems
LOOPS	Wide spectrum	Interactive systems
Prolog	Logic	Symbolic processing
Lisp	List-based	Symbolic processing
Miranda	Functional	Symbolic processing
SETL	Set-based	Symbolic processing
APL	Mathematical	Scientific systems
4GLs	Database	Business DP
CASE tools	Graphical	Business DP

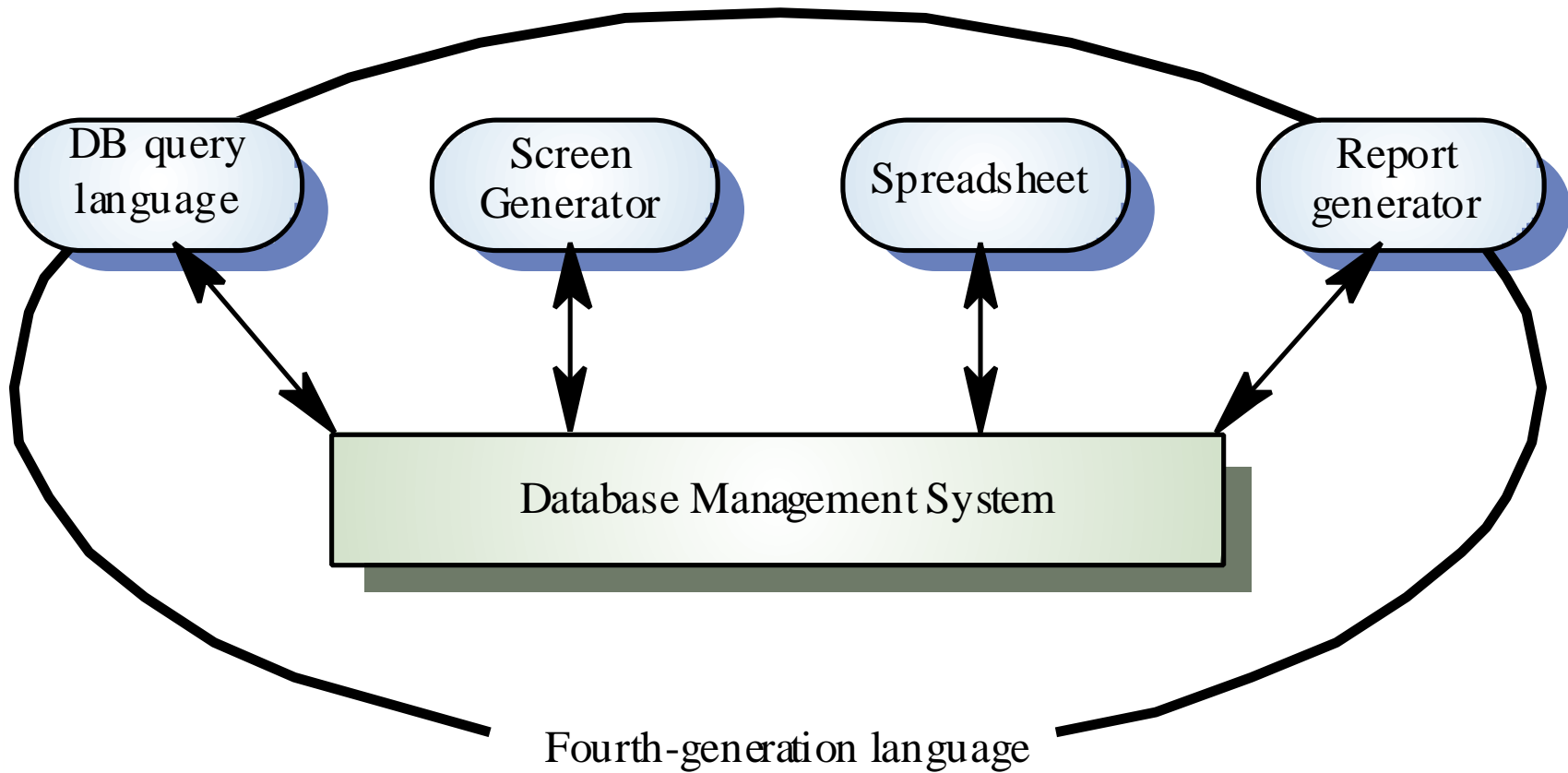
Smalltalk

- ◆ Very powerful system for prototyping interactive systems
- ◆ Object-oriented language so systems are resilient to change
- ◆ The Smalltalk environment objects are available to the prototype developer
- ◆ The system includes support software such as graphical user interface generation tools

Fourth-generation languages

- ◆ Domain specific languages for business systems based around a database management system
- ◆ Normally include a database query language, a screen generator, a report generator and a spreadsheet
- ◆ May be integrated with a CASE toolset
- ◆ Cost-effective for small to medium sized business systems

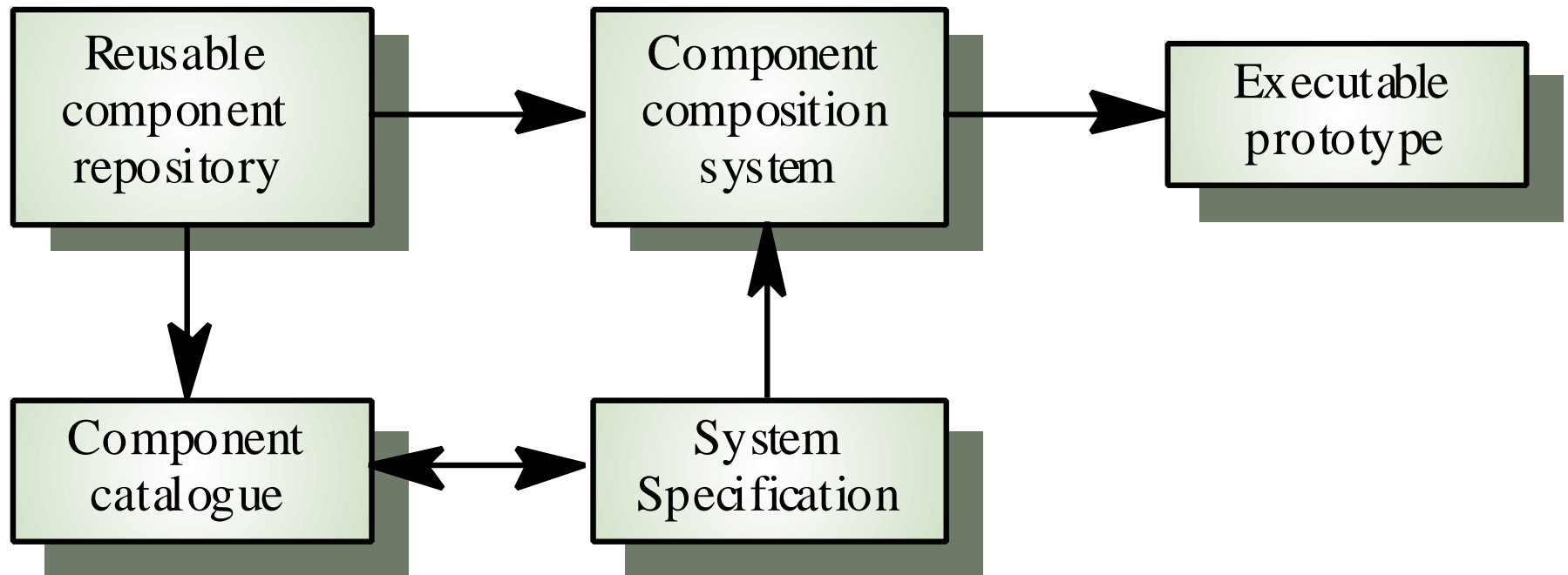
4GLs



Prototyping with reuse

- ◆ The system is prototyped by ‘gluing’ together existing components
- ◆ Likely to become more widely used as libraries of objects become available
- ◆ Needs a composition language such as a Unix shell language
- ◆ Visual Basic is largely based on this approach

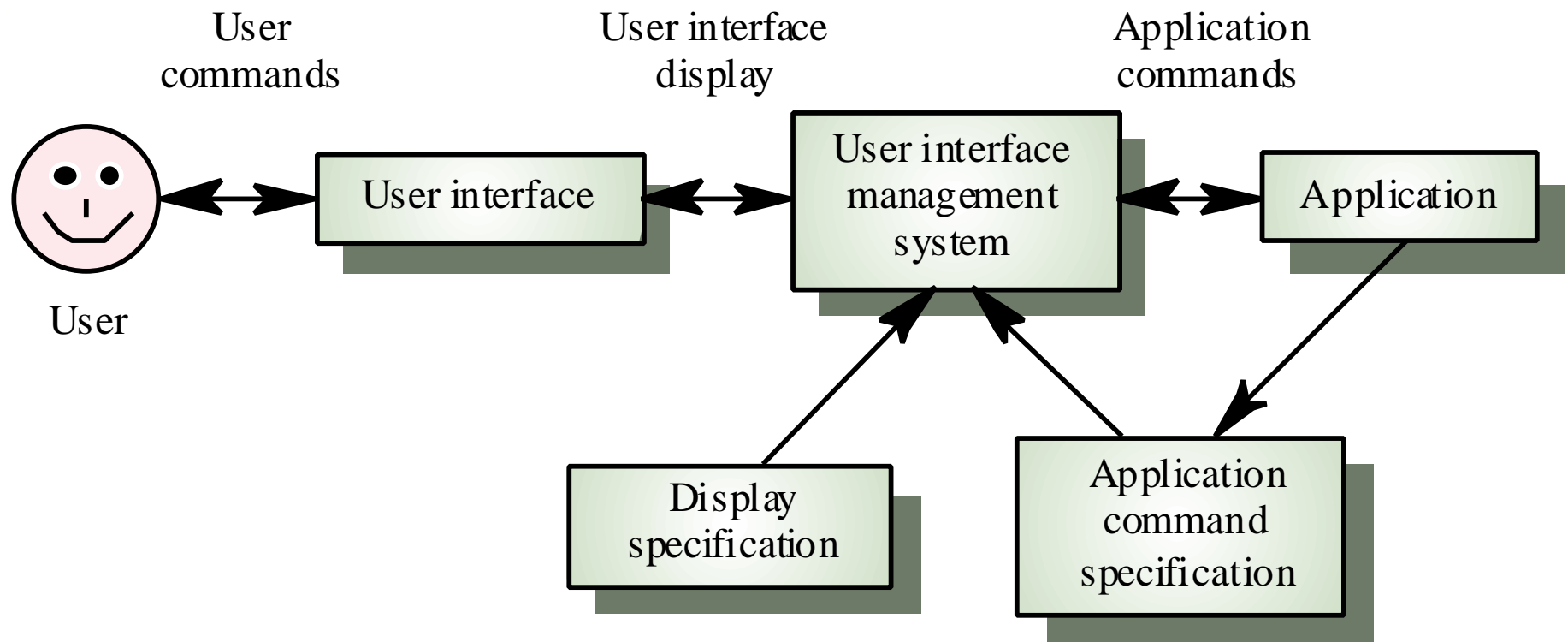
Reusable component composition



User interface prototyping

- ◆ It is impossible to pre-specify the look and feel of a user interface in an effective way. prototyping is essential
- ◆ UI development consumes an increasing part of overall system development costs
- ◆ Prototyping may use very high level languages such as Smalltalk or Lisp
- ◆ User interface generators may be used to ‘draw’ the interface and simulate its functionality

User interface management system



Key points

- ◆ A prototype can be used to give end-users a concrete impression of the system's capabilities
- ◆ Prototyping may be evolutionary prototyping or throw-away prototyping
- ◆ Rapid development is essential for prototype systems
- ◆ Prototype structures become corrupted by constant change. Hence, long-term evolution is difficult

Key points

- ◆ In a throw-away prototype start with the least well-understood parts; in an evolutionary prototype, start with the best understood parts
- ◆ Prototyping methods include the use of executable specification languages, very high-level languages, fourth-generation languages and prototype construction from reusable components
- ◆ Prototyping is essential for parts of the system such as the user interface which cannot be effectively pre-specified