3. Computer Aided Systems Engineering

IT 3106– Object Oriented Analysis and Design

Level II - Semester 3

Overview

In this section students will be introduced to

- Computer aided Software Engineering (CASE)
- Case tools and their Evolution
- Popular categories of Case Tools

Intended Learning Outcomes

At the end of this lesson students will be able to

- define the term Computer aided Software Engineering (CASE).
- describe Case tools and their evolvement.
- identify popular categories of Case Tools.

List of Subtopics

Computer Aided Systems Engineering (2 hours)

3.1 Introduction to CASE and CASE tools [Ref 1 Pg 77]

3.2 Evolution of CASE tools [Ref 1: 77-79 , Ref 3, Ref Teacher's Note]

3.3 Popular Classification of CASE tools [Ref 1 77, 79 ,Ref 3, Ref Teacher's Note]

Ref 1: Alan Dennis, Barbara Haley, David Tegarden, Systems analysis design, An Object Oriented Approach with UML : an object oriented approach, 5th edition, John Wiley & Sons, 2015, ISBN 978-1-118-80467-4

Ref3 : https://www.geeksforgeeks.org/computer-aided-software-engineering-case/

3.1 Introduction to CASE and CASE tools

- Computer aided software engineering (CASE) is the implementation of computer assisted tools and methods in software development.
- CASE ensures a disciplined approach and helps designers, developers, testers, managers and other stakeholders in system development to see the project milestones during the development.
- CASE is also considered as a warehouse to store documents related to projects such as
  - business plans,
  - requirements
  - design specifications etc.

3.1 Introduction to CASE and CASE tools

- Computer-aided software engineering (CASE) is a category of software that automates all or part of the development process.
- Some CASE software packages are used primarily to support the analysis workflow to create integrated diagrams of the system and to store information regarding the system components.
- Some tools support the design workflow that can be used to generate code for database tables and system functionality.
- Some tools contain functionality that supports tasks throughout the system-development process.
- Some tools are considered as established software development support tools (e.g. interactive debuggers, compilers, etc.)
- Some tools support only planning, analysis and design stages of the software development life cycle(SDLC).
- They are also tools that are helpful in all the stages of SDLC, from Requirement gathering to Testing and documentation.

3.1 Introduction to CASE and CASE tools

- CASE comes in a wide variety options in terms of complexity and functionality.
- Many good tools are available in the marketplace to support object-oriented systems development,

  e.g., ArgoUml, Visual Paradigm, Enterprise Architect, and IBM's Rational Rose etc.

ArgoUML - https://argouml.en.softonic.com/

https://www.visual-paradigm.com/download/community.jsp

- Popular categories of CASE tools will be discussed later.

3.1 Introduction to CASE and CASE tools

- There are number of CASE tools available to simplify various stages of Software Development Life Cycle.

Eg. Business Analysis and modelling,
Project management tools,
Design and Development toots,
Testing,
Maintenance etc

3.1 Introduction to CASE and CASE tools

CASE tools can be broadly categorized as:

- **Classic CASE tools** - Established software development support tools (e.g. interactive debuggers, compilers, etc.)
- **Real CASE tools** - Can be separated into three different categories, depending on where in the development process they are most involved in:

3.1 Introduction to CASE and CASE tools

Classic CASE Tools

- They are long-established computerized tools that support developers.
- Compilers and interpreters falls into this category.

  eg. Dev C++

3.1 Introduction to CASE and CASE tools

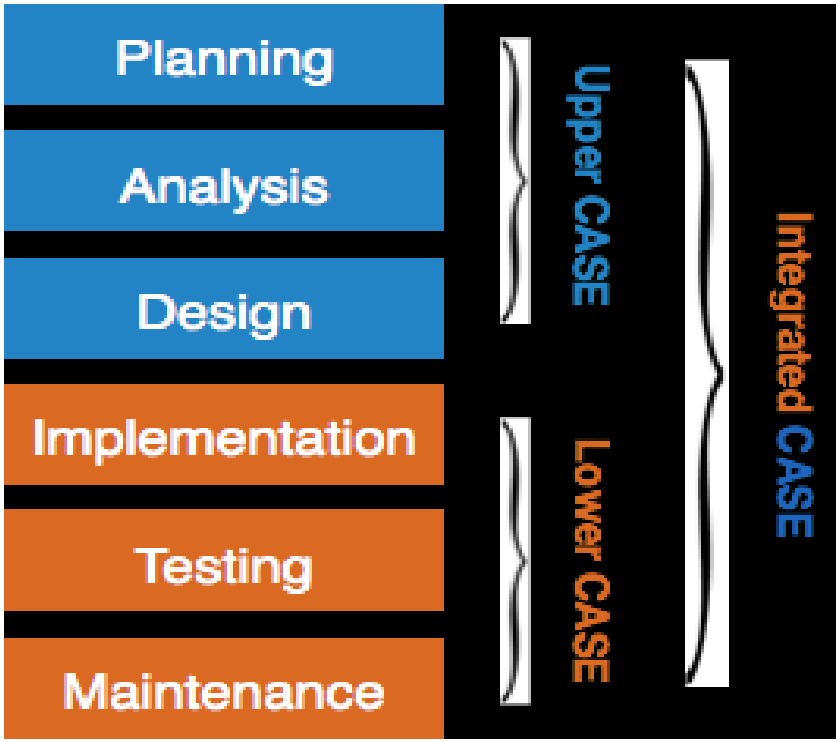
Real CASE tools

- Real CASE tools can be broadly divided into the following categories based on their use at a particular SDLC stage:
  - Upper Case Tools
  - Lower Case Tools
  - Integrated Case Tools

I-CASE Has a

Central Repository

-Stores all information Related to the Project



3.1 Introduction to CASE and CASE tools

Central Repository

- A major difference between classic and real CASE tools is that real CASE tools have a repository which stores all the information related to the project.
- Real CASE tools require a central repository which can serve as a source of integrated and consistent information.
- Central repository is a central place of storage where product specifications, requirement documents, related reports and diagrams etc. are stored.
- It is also serves as a ***data dictionary***.

3.1 Introduction to CASE and CASE tools

Upper Case Tools

- Used in planning, analysis and design stages of SDLC.
- Supports Business modeling.
- They **do not** support implementing , testing and maintenance.

Eg. Diagramming tools such as UML tools which support drawing of UML diagrams.

StarUML, ArgoUML

3.1 Introduction to CASE and CASE tools

Lower CASE Tools

- Used in implementation, testing and maintenance stages of SDLC.
- Do not support Planning, Analysis and Design

Eg. Tools to support code generation.

Eclipse

3.1 Introduction to CASE and CASE tools

Integrated CASE Tools : I-CASE

- They are helpful in all the stages of SDLC, from Requirement gathering to Testing and documentation

Eg.

Visual Paradigm - https://www.visual-paradigm.com/

Enterprise Architect - http://www.sparxsystems.com/products/ea/

3.1 Introduction to CASE and CASE tools

Benefits of using I-CASE tools for System Development

- Tasks can be completed and altered faster.
- Development documentation is centralized. Better and more consistent documentation – because the tools make it easier to create them and check for consistency.
- Information is illustrated through diagrams, which are typically easier to understand.
- Reduce the maintenance costs.
- Improve software quality and enforce discipline. They check for completeness, consistency, and contradictions using the Central Repository.
- Substantial savings in software development resources.
- Shorter time to market.
- Reduced generation of defects. Increased automatic identification of defects and their correction during development.

3.1 Introduction to CASE and CASE tools

Benefits of using I-CASE tools for System Development cont…

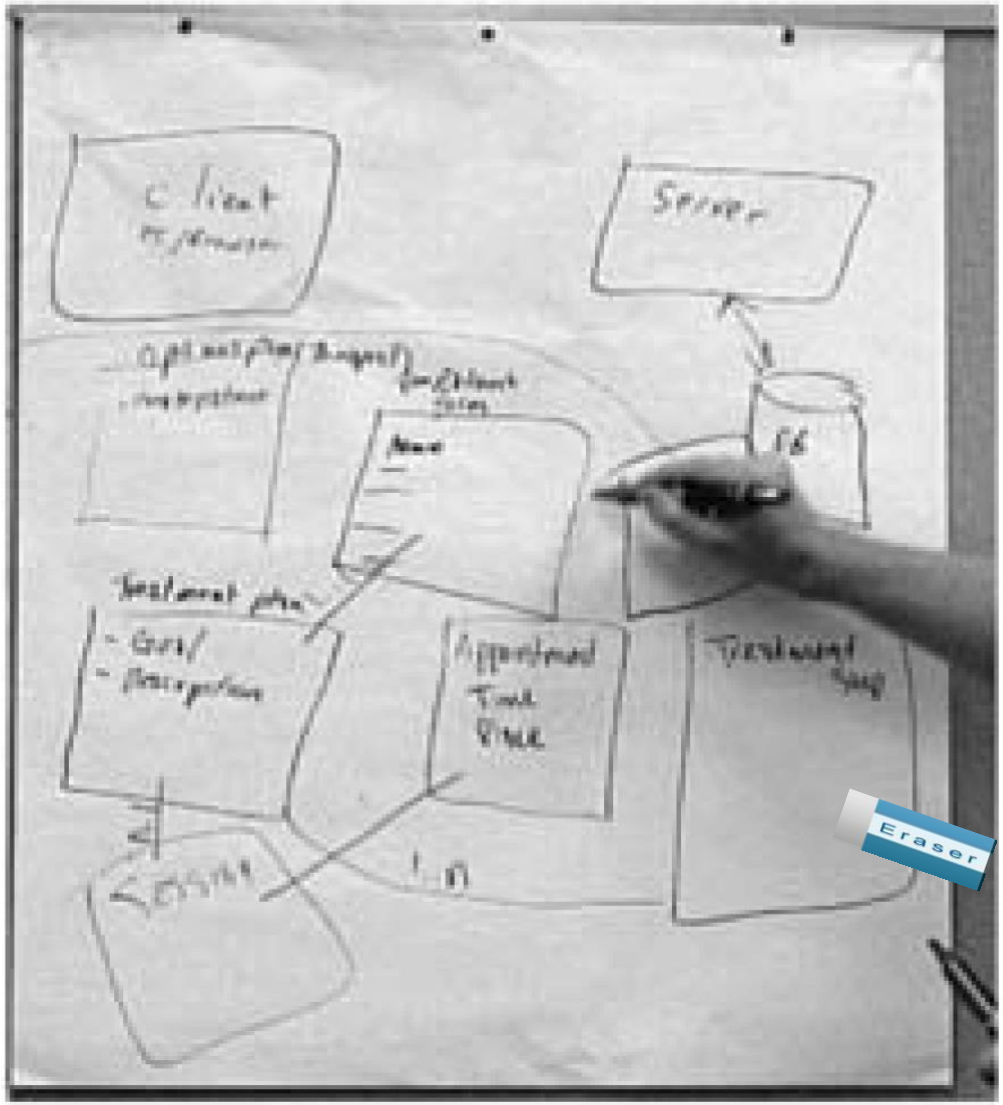
- Many modern CASE tools that support object-oriented systems development support a development technique known as *round-trip engineering*. Round-trip engineering supports not only code generation but also the reverse engineering of UML diagrams from code. In this way, the system can evolve via diagrams and via code in a round-trip manner.

  e.g. generate a java class directly from a class diagram(Forward Engineering), generate a sequence diagram from an existing java program (Reverse Engineering)

3.2 Evolution of CASE tools

Era before CASE tools

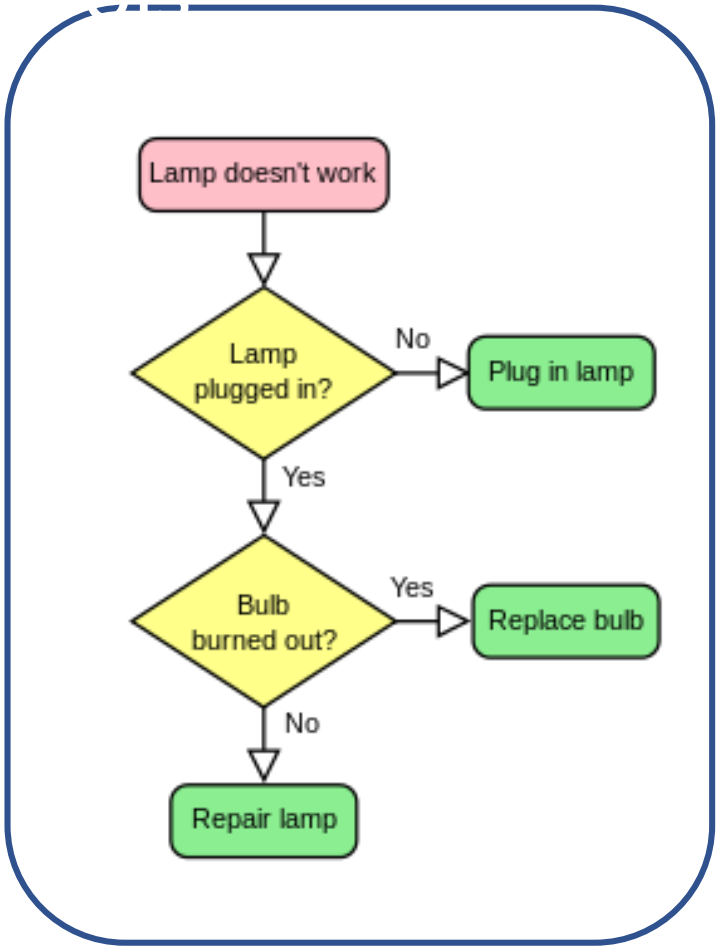
- Systems Analysts use pencil and paper for modelling.
- Editing was not easy.
- Later introduced graphics editors to support modelling.
- Case tools Were Introduced in early 1980's
- No UML



3.2 Evolution of CASE tools

Era before CASE tools cont….

- Modeling notations were introduced before graphics editors
- The first structured method for document process flow, was known as the "flow process chart". It was introduced by Frank and Lillian Gilbreth to members of the American Society of Mechanical Engineers (ASME) in 1921.
- Latest UML activity diagrams were very similar but there are differences too.

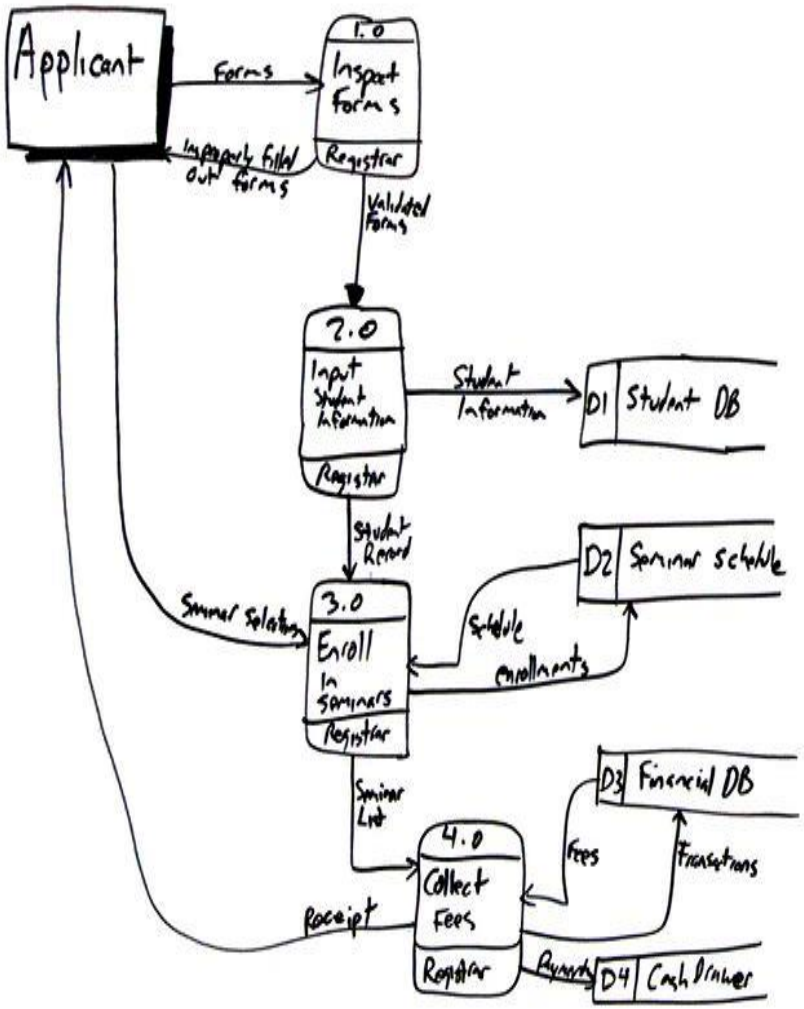


A simple flowchart representing a process for dealing with a non-functioning lamp.

3.2 Evolution of CASE tools

Era before CASE tools cont….

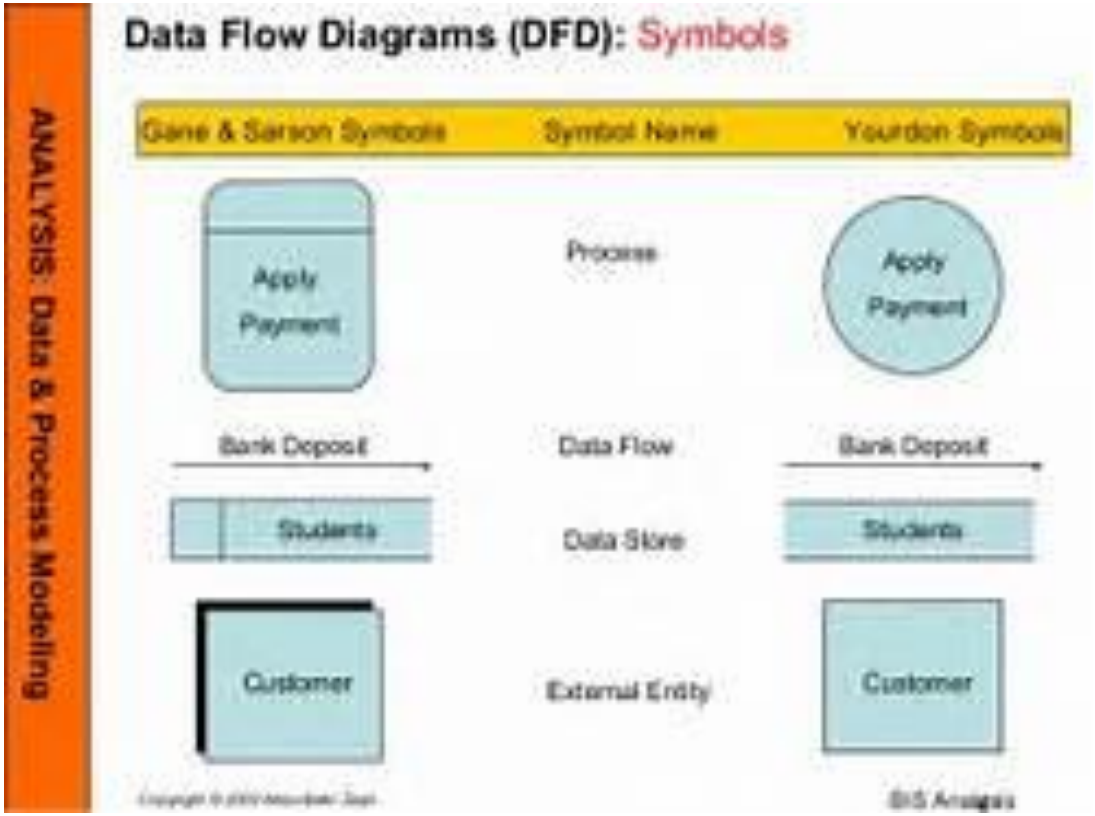
- In the late 1970s data-flow diagrams (DFDs) were introduced and used with structured analysis and design (Gane and Sarson, 1979).
- DFDs show the flow of data from external entities into the system, showed how the data moved from one process to another, as well as its logical storage.



3.2 Evolution of CASE tools

Era before CASE tools cont….

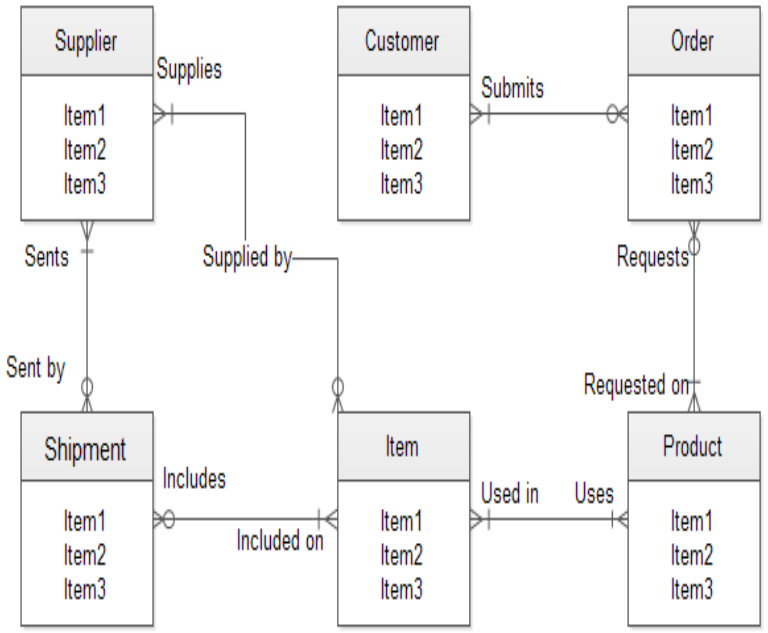
- Modeling notations for DFDs
- Gane and Sarson Popular Notation
- No Standard



3.2 Evolution of CASE tools

Era before CASE tools cont….

- Data modeling introduced in the 1970s driven by the need to properly model databases.
- Peter Chen, an attendee at the Enterprise Data World conference, popularized the Entity-Relationship model in a paper published in 1976.
- Chens paper considered to be the beginning of the Data Modeling practice as it is known today.
- Since then many notations introduced. Cross feet, Oracle. Draw oracle notation etc.

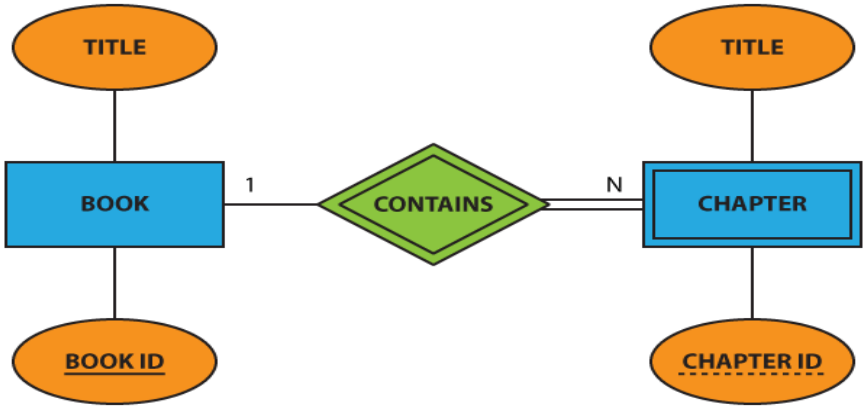


ERD for an Order Processing System

3.2 Evolution of CASE tools

Era before CASE tools cont....

- Modeling notations for ERDs
- Chens notation is a popular notation.



OTHER RELATIONSHIP CARDINALITY NOTATION

Notation	Zero or One Relation-ship	One and Only One	Zero or Many Relation-ship	One or Many Relation-ship
Crow's Foot Notation				
Arrow Notation				
Bachman Notation				
ADW				
Oracle				

ERD Notations (No standard)

3.2 Evolution of CASE tools

Era before CASE tools cont….

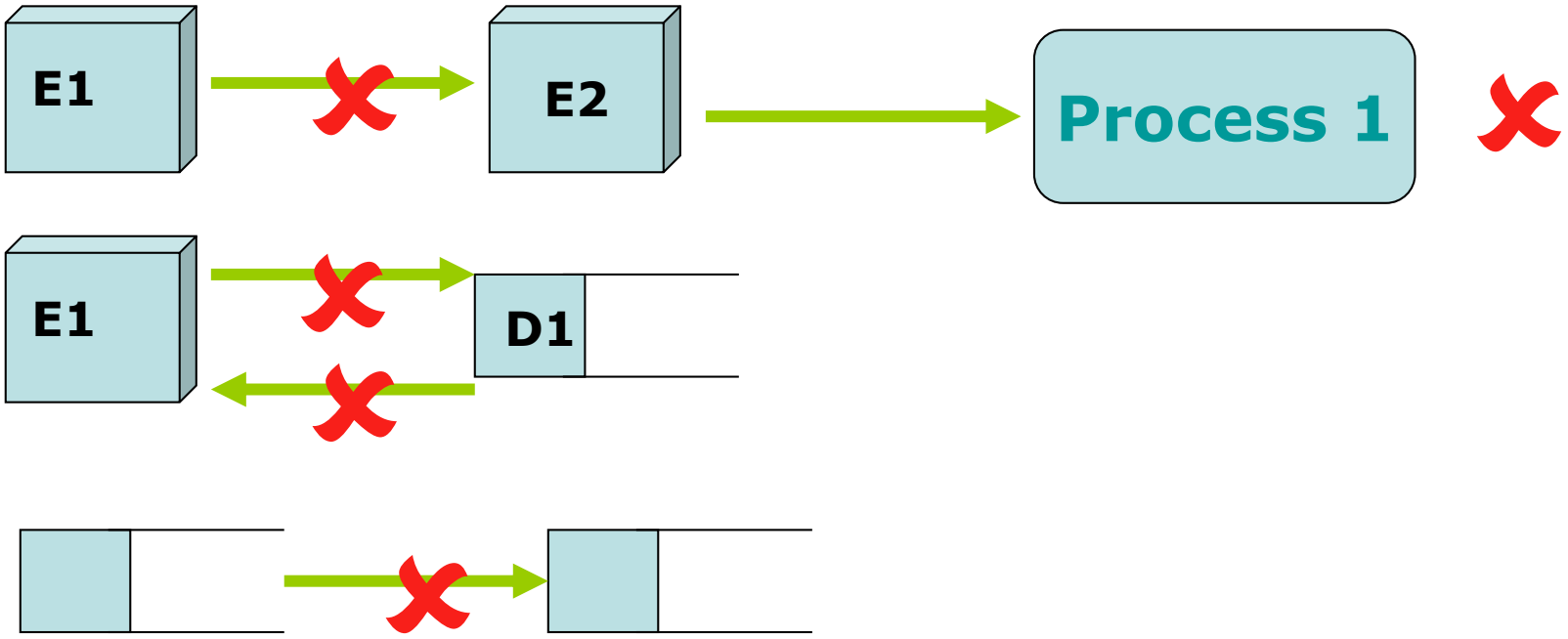
- Word Processors (around since 1964)
- Diagram Editors
- Intelligent Diagram Editors (DesignAid-Early 80’s)

3.2 Evolution of CASE tools

Era before CASE tools cont….

Intelligent Diagram Editors

Eg. Automatically detect syntactic check and semantic checks in DFDs



3.2 Evolution of CASE tools

History of CASE (Computer Aided Software Engineering)

- Computer Aided Software Engineering was originally used by Nastec Corporation of Southfield, Michigan in 1982.
- CASE tools are set of software application programs, which are used to automate SDLC activities.

3.2 Evolution of CASE tools

CASE tools in 80's

- 4GL products

  Evolved from enhanced query languages and report generators into application development tools.

  Eg. Nomad, Focus,

  Dbase III +, Foxpro 1.0 (Popular in late 80s)

- Analysis Tools, Design tools (Assist user to sketch blueprints, Interface design tools.)
- Most supported only some phases of the SDLC

Evolvement of CASE Tools

CASE tools in ‘80s

- Excelerator introduced in 1984 by Index Technology.
- Excelerator became popular and was the best seller in 1989 (According to the PC Magazine of January 1990).
- Over 100 companies were offering nearly 200 different CASE tools (According to the PC Magazine of January 1990).

Evolvement of CASE Tools

Excelerator

- Excelerator combines the Yourdan/Demarco Structured Analysis methodology with data modeling and structured design methodologies.
- Supported both Yourdan and Gane/Sarson notation for data-flow diagrams.
- Excelerator also supported Ward & Mellor notation for state, control, and event modeling.
- ERD could be drawn using both Chen and Merise notation.
- Structure charts and Jackson structure diagrams were provided to help analyze process logic.

Evolvement of CASE Tools

CASE tools in 90's

- Usually confirm to some system development methodology.
- Included some of the latest versions of earlier mentioned CASE tools (80's).
- Automate part or all of the supported methodology.

Evolvement of CASE Tools

CASE tools in ‘90s

When using these CASE tools the organizations had to consider

- whether the features of a CASE tool fit the methods they use in system development or
- whether they wish to modify their methods to obtain CASE benefits.

Evolution of CASE tools

Some of the PC CASE tools that were available in early 90's.

Product	Vendor	Hardware
Analyst Designer ToolKit	Yourdon	IBM PC and Compatibles
Automate +	LBMS	IBM PC and Compatibles
CASE 2000	Nastec Corp.	IBM PC Compatibles, VAZ Workstations
Excelerator	Index Technologies	IBM PC Compatibles, Sun, Apollo
Information Engineering Workbench	Knowledge Ware	IBM PC Compatibles, IBM MVs, DEC VAX
Teamwork	Cadre Technologies	Sun,Apollo,VAX, HP 9000
Deft	Deft Inc.	Macintosh
Oracle *CASE	Oracle Corp.	IBM PC and Compatibles, Sun

Evolution of CASE tools

Popular System Development Methodologies used in 90's with their supportive techniques

SD Methods	Techniques
HIPO-Hierarchical Input Process Output Charts	FHD,IPO charts
LSDM-LearMouth Structured Development Method	DFD,ERD,Data Analysis, ELH
SSADM (Structured System Analysis and Design Methodology)	DFD,ERD,Data Analysis, ELH
YSM-Yourdon Structured Method	DFD,ERD, STD,SC
Oracle* Method	DFD,ERD, Data Analysis, FHD, Matrix Plotting
JSD-Jackson Structured Method	PSD

Evolution of CASE tools

Briefly look at 3 CASE tools that were popular in early 90's

Automate Plus (Version 3.0)

- Automate + was a commercially available CASE tool for IBM PC and compatible machines.
- The LSDM (Learmouth Structured Development Method), is the only System development methodology supported by this tool.
- Only supported techniques used in LSDM. ie DFD,ERD, ELH
- DFDs (Yourdan/Demarco and Gane & Sarson) were supported by the tool whereas only the Benchman/Chen (arrow head) and Martin (Crowsfeet) notations for ERD were supported.
- User had to select the notations required at the installation time.
- Version 3.0 of Automate + supported only up to the system design stage.

Evolution of CASE tools

Deft (Version 3.1)

- Deft was a commercially available CASE tool for Macintosh PCs.
- It does not support any of the traditional design methodologies directly.
- It supports the techniques such as DFD,ERD and PSD.
- For DFDs it supported Yourdan/Demarco and Gane and Sarson notations where as for ERD it supported Benchman/Chen, Martin and IRM notations.
- Gateway module allowed the user to ‘reverse engineer’ an Ingress SQL or QUEL database the user had already created.

Evolution of CASE tools

Oracle *CASE
(CASE * Designer ver. 1.1 , CASE *Dictionary ver. 5.0)

- Oracle *CASE was a commercially available CASE tool for SUN workstations, IBM PC's and compatibles.
- Oracle *CASE supported only a method call CASE *Method.
- It supported four techniques namely DFD,ERD, FHD and Matrix Plotter.
- It supported only Gane & Sarson notation for DFDs and Oracle *CASE notation (its own) for ERD.
- It uses an Oracle relational database repository.
- Oracle *CASE can generate default applications, customize forms and reports.

Evolvement of CASE Tools

OO CASE Tools

- In the mid nineties, with the rise of Object Orientation, the traditional CASE tools were perceived as a failure by many people.
- The first OO CASE tools had the notation battle to fight (before 1997 Nov.)
- After the introduction of UML in 1997 this problem was resolved. (Main authors of UML -Rumbaugh, Booch, and Jacobson)
- New set of CASE tools that supported UML diagrams were introduced after 1997.

  e.g. IBM's Rational Rose, Sparx Systems Enterprise Architect etc.

Popular Classification of CASE tools

- Diagramming Tools
- Project Management Tools
- Documentation Tools
- Configuration Management Tools
- Programming Tools
- Quality Assurance Tools

Some tools supports several of these categories

3.3 Popular Classification of CASE tools

Diagramming tools

- These tools are used to represent system components, data and control flows in a graphical form.
- Diagrammatic Representation of system in different view points.

  Examples
  - StarUML, ArgoUML - used for creating UML diagrams
  - MS Visio
  - Draw.io
  - Lucidchart
  - Creately
  - PlantUML- is an open-source tool and syntax for creating diagrams from plain-text definitions.

Popular Classification of CASE tools

Diagramming tools cont..

- You can also use any I-Case tools to draw most of the diagrams.

  eg. Visual Paradigm supports UML, ERD, DFD, PERT, Organization charts, BPMN, CRC cards etc.

  (https://www.visual-paradigm.com/)

Popular Classification of CASE tools

Diagramming tools cont..

PlantUML(https://plantuml.com/)

- PlantUML is an open-source tool and syntax for creating diagrams from plain-text definitions. You use simple text syntax to describe a type of diagram, as well as the elements which make up the diagram.
- Using this plain text syntax and a rendering server / plugin to convert your text into diagrams, you can draw any architectural diagram that you need when designing a system.

Popular Classification of CASE tools

Diagramming tools cont..

PlantUML

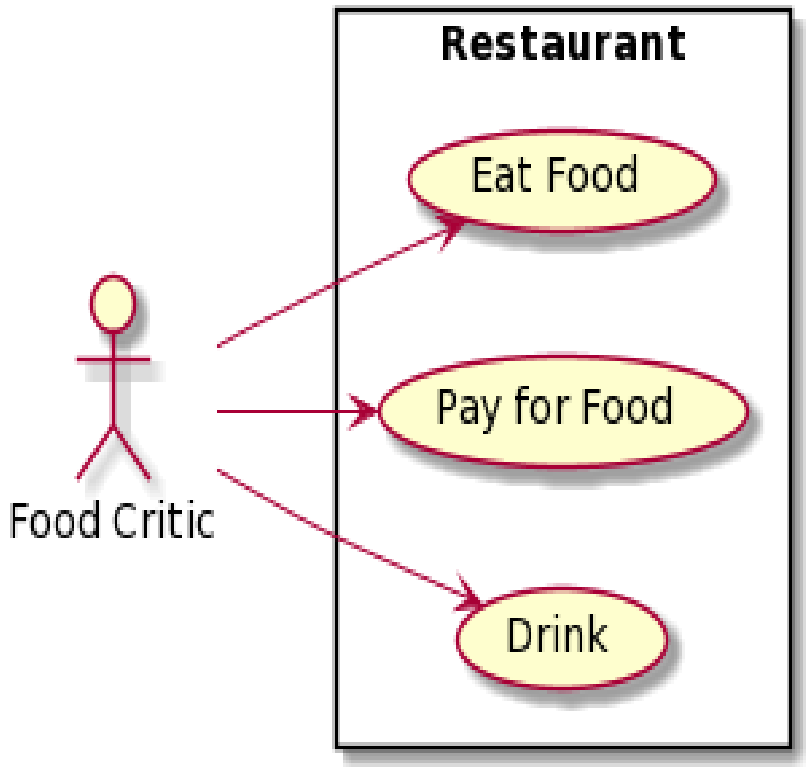
- Textual UML tools market is one of the fastest-growing segment in the UML tools market.
- They provide some kind of lightweight solution to draw some models.
- It has been used to allow blind students to work with UML. PlantUML also helps blind software engineers to design and read UML diagrams.

Popular Classification of CASE tools

Diagramming tools cont..

PlantUML Example

```
@startuml
left to right direction
actor "Food Critic" as fc
rectangle Restaurant {
  usecase "Eat Food" as UC1
  usecase "Pay for Food" as UC2
  usecase "Drink" as UC3
}
fc --> UC1
fc --> UC2
fc --> UC3
@enduml
```



Popular Classification of CASE tools

Project Management Tools

- Used for project planning, cost and effort estimation, project scheduling, resource planning, and progress monitoring of a project.
- Help managers to comply project execution with every mentioned step in software project management.
- Help in storing and sharing real-time project information like time tracking etc. throughout the organization.

Examples

- Trello
- TeamWork
- Basecamp
- JIRA -Focus on issue tracking (Agile PM tool)
- etc

Popular Classification of CASE tools

Documentation Tools or Help Authoring Software

- Documentation tools generate documents for technical users and end users.
- Technical users are mostly in-house professionals of the development team who refer to system manual, reference manual, training manual, installation manuals etc.
- The end user documents describe the functioning and how-to of the system such as user manual.
- Training Manuals, Installation Manual, User Manuals can be generated by documentation tools.

  Examples: Doxygen, DrExplain, Adobe Robohelp , Confluence etc.

Popular Classification of CASE tools

Configuration Management (CM) Tools

- Configuration management is a systems engineering process for establishing consistency of a product's attributes throughout its life.
- In the technology world, configuration management is an IT management process that tracks individual configuration items of an IT system.
- Configuration management helps engineering teams build robust and stable systems through the use of tools that automatically manage and monitor updates to configuration data.

Popular Classification of CASE tools

Configuration Management (CM) Tools cont…

- An instance of software is released under one version. Configuration Management tools deal with
  - Version ,Baseline configuration and Change control management
- Bug tracking and Blogging can be done by CM tools

Examples

- Git, (free and open-source distributed version control system)
- Docker
- Terraform etc.

Popular Classification of CASE tools

Programming Tools cont….

- These tools consist of programming environments like IDE (Integrated Development Environment), in-built modules library and simulation tools.
- These tools provide comprehensive aid in building software product and include features for simulation and testing.
- Software tools are used to accomplish and investigate the business processes, document the development process of the software and optimize all the processes.
- By using these tools in the software development process, the outcome of the projects will be more productive.
- Using the development tools, a developer can easily maintain the workflow of the project.

Popular Classification of CASE tools

Programming Tools cont….

Examples

- **Eclipse** - Eclipse is a popular IDE that is used by Java developers in computer programming. It is used to develop applications not only in Java but also in other programming languages like C, C++, C#, PHP, ABAP etc.
- **Netbeans -** Netbeans is an open source and a free software development tool written in Java that develops web, mobile, and desktop applications easily and quickly. It uses C / C++, PHP, JavaScript, Java etc.
- **Bootstrap** – Bootstrap is an open source and free framework for developing responsive websites and mobile-first projects using CSS, HTML, and JS. Bootstrap is widely used to design faster and simpler websites.
- **Adobe Dreamweaver –** Adobe Dreamweaver is an exclusive software program and programming editor that is used for creating simple or complex websites. It supports many markup languages like CSS, XML, HTML, and JavaScript.

Popular Classification of CASE tools

Programming Tools cont….

- **Microsoft Visual Studio** is an integrated development environment from Microsoft. It is used to develop computer programs, as well as websites, web apps, web services and mobile apps.
- **Android Studio** is the official IDE for Android application development, based on IntelliJ IDEA.
- **Etc.**

Popular Classification of CASE tools

Quality Assurance Tools

- Quality assurance(QA) in a software organization is monitoring the engineering process and methods adopted to develop the software product in order to ensure conformance of quality as per organization standards.
- QA tools are utilized by many organizations to assist in monitoring and managing their quality initiatives.
- QA tools consist of configuration and change control tools and software testing tools.

Examples: Apache **JMeter** is an open source, Java-based, load testing tool that can be used to analyze the functional behavior of a system and measure the performance of a system under a load test.

Popular Classification of CASE tools

Quality Assurance Tools cont..

- **LambdaTest** is an automation testing tool for desktop & web applications.
- **TestProject** is a 100% FREE end-to-end test automation platform for web, mobile, and API testing.
- **IBM Rational Functional Tester** is primarily intended for automated functional testing & regression testing. It also allows you to perform data-driven and GUI testing.
- **IBM Rational Performance Tester** tool is designed for doing automated performance testing over web and server-based apps.

Popular Classification of CASE tools

Quality Assurance Tools cont..

Apache JMeter

- Apache JMeter is a software that can perform load test, performance-oriented business (functional) test, Stress test, etc., on different protocols or technologies.

  Performance Test – This test sets the best possible performance expectation under a given configuration of infrastructure. It also highlights early in the testing process if any changes need to be made before the application goes into production.

  Load Test – This test is basically used for testing the system under the top load it was designed to operate under.

  Stress Test – This test is an attempt to break the system by overwhelming its resources.

Summary

- Computer aided software engineering (CASE) is the implementation of computer assisted tools and methods in software development.
- Computer-aided software engineering (CASE) is a category of software that automates all or part of the development process.
- Some CASE software packages are used primarily to support the analysis workflow to create integrated diagrams of the system and to store information regarding the system components.
- Many good tools are available in the marketplace to support object-oriented systems development.

  e.g., ArgoUml, Visual Paradigm, Enterprise Architect, and IBM's Rational Rose etc.

Summary cont...

- CASE tools can be broadly categorized as Classic CASE tools (Established software development support tools) and Real CASE tools (Can be separated into three different categories, depending on where in the development process they are most involved in).
- Real CASE tools require a central repository which can serve as a source of integrated and consistent information.
- Upper Case Tools are diagramming tools such as UML tools which support drawing of UML diagrams.

  e.g. ArgoUML
- Lower Case Tools are tools to support code generation.

  e.g. Eclipse
- I-Case tools are helpful in all the stages of SDLC, from requirement gathering to testing and documentation.

  e.g. Visual Paradigm

Summary cont...

- There are many benefits of using I-CASE tools for System Development such as tasks can be completed and altered faster, can reduce maintenance costs etc.
- Before graphics editors were introduced to support modelling, Systems Analysts use pencil and paper for modelling. Case tools were Introduced in early 1980's.
- CASE tools in 1980s – 4GL products such as Dbase III +, Foxpro 1.0 , Excelerator.
- CASE tools in 90's - Usually confirm to some system development methodology. E.g. Automate + , Deft, Oracle CASE
- OO Case tools - In the mid nineties, with the rise of Object Orientation, the traditional CASE tools were perceived as a failure by many people.
- UML diagrams were introduced after 1997 and the notation issue was resolved.
- Examples of OO Case tools- IBM's Rational Rose, Sparx Systems Enterprise Architect etc.

Summary cont...

Popular Classification of CASE tools

- Diagramming Tools
- Project Management Tools
- Documentation Tools
- Configuration Management Tools
- Programming Tools
- Quality Assurance Tools