SOFTWARE ENGINEERING

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Software Life Cycle

- Software life cycle (or software process):
  - series of **identifiable stages** that a software product undergoes during its life time:
    - Feasibility study
    - requirements analysis and specification,
    - design
    - coding
    - testing
    - maintenance.

Life Cycle Model

- A software life cycle model (or process model):
  - a **descriptive and diagrammatic** model of software life cycle:
  - **identifies all the activities** required for product development,
  - **establishes a precedence ordering** among the different activities,
  - Divides life cycle into **phases**.

Life Cycle Model (CONT.)

- Several different activities may be carried out in each life cycle phase.
  - For example, the **design stage** might consist of:
    - structured analysis activity followed by
    - structured design activity.

Life Cycle Model (CONT.)

- Software life cycle:- SDLC(software development life cycle).
- SDLC:- graphically depicts different phase through which software develop.
- Process:- all the **activities taking place** during software development.
- Methodology:- set of **steps for carrying out a specific** life cycle activity.

Life Cycle Model (CONT.)

- The development team must **identify a suitable life cycle model**:

  and then adhere to it.

  Primary advantage of adhering to a life cycle model:

  helps development of software in a systematic and disciplined manner.

Life Cycle Model (CONT.)

- When a program is developed by a single programmer ---
  - he has the **freedom to decide** his exact steps.

Life Cycle Model (CONT.)

- When a software product is being developed by a team:
  - there must be a precise **understanding among team members** as to when to do what,
  - otherwise it would lead to chaos and **project failure.**

Life Cycle Model (CONT.)

- A software project will never succeed if:
  - one engineer starts **writing code**,
  - another concentrates on **writing the test** document first,
  - yet another engineer first **defines the file structure**
  - another **defines the I/O** for his portion first.

Life Cycle Model (CONT.)

- A life cycle model:
  - defines **entry and exit criteria** for every phase.
  - A phase is considered to be complete:
    - only when all its exit criteria are satisfied.

Life Cycle Model (CONT.)

- The phase **exit criteria** for the software requirements specification phase:
  - **Software Requirements Specification** (SRS) document is complete, reviewed, and approved by the customer.
- A phase can start:
  - only if its phase-entry criteria have been satisfied.

Life Cycle Model (CONT.)

- It becomes easier for software **project managers**:
  - to **monitor the progress of the project**.

Life Cycle Model (CONT.)

- When a life cycle model is adhered to,
  - the **project manager** can at any time fairly accurately tell,
    - at which stage (e.g., design, code, test, etc.) of the project is.
  - Otherwise, it becomes very difficult to **track the progress of the project.**

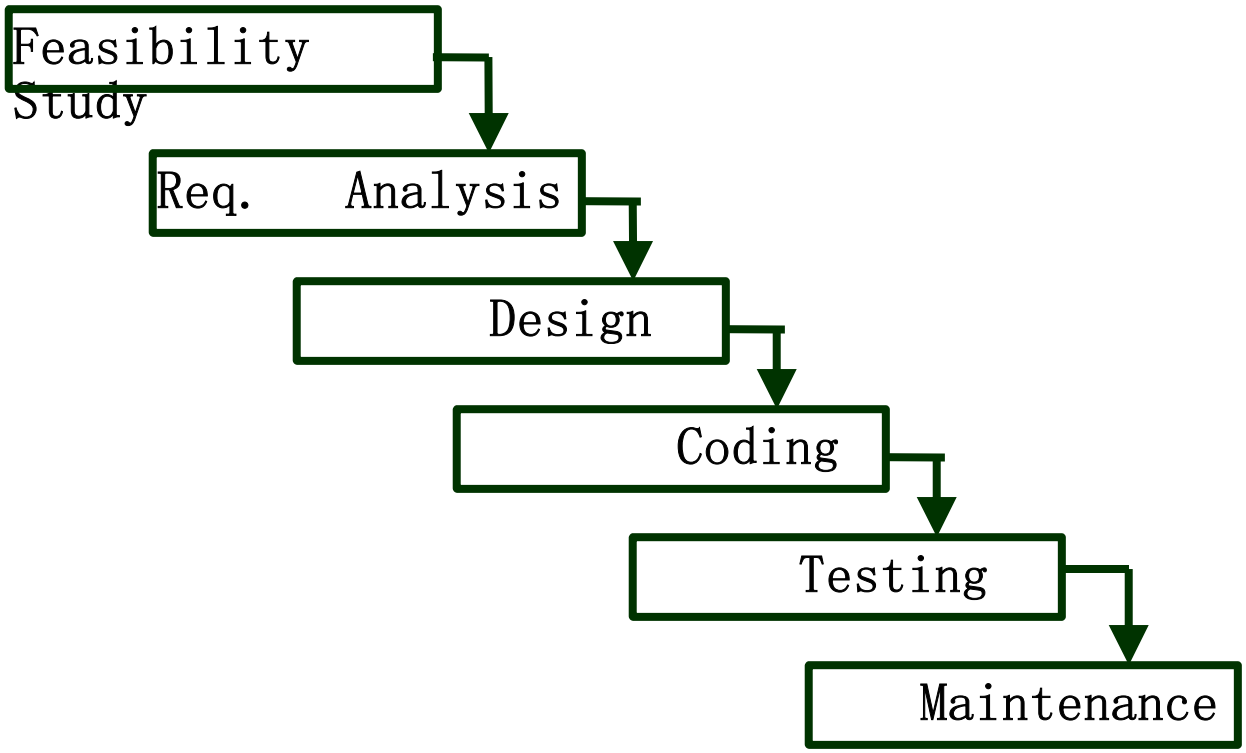
Life Cycle Model (CONT.)

- Many life cycle models have been proposed.
- We will confine our attention to a few important and commonly used models.
  - classical waterfall model
  - iterative waterfall,
  - evolutionary,
  - prototyping,
  - spiral model

(1) Classical Waterfall Model

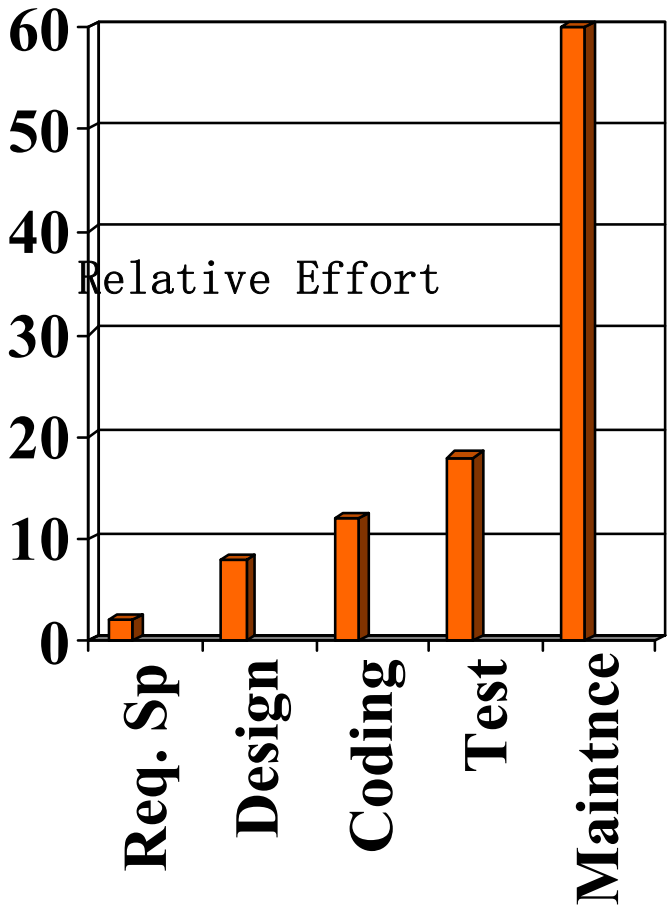
- Classical waterfall model divides life cycle into phases:
  - feasibility study,
  - requirements analysis and specification,
  - design,
  - coding and unit testing,
  - integration and system testing,
  - maintenance.

Classical Waterfall Model



Relative Effort for Phases

- Phases between feasibility study and testing
  - known as development phases.
- Among all life cycle phases
  - maintenance phase consumes maximum effort.
- Among development phases,
  - testing phase consumes the maximum effort.



Classical Waterfall Model (CONT.)

- Most organizations usually define:
  - **standards on the outputs** (deliverables) produced at the end of every phase
  - entry and exit **criteria for every phase**.
- They also prescribe **specific methodologies** for:
  - specification,
  - design,
  - testing,
  - project management, etc.

Classical Waterfall Model (CONT.)

- The **guidelines and methodologies** of an organization:
  - called the organization's software development methodology.

a) Feasibility Study

- Main aim of feasibility study: determine whether developing the product
  - financially worthwhile
  - technically feasible.
- First roughly **understand what the customer wants**.

Activities during Feasibility Study

- Work out an **overall understanding** of the problem.
- Formulate **different solution strategies**.
- Examine alternate solution strategies in terms of:
  - resources required,
  - cost of development, and
  - development time.

Activities during Feasibility Study

- Perform a cost/benefit analysis:
  - to **determine which solution is the best**.

b) Requirements Analysis and Specification

- Aim of this phase:
  - understand the **exact requirements** of the customer,
  - **document** them properly.
- Consists of two distinct activities:
  - requirements gathering and analysis
  - requirements specification.

Goals of Requirements Analysis

- **Collect all related data** from the customer:
  - **analyze** the collected data to clearly understand what the customer wants,
  - **find out** any inconsistencies and incompleteness in the requirements,
  - **resolve** all inconsistencies and incompleteness.

Requirements Gathering

- Gathering relevant data:
  - usually collected from the end-users through **interviews and discussions**.
  - For example, for a business accounting software:
    - interview all the accountants of the organization to find out their requirements.

Requirements Analysis (CONT.)

- The data **you initially collect** from the **users**:
  - would usually contain several **contradictions and ambiguities**:
  - each user typically has only a **partial and incomplete view of the system**.

c). Design

- Design phase **transforms requirements specification:**
  - into a form suitable for **implementation** in some programming language.

Design

- In technical terms:
  - during design phase, software architecture is derived from the SRS document.
- Two design approaches:
  - **traditional** approach,
  - **object oriented** approach.

Traditional Design Approach

- Consists of two activities:
  - Structured analysis
  - Structured design

Structured Analysis Activity

- **Identify** all the **functions** to be performed.
- Identify **data flow among the functions**.
- Decompose **each function** recursively into **sub-functions**.
  - Identify data flow among the subfunctions as well.

Structured Analysis (CONT.)

- Carried out using Data flow diagrams (DFDs).
- After structured analysis, carry out structured design:
  - **architectural design (or high-level design)**
  - **detailed design (or low-level design).**

Structured Design

- High-level design:
  - decompose the system into *modules*,
  - represent invocation **relationships among the modules.**
- Detailed design:
  - different modules designed in greater detail:
    - **data structures and algorithms** for each module are designed.

Object Oriented Design

- First identify various **objects** (real world entities) occurring in the problem:
  - identify the **relationships among the objects**.
  - For example, the objects in a pay-roll software may be:
    - employees,
    - managers,
    - pay-roll register,
    - Departments, etc.

Object Oriented Design (CONT.)

- OOD has several advantages:
  - lower development effort,
  - lower development time,
  - better maintainability.

d) Implementation

- Purpose of implementation phase (aka coding and unit testing phase):
  - **translate** software **design into source code.**

Implementation

- During the implementation phase:
  - **each module of the design is coded**,
  - each module is **unit tested**
  - each module is **documented.**

Implementation (CONT.)

- The purpose of unit testing:
  - test if individual modules **work correctly**.

e). Integration and System Testing

- Different **modules are integrated** in a planned manner:
  - Normally **integration is carried out** through a **number of steps**.
- During each integration step,
  - the partially integrated system is tested.

f). System Testing

- After all the **modules** have been **successfully integrated and tested**:
  - system testing is carried out.
- Goal of system testing:
  - ensure that the developed **system functions according to its requirements** as specified in the SRS document.

g). Maintenance

- **Maintenance of any software product:**
  - requires **much more effort** than the effort to develop the product itself.
  - **development effort to maintenance effort** is typically **40:60**.

Maintenance (CONT.)

- Corrective maintenance:
  - Correct **errors** which were **not discovered** during the product **development phases**.
- Perfective maintenance:
  - **Improve implementation** of the system
  - **enhance functionalities** of the system.
- Adaptive maintenance:
  - **Port software** to a new environment,
    - e.g. to a new computer or to a new operating system.

Waterfall model

- No feedback path.
- Difficult to accommodate change request.
- Inefficient error corrections.
- No overlapping of phases.

(2) Iterative Waterfall Model

- Classical waterfall model is **idealistic**:
  - assumes that **no defect** is introduced during any development activity.
  - in practice:
    - defects do get introduced in **almost every phase of the life cycle**.

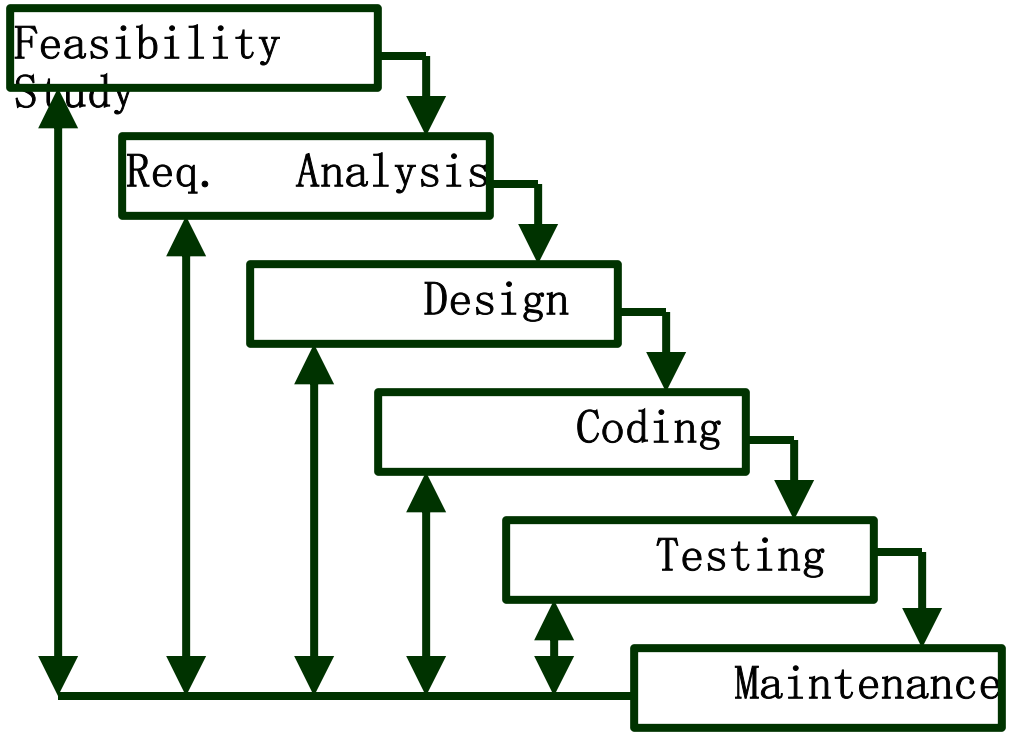
Iterative Waterfall Model (CONT.)

- Defects usually get **detected much later** in the life cycle:
  - For example, **a design defect** might go unnoticed till the **coding or testing phase**.

Iterative Waterfall Model (CONT.)

- Once a defect is detected:
  - we need to **go back to the phase** where it was introduced
- Therefore we need **feedback paths** in the **classical waterfall model.**

Iterative Waterfall Model (CONT.)



Iterative Waterfall Model (CONT.)

- **Errors should be detected**
  - in the same phase in which they are introduced.
- For example:
  - if a design problem is detected in the design phase itself

Phase containment of errors

- Reason: **rework** must be carried out **not only to the design** but also to code and test phases.
- The principle of **detecting errors** as close to its point of **commitment** as possible:
  - is known as phase containment of errors.
- Iterative waterfall model is by far the **most widely used model.**
  - **Almost every other model is derived** from the waterfall model.

3).Prototyping Model

- Before **starting actual development**,
  - a **working prototype** of the system should first be built.
- A prototype is **a toy implementation** of a system.

Reasons for developing a prototype

- **Illustrate** to the customer:
  - input data formats, messages, reports, or interactive dialogs.
- **Examine technical issues** associated with product development:
  - Often major design decisions depend on issues like:
    - response time of a hardware controller,
    - efficiency of a sorting algorithm, etc.

Prototyping Model (CONT.)

- The third reason for developing a prototype is:
  - it is impossible to ``**get it right**'' the first time.

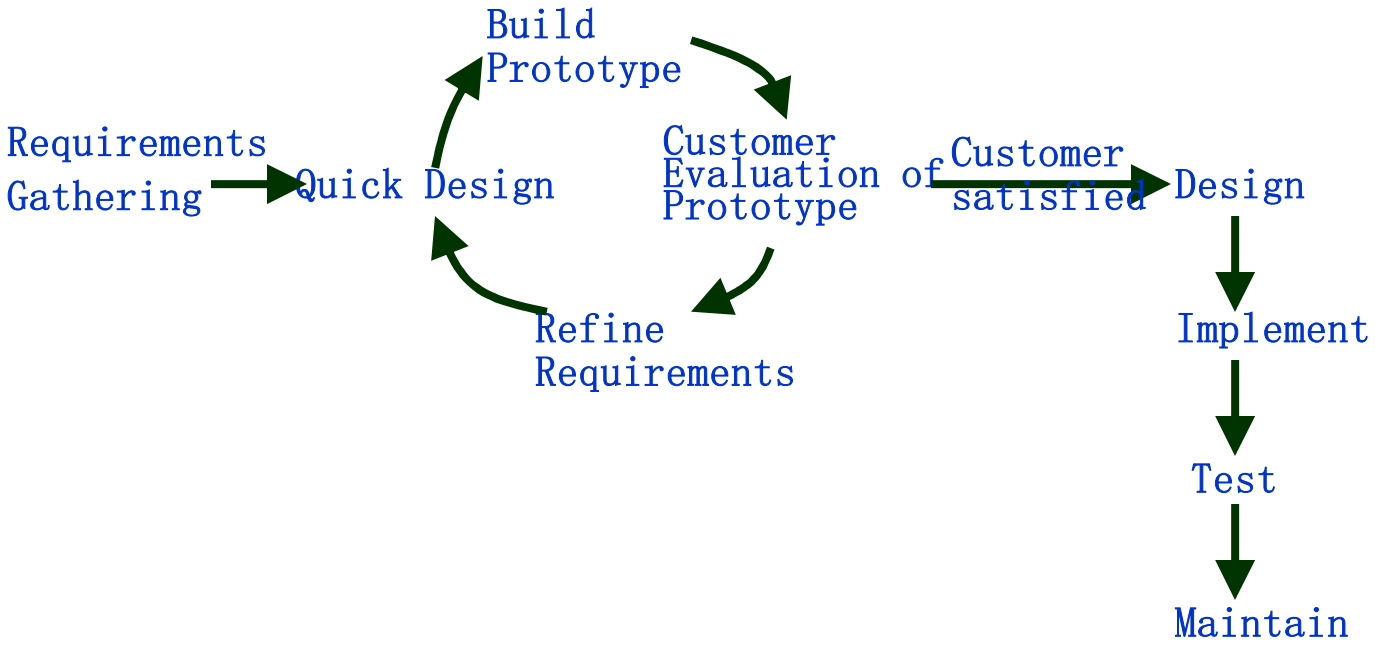
Prototyping Model (CONT.)

- Start with **approximate requirements**.
- Carry out a **quick design**.
- Prototype model is built using **several short-cuts**:

Prototyping Model (CONT.)

- The **developed prototype** is **submitted** to the **customer** for his evaluation:
  - Based on the user **feedback**, requirements are refined.
  - This cycle continues until the **user approves the prototype**.
- The actual system is developed using the classical waterfall approach.

Prototyping Model (CONT.)



Prototyping Model (CONT.)

- **Requirements analysis** and **specification ph**ase

  becomes redundant.

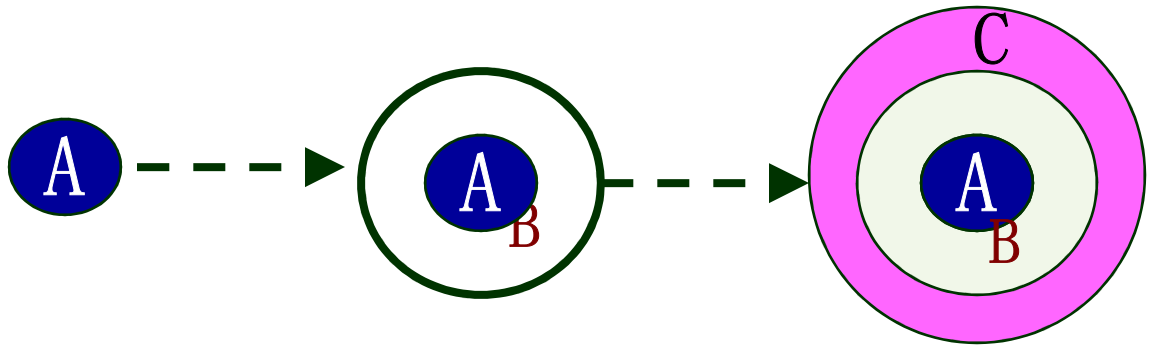
Prototyping Model (CONT.)

- Even though construction of a **working prot**otype model involves **additional cost**
- Many **user requirements get properly defined** and technical issues get resolved.

4).Evolutionary Model

- Evolutionary model (aka successive versions or **incremental model**):
  - The **system is broken** down into several **modules** which can be **incrementally implemented and delivered**.
- First **develop** the **core modules** of the system.

Evolutionary Model (CONT.)



Advantages of Evolutionary Model

- Users get a chance to **experiment with a partially developed system**:
  - much before the **full working version is released**,
- Helps **finding exact user requirements**:
  - much before fully working system is developed.
- Core modules get tested thoroughly:
  - **reduces chances of errors** in final product.

Disadvantages of Evolutionary Model

- Often, **difficult to subdivide** problems into functional units:
  - evolutionary model is useful for **very large problems,**
    - where it is easier to find modules for incremental implementation.

Evolutionary Model with Iteration

- Many organizations use a **combination of iterative and incremental development**:
  - a new release may include new functionality
  - existing functionality from the current release may also have been modified.

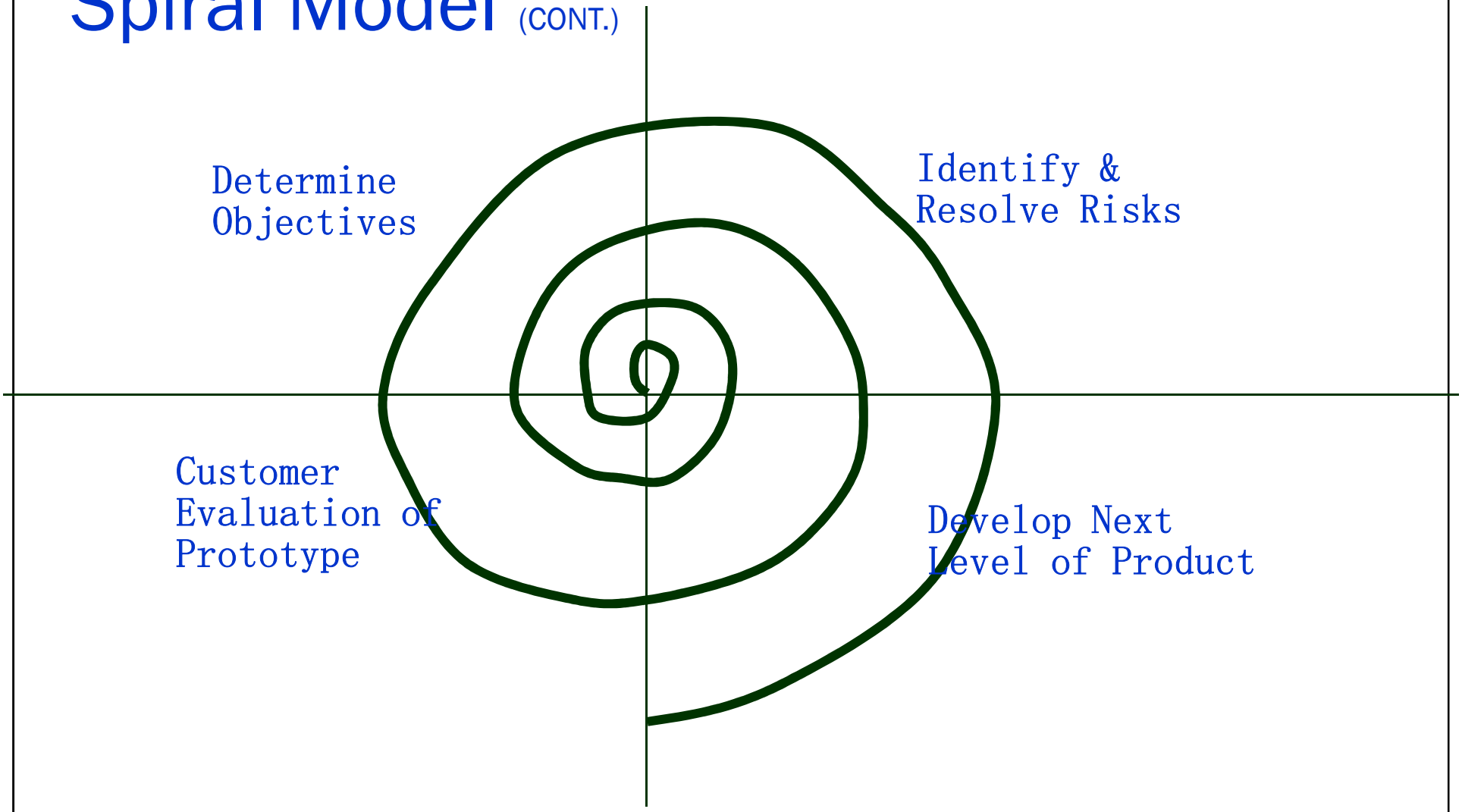
Evolutionary Model with iteration

- Several advantages:
  - **Training can start** on an earlier release
    - **customer feedback** taken into account
  - Markets can be created:
    - for functionality that has never been offered.
  - **Frequent releases** allow developers to fix unanticipated problems quickly.

5).Spiral Model

- Proposed by Boehm in 1988.
- Each **loop of the spiral** represents a **phase** of the software process:
  - the **innermost loop** might be concerned with **system feasibility**,
  - the **next loop** with system **requirements definition,**
  - the next one with **system design**, and so on.
- There are **no fixed phases** in this model, the phases shown in the figure are just examples.

Spiral Model (CONT.)



Objective Setting (First Quadrant)

- **Identify objectives** of the phase,
- **Examine the risks** associated with these objectives.
- **Find alternate solutions** possible.

Risk Assessment and Reduction (Second Quadrant)

- For each identified project risk,
  - a **detailed analysis** is carried out.
- Steps are taken **to reduce the risk.**

Spiral Model (CONT.)

- Development and Validation (Third quadrant):
  - **develop and validate** the next level of the product.
- Review and Planning (Fourth quadrant):
  - **review the results** achieved so far with the customer and plan the next iteration around the spiral.
- With each iteration around the spiral:
  - progressively more complete version of the software gets built.

Spiral Model as a meta model

- **Subsumes all discussed models:**
  - a **single loop spiral** represents **waterfall model.**
  - **uses** an **evolutionary a**pproach **--**
    - iterations through the spiral are evolutionary levels.
  - enables **understanding and reacting to risks during each iteration** along the spiral.
  - uses:
    - **prototyping as a risk reduction** mechanism
    - retains the step-wise approach of the waterfall model.

Comparison of Different Life Cycle Models

- Iterative waterfall model
  - most **widely used model**.
  - But, suitable only for well-understood problems.
- Prototype model is suitable for projects not well understood:
  - **user requirements**
  - technical aspects

Comparison of Different Life Cycle Models
(CONT.)

- Evolutionary model is suitable **for large problems**:
  - can be decomposed into a set of modules that can be incrementally implemented,
  - incremental delivery of the system is acceptable to the customer.
- The spiral model:
  - suitable for development of **technically challenging software products** that are subject to several kinds of risks.


THANK
YOU!