"You've got to be very careful if you don't know where you're going, because you might not get there."

Yogi Berra

Thanks to Professor Kirstie Hawkey for providing these slides!

SOFTWARE DEVELOPMENT LIFE CYCLE (SDLC)

There is no Silver Bullet

Primary thing to remember with SDLC methods!

It does NOT mean that there is no one method that will work in all cases

It means: "*There is no single development, in either technology or management technique, which by itself promises even one order-of-magnitude improvement within a decade in productivity, in reliability, in simplicity*"

Fred Brooks, No Silver Bullet -- Essence and Accident in Software Engineering, *Proceedings of the IFIP Tenth World Computing Conference*: 1069–1076, 1986

SDLC Model

A framework that describes the activities performed at each stage of a software development project.

Aside: You Own a Construction Company

- Not a small one – you build skyscrapers
- Do you just start pouring concrete for the foundation or do you do a lot of planning? Why?

Aside: You Own a Construction Company

- You may have built skyscrapers before, but each one is effectively custom built.
- Clients are paying a lot of money
- You're paying a lot of money
  - Materials and labor, among other costs
- Once you've started, it's going to be very difficult to change things up

Aside: You Own a Construction Company

- What if the customer doesn't like the finished product?
  - For that matter, how will the customer anticipate the finished product?
  - For that matter, how do you know what the customer wants in the first place?
    - They might actually want things that are different than what they think they want
      - And may not realize until it's built

Aside: You Own a Construction Company

- If you've built similar buildings before, then you might have a good idea of the time and cost

Aside: You Own a Construction Company

But what if this building requires things that have never been done before?

Aside: You Own a Construction Company

But what if this building requires things that have never been done before?

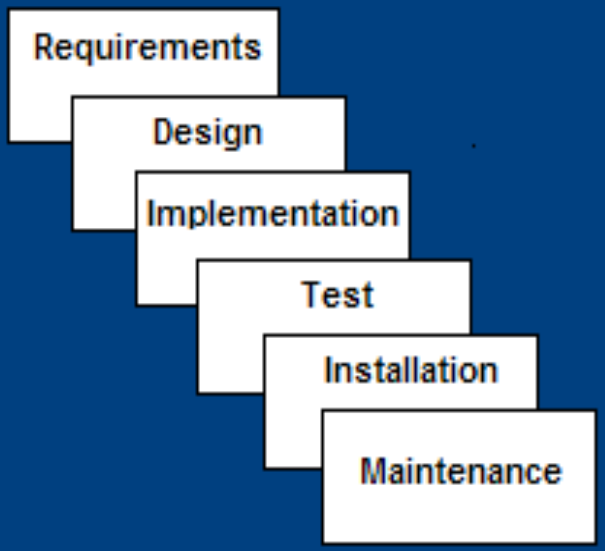
Aside: You Own a Construction Company

But what if this building requires things that have never been done before?

Aside: You Own a **Software** Company

- What makes you think that software doesn't have many of the same issues?
- It does. So when building large software, you had better have a good development model!
  - It's no guarantee
  - But it greatly increases the likelihood of a successful project

Waterfall Model



Requirements – defines needed information, function, behavior, performance and interfaces.

Design – data structures, software architecture, interface representations, algorithmic details.

Implementation – source code, database, user documentation, testing.

BRAND CAMP

by Tom Fishburne

THE NEW PRODUCT WATERFALL

HOW DO WE CHART OUR ENTIRE COURSE IF WE DON'T KNOW WHAT'S AHEAD?

PLAN

WHATEVER HAPPENS, JUST KEEP PADDLING!

BUILD

I WISH WE'D DESIGNED FOR THIS SCENARIO UPFRONT

TEST

PATCH IT AS BEST WE CAN. NO TIME TO CHANGE COURSE NOW

LAUNCH

TOMFISHBURNE.COM

Waterfall Strengths

- Easy to understand, easy to use
- Provides structure to inexperienced staff
- Milestones are well understood
- Sets requirements stability
- Good for management control (plan, staff, track)
- Works well when quality is more important than cost or schedule

Waterfall Deficiencies

- All requirements must be known upfront
- Deliverables created for each phase are considered frozen – inhibits flexibility
- Can give a false impression of progress
- Does not reflect problem-solving nature of software development – iterations of phases
- Integration is one big bang at the end
- Little opportunity for customer to preview the system (until it may be too late)

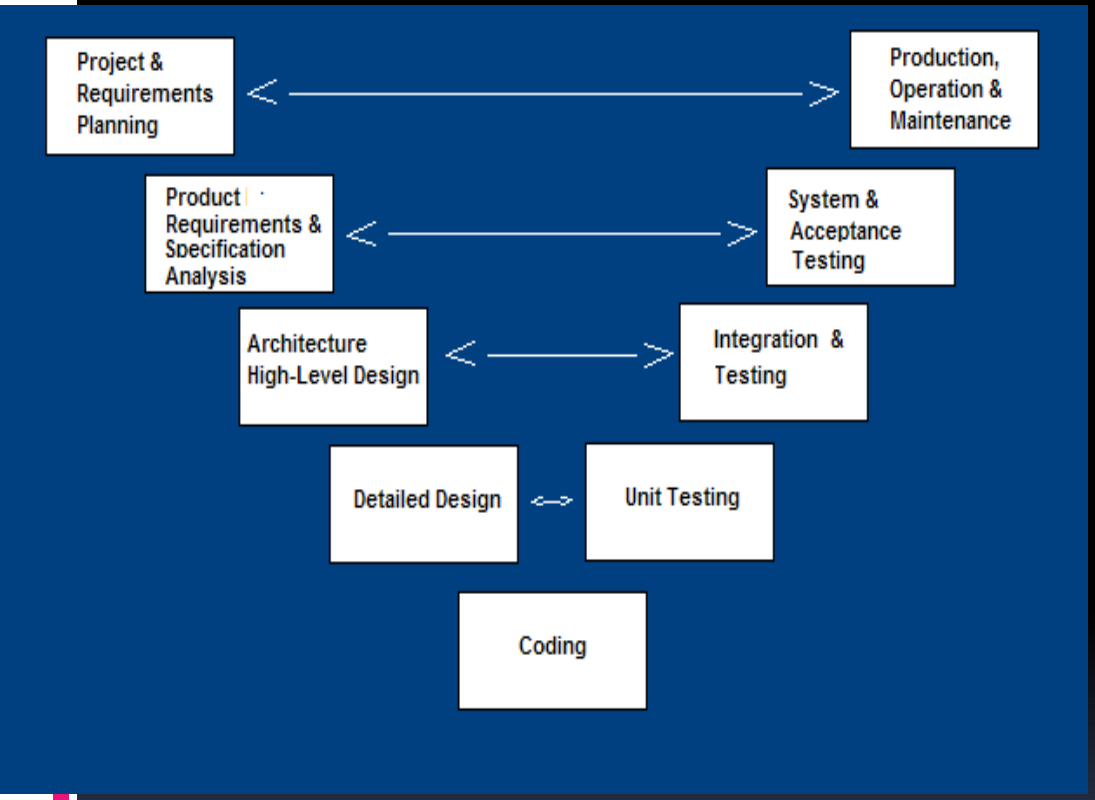
When to use the Waterfall Model

Requirements are very well known
Product definition is stable
Technology is understood
New version of an existing product
Porting an existing product to a new platform.

High risk for new systems because of specification and design problems.

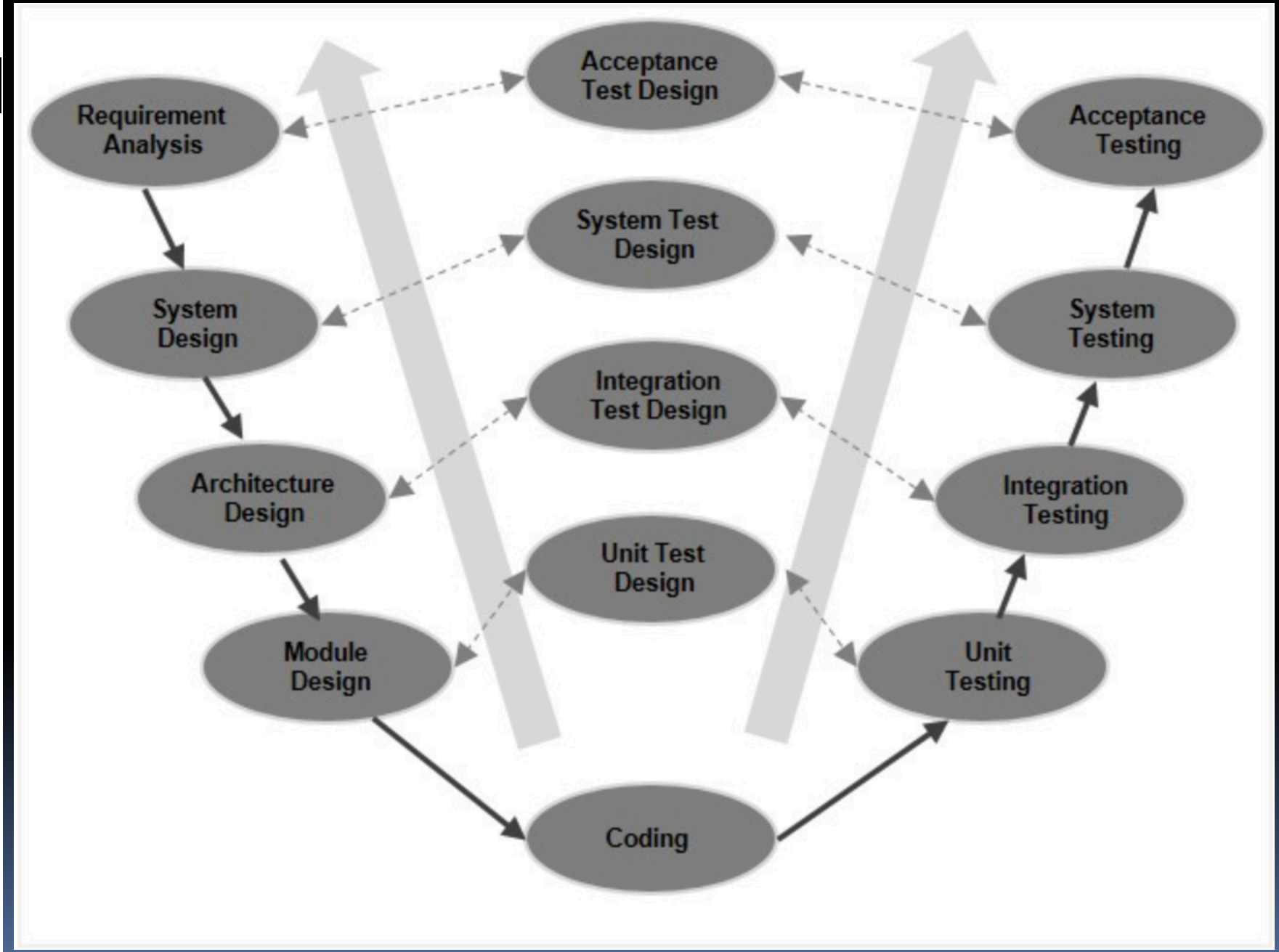
Low risk for well-understood developments using familiar technology.

V-Shaped SDLC Model



A variant of the Waterfall that emphasizes the verification and validation of the product.

Testing of the product is planned in parallel with a corresponding phase of development


Acceptance Test Design
Requirement Analysis
Acceptance Testing
System Test Design
System Design
System Testing
Integration Test Design
Architecture Design
Integration Testing
Unit Test Design
Module Design
Unit Testing
Coding

V-Shaped Steps

Project and Requirements Planning – allocate resources

Product Requirements and Specification Analysis – complete specification of the software system

Architecture or High-Level Design – defines how software functions fulfill the design

Detailed Design – develop algorithms for each architectural component

Coding – transform algorithms into software

Unit testing – check that each module acts as expected

Integration and Testing – check that modules interconnect correctly

System and acceptance testing – check the entire software system in its environment

Production, operation and maintenance – provide for enhancement and corrections

V-Shaped Strengths

- Emphasize planning for verification and validation of the product in early stages of product development
- Each deliverable must be testable
- Project management can track progress by milestones
- Easy to use

V-Shaped Weaknesses

- Does not easily handle concurrent events
  - Saw this 100 times. No one says why this is with any specificity
- Does not handle iterations or phases
- Does not easily handle dynamic changes in requirements
  - Like Waterfall model, not flexible
- Does not contain risk analysis activities

When to use the V-Shaped Model

- Excellent choice for systems requiring high reliability – hospital patient control applications
- All requirements are known up-front
- When it can be modified to handle changing requirements beyond analysis phase
- Solution and technology are known

Protoyping: Basic Steps

- Identify basic requirements
  - Including input and output info
  - Details (e.g., security) generally ignored
    - That's not a good thing, but not unique to prototyping
- Develop initial prototype
  - UI first
- Review
  - Customers/end –users review and give feedback
- Revise and enhance the prototype & specs
  - Negotiation about scope of contract may be necessary

Dimensions of prototyping

- Horizontal prototype
  - Broad view of entire system/sub-system
  - Focus is on user interaction more than low-level system functionality (e.g., database access)
  - Useful for:
    - Confirmation of UI requirements and system scope
    - Demonstration version of the system to obtain buy-in from business/customers
    - Develop preliminary estimates of development time, cost, effort

Dimensions of Prototyping

- Vertical prototype
  - More complete elaboration of a single sub-system or function
  - Useful for:
    - Obtaining detailed requirements for a given function
    - Refining database design
    - Obtaining info on system interface needs
    - Clarifying complex requirements by drilling down to actual system functionality

Types of prototyping

- Throwaway/rapid/close-ended prototyping
  - Creation of a model that will be discarded rather than becoming part of the final delivered software
  - After preliminary requirements gathering, used to visually show the users what their requirements may look like when implemented
- Focus is on quickly developing the model
  - focus is not on good programming practices
  - Can Wizard of Oz things

Wizard of Oz Prototyping

Requires three things:

- Script: tells what is to take place
- Person: Acts as end user
- Human “wizard”: simulates the end product

Person may not know that the “software” is actually a human simulating behavior

WOZ name comes from Toto pulling back curtain to reveal Wizard is actually a person pulling levers

Wizard of Oz Prototyping

Purpose is to improve user experience (UX)

Fidelity of Protype

- Low-fidelity
  - Paper/pencil
    - Mimics the functionality, but does not look like it
- Often implemented with interpreted scripting language (e.g., Python)
  - Goal is not typically optimization at this stage

Fidelity of Protype

- Medium to High-fidelity
  - GUI builder
  - “Click dummy” prototype – looks like the system, but does not provide the functionality
  - Or provide functionality, but have it be general and not linked to specific data

http://www.youtube.com/watch?v=VGjcFouSlpk

http://www.youtube.com/watch?v=5oLlmNbxap4&feature=related

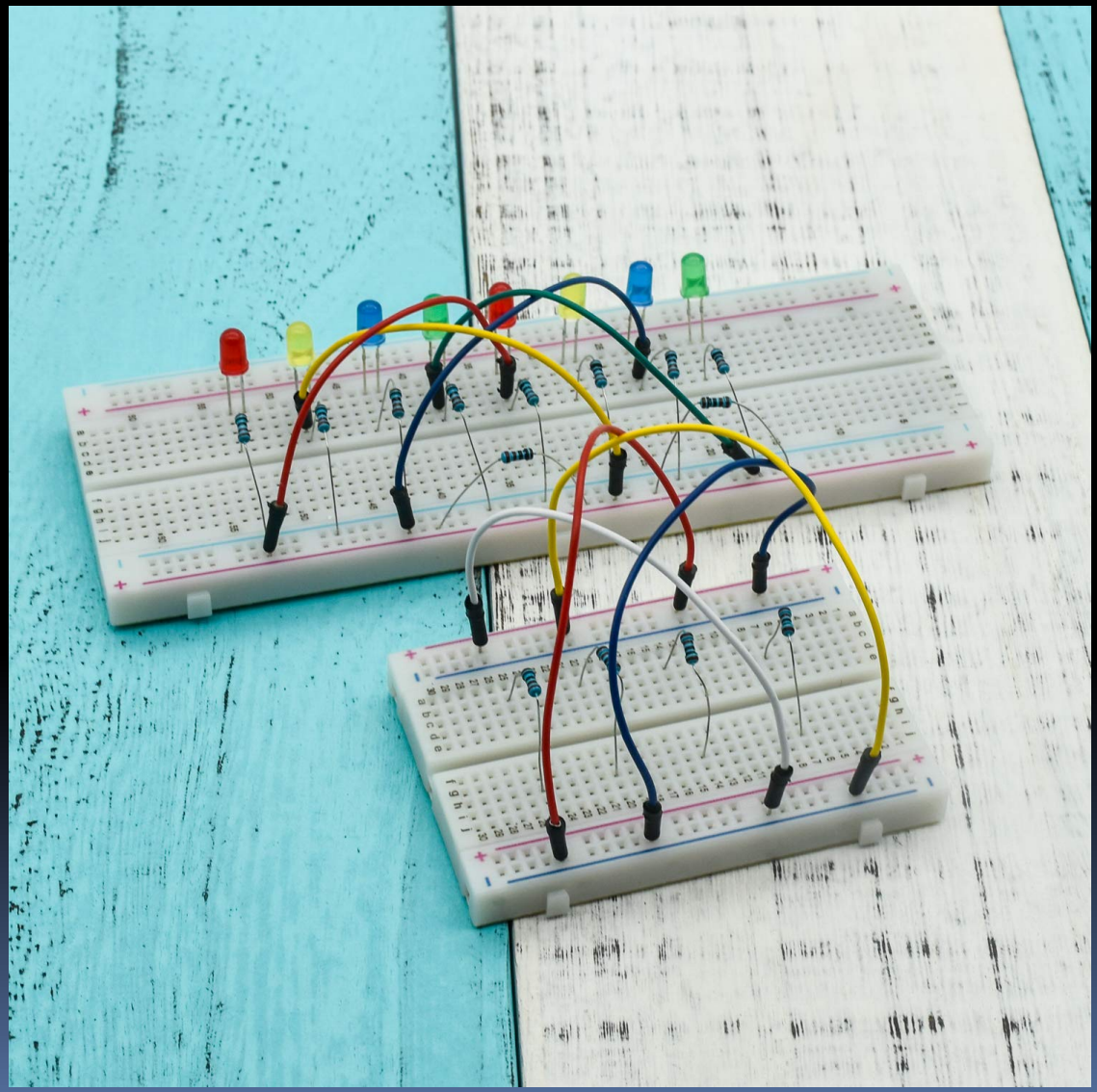
Throwaway Prototyping steps

- Write preliminary requirements
- Design the prototype
- User experiences/uses the prototype, specifies new requirements
- Repeat if necessary
- Write the final requirements
- Develop the real products

Evolutionary Prototyping

- A.k.a breadboard prototyping
  - (analogous to electronics breadboard)
- Goal is to build a very robust prototype in a structured manner and constantly refine it
- The evolutionary prototype forms the heart of the new system and is added to and refined
- Allow the development team to add features or make changes that were not conceived in the initial requirements

Evolutionary Prototyping



Evolutionary Prototyping Model

- Developers build a prototype during the requirements phase
- Prototype is evaluated by end users
- Users give corrective feedback
- Developers further refine the prototype
- When the user is satisfied, the prototype code is brought up to the standards needed for a final product.

EP Steps

- A preliminary project plan is developed
- A partial high-level paper model is created
- The model is source for a partial requirements specification
- A prototype is built with basic and critical attributes
- The designer builds
  - the database
  - user interface
  - algorithmic functions
- The designer demonstrates the prototype, the user evaluates for problems and suggests improvements.
- This loop continues until the user is satisfied

EP Strengths

- Customers can "see" the system requirements as they are being gathered
- Developers learn from customers
- A more accurate end product
- Unexpected requirements accommodated
- Allows for flexible design and development
- Steady, visible signs of progress produced
- Interaction with the prototype stimulates awareness of additional needed functionality

Incremental prototyping

- Final product built as separate prototypes
- At the end, the prototypes are merged into a final design

Extreme Prototyping

Often used for web applications

Development broken down into 3 phases, each based on the preceding phase

1. Static prototype consisting of HTML pages
2. Screens are programmed and fully functional using a simulated services layer
   - Fully functional UI is developed with little regard to the services, other than their contract
3. Services are implemented

Prototyping advantages

- Reduced time and cost
  - Can improve the quality of requirements and specifications provided to developers
    - Early determination of what the user really wants can result in faster and less expensive software
- Improved/increased user involvement
  - User can see and interact with the prototype, allowing them to provide better/more complete feedback and specs
  - Misunderstandings/miscommunications revealed
  - Final product more likely to satisfy their desired look/feel/performance

Disadvantages of prototyping 1

- Insufficient analysis
  - Focus on limited prototype can distract developers from analyzing complete project
    - Think of house with lots of “add ons”
  - May overlook better solutions
  - Conversion of limited prototypes into poorly engineered final projects that are hard to maintain
  - Limited functionality may not scale well if used as the basis of a final deliverable
    - May not be noticed if developers too focused on building prototype as a model

Disadvantages of prototyping 2

- User confusion of prototype and finished system
  - Users can think that a prototype (intended to be thrown away) is actually a final system that needs to be polished
    - Unaware of the scope of programming needed to give prototype robust functionality
  - Users can become attached to features included in prototype for consideration and then removed from final specification
    - Especially problematic if those features turn out to be difficult/impossible to implement at production quality (e.g., required infrastructure unavailable)

Disadvantages of prototyping 3

- Developer attachment to prototype
  - If spend a great deal of time/effort to produce, may become attached
  - Might try to attempt to convert a limited prototype into a final system
    - Bad if the prototype does not have an appropriate underlying architecture

Disadvantages of prototyping 4

- Excessive development time of the prototype
  - Prototyping supposed to be done quickly
  - If developers lose sight of this, can try to build a prototype that is too complex
  - For throw away prototypes, the benefits realized from the prototype (precise requirements) may not offset the time spent in developing the prototype — expected productivity reduced
  - Users can be stuck in debates over prototype details and hold up development process

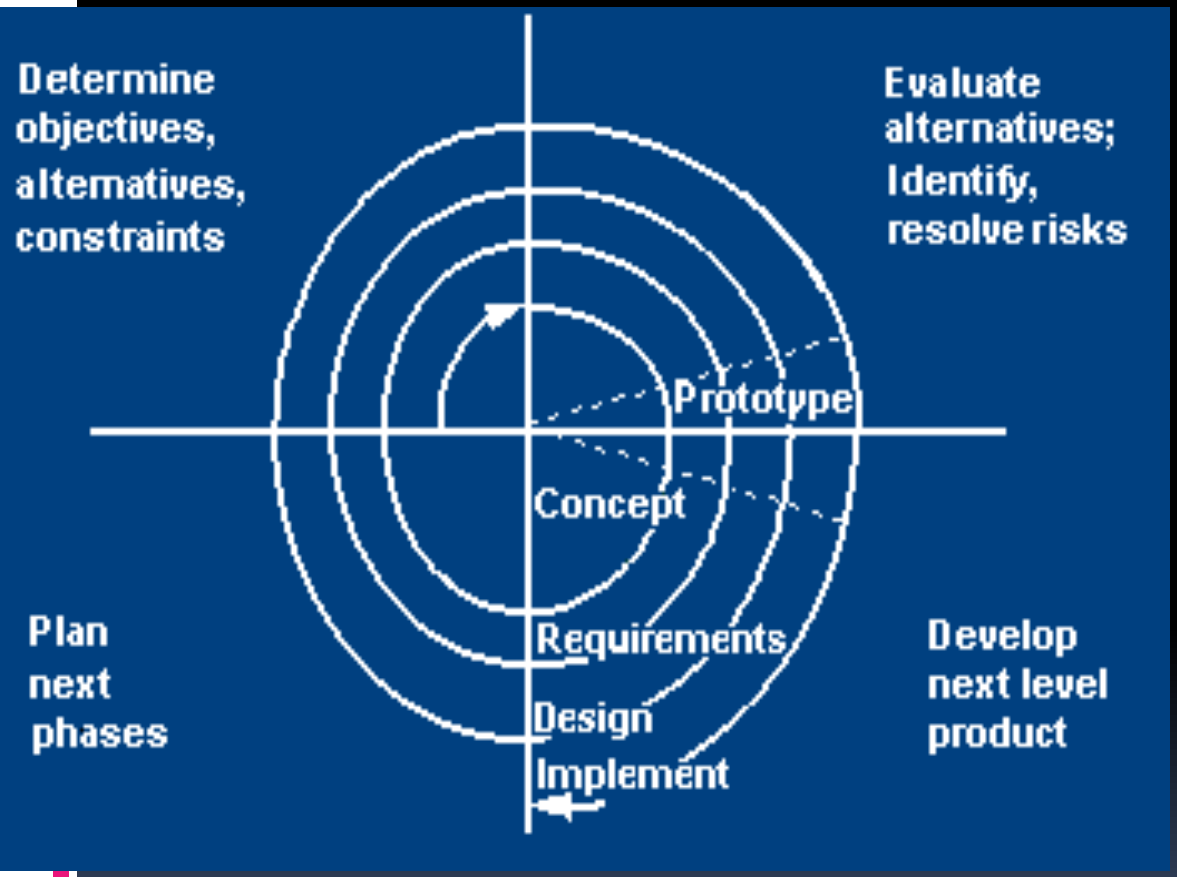
Disadvantages of prototyping 5

- Expense of implementing prototyping
  - Start up costs of prototyping may be high
  - Expensive to change development methodologies in place (re-training, re-tooling)
  - Slow development if proper training not in place
    - High expectations for productivity unrealistic if insufficient recognition of the learning curve
  - Lower productivity can result if overlook the need to develop corporate and project specific underlying structure to support the technology

Best uses of prototyping

- Most beneficial for systems that will have many interactions with end users
- The greater the interaction between the computer and the user, the greater the benefit of building a quick system for the user to play with
- Especially good for designing good human-computer interfaces

Spiral SDLC Model



Adds risk analysis, and 4gl RAD prototyping to the waterfall model

Each cycle involves the same sequence of steps as the waterfall process model

4gl = “fourth generation language”
RAD = “Rapid Application Development” (e.g., rapid prototyping)

Aside: Generation Languages

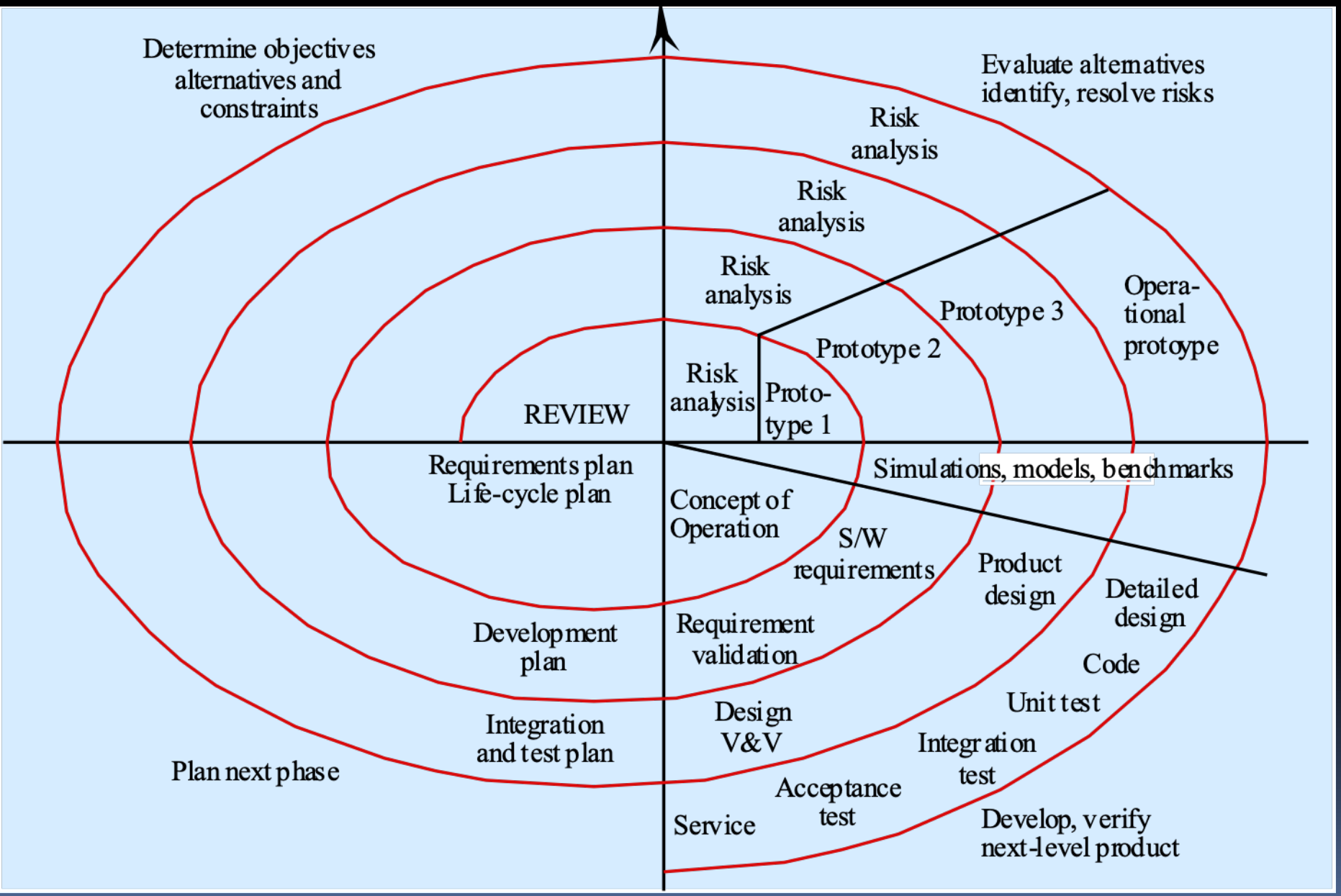
First generation (1gl): Machine language

2gl: Low-level assembly language: hardware dependent

3gl: High-level languages: C, C++, Java, Javascript, Visual Basic

4gl: Statements similar to statements in a human language: Perl, Python, PHP, Ruby, SQL

5gl: Programming languages that contain visual tools to help develop a program: Mercury, OPS5, Prolog


Determine objectives alternatives and constraints
Evaluate alternatives identify, resolve risks
Risk analysis
Risk analysis
Risk analysis
Risk analysis
Prototype 3
Opera-tional protoype
Prototype 2
Proto-type 1
REVIEW
Requirements plan Life-cycle plan
Simulations, models, benchmarks
Concept of Operation
S/W requirements
Product design
Detailed design
Development plan
Requirement validation
Code
Unit test
Design V&V
Integration and test plan
Integration test
Acceptance test
Plan next phase
Service
Develop, verify next-level product

Spiral Quadrant: Determine objectives, alternatives and constraints

Objectives: functionality, performance, hardware/software interface, critical success factors, etc.

Alternatives: build, reuse, buy, sub-contract, etc.

Constraints: cost, schedule, interface, etc.

Spiral Quadrant: Evaluate alternatives, identify and resolve risks

- Study alternatives relative to objectives and constraints
- Identify risks: lack of experience, new technology, tight schedules, poor process, etc.
- Resolve risks: evaluate if money could be lost by continuing system development

Spiral Quadrant: Develop next-level product

Typical activites:

- Create a design
- Review design
- Develop code
- Inspect code
- Test product

Spiral Quadrant: Plan next phase

Typical activities

- Evaluate already developed project
- Develop project plan
- Develop configuration management plan
- Develop a test plan
- Develop an installation plan
- Develop plan for next spiral

Spiral Model Strengths

- Provides early indication of insurmountable risks, without much cost
- Users see the system early because of rapid prototyping tools
- Critical high-risk functions are developed first
- The design does not have to be perfect
- Users can be closely tied to all lifecycle steps
- Early and frequent feedback from users
- Cumulative costs assessed frequently

Spiral Model Weaknesses

- Time spent for evaluating risks too large for small or low-risk projects
- Time spent planning, resetting objectives, doing risk analysis and prototyping may be excessive
- The model is complex
- Risk assessment expertise is required
- Spiral may continue indefinitely
- Developers must be reassigned during non-development phase activities
- May be hard to define objective, verifiable milestones that indicate readiness to proceed through the next iteration

When to use Spiral Model

- When creation of a prototype is appropriate
- When costs and risk evaluation is important
- For medium to high-risk projects
- Long-term project commitment unwise because of potential changes to economic priorities
- Users are unsure of their needs
- Requirements are complex
- New product line
- Significant changes are expected (research and exploration)

The Rise and Fall of Waterfall

http://www.youtube.com/watch?v=X1c2--sP3o0&NR=1&feature=fvwp

Warning: bad language at 3:50! (hands over ears if easily offended!)

AGILE SOFTWARE DEVELOPMENT LIFE CYCLES

Agile SDLC's

- Speed up or bypass one or more life cycle phases
- Usually less formal and reduced scope
- Used for time-critical applications
- Used in organizations that employ disciplined methods

Some Agile Methods

- Rapid Application Development (RAD)
- Incremental SDLC
- Scrum
- Extreme Programming (XP)
- Adaptive Software Development (ASD)
- Feature Driven Development (FDD)
- Crystal Clear
- Dynamic Software Development Method (DSDM)
- Rational Unify Process (RUP)

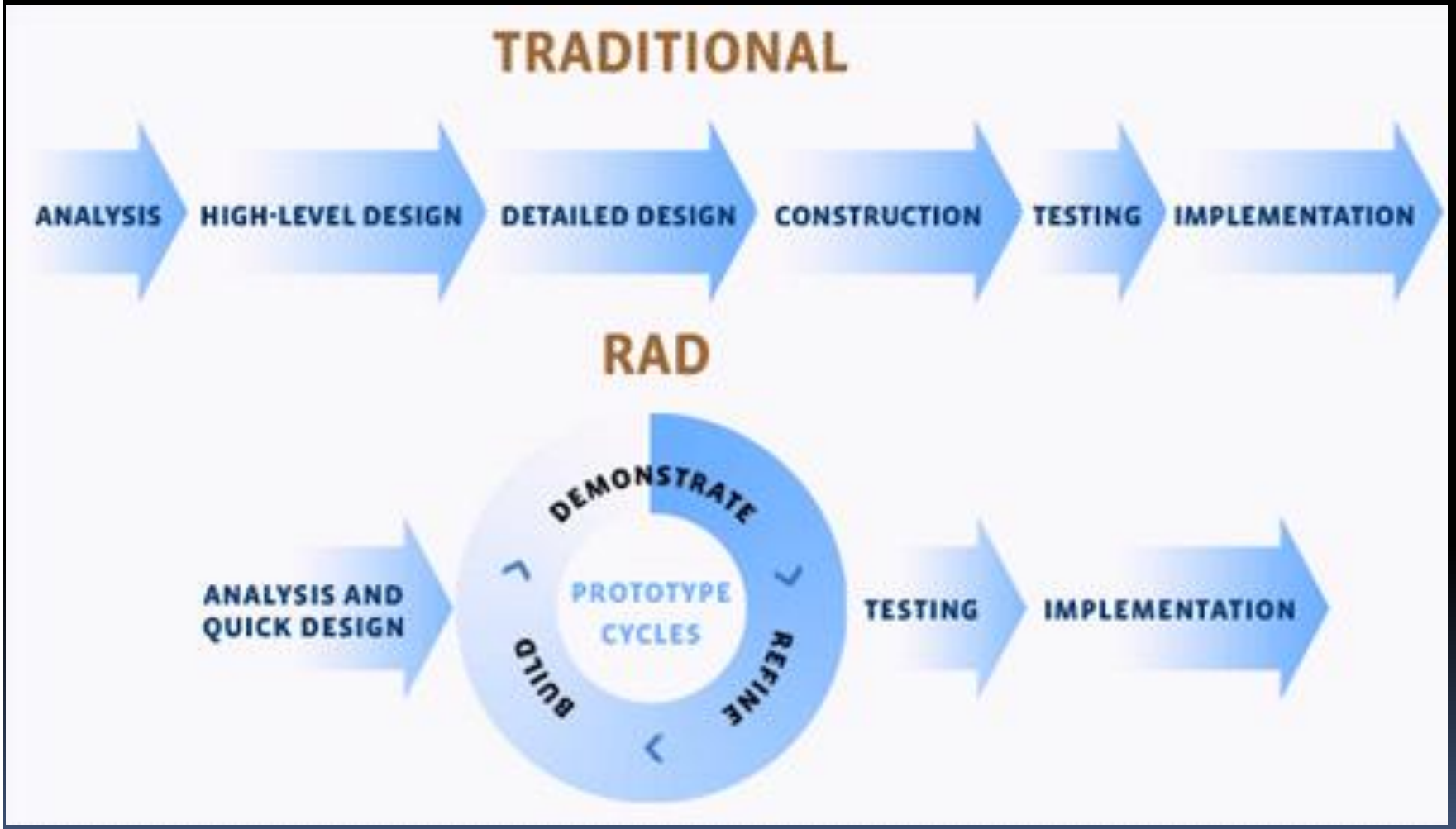
Agile vs Waterfall Propaganda

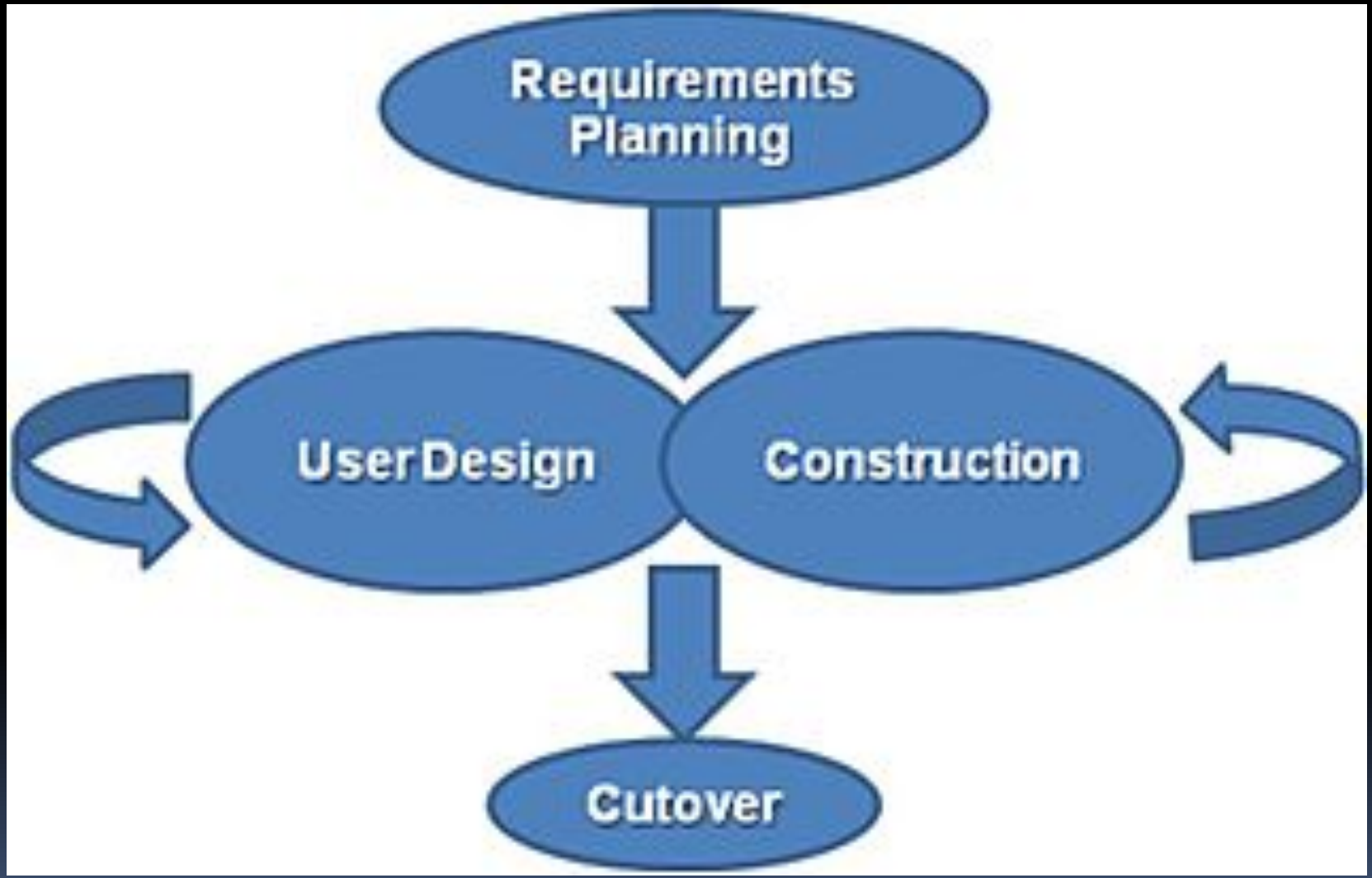
https://www.youtube.com/watch?v=CKD9nWVsDzc

RAPID APPLICATION DEVELOPMENT (RAD) MODEL

RAD is **not** Rapid Prototyping

- Rapid application development (RAD)is a method for rapidly developing the final product
  - As the title implies, you are rapidly developing the application
- Rapid prototyping uses a throwaway prototype in order to better learn the needs/requirements of the user


TRADITIONAL
ANALYSIS
HIGH-LEVEL DESIGN
DETAILED DESIGN
CONSTRUCTION
TESTING
IMPLEMENTATION
RAD
ANALYSIS AND QUICK DESIGN
DEMONSTRATE
REFINE
BUILD
PROTOTYPE CYCLES
TESTING
IMPLEMENTATION


Requirements Planning
User Design
Construction
Cutover

Rapid Application Model (RAD)

Requirements planning phase (a workshop utilizing structured discussion of business problems)

User description phase – automated tools capture information from users

Construction phase – productivity tools, such as code generators, screen generators, etc. inside a time-box. ("Do until done")

Cutover phase -- installation of the system, user acceptance testing and user training

Aside: Timeboxing

Timeboxing is a planning technique common in planning projects, where the schedule is divided into a number of separate time periods (*timeboxes*, normally two to six weeks long), with each part having its own deliverables, deadline and budget.

Aside: Timeboxing

- Timeboxes are used as a form of risk management, especially for tasks that may easily extend past their deadlines. The end date (deadline) is one of the primary drivers in the planning and should not be changed as it is usually linked to a delivery date of the product. If the team exceeds the deadline, the team failed in proper planning and/or effective execution of the plan. This can be the result of: the wrong people on the wrong job (lack of communication between teams, lack of experience, lack of commitment/ drive/motivation, lack of speed) or underestimation of the complexity of the requirements.
- When the team exceeds the deadline, the following actions might be taken after conferring with the Client:
  - Dropping requirements of lower impact (the ones that will not be directly missed by the user)
  - Working overtime to compensate for the time lost
  - Moving the deadline

Requirements Planning Phase

- Combines elements of the system planning and systems analysis phases of the System Development Life Cycle (SDLC).
- Users, managers, and IT staff members discuss and agree on business needs, project scope, constraints, and system requirements.
- It ends when the team agrees on the key issues and obtains management authorization to continue.

User Design Phase

Users interact with systems analysts and develop models and prototypes that represent all system processes, inputs, and outputs.

Typically use a combination of Joint Application Development (JAD) techniques and CASE tools to translate user needs into working models.

A continuous interactive process that allows users to understand, modify, and eventually approve a working model of the system that meets their needs.

JAD Techniques

http://en.wikipedia.org/wiki/Joint_application_design

CASE Tools

http://en.wikipedia.org/wiki/Computer-aided_software_engineering

Construction Phase

Focuses on program and application development task similar to the SDLC.

However, users continue to participate and can still suggest changes or improvements as actual screens or reports are developed.

Its tasks are programming and application development, coding, unit-integration, and system testing.

Cutover Phase

- Resembles the final tasks in the SDLC implementation phase.
- Compared with traditional methods, the entire process is compressed. As a result, the new system is built, delivered, and placed in operation much sooner.
- Tasks are data conversion, full-scale testing, system changeover, user training.

RAD Strengths

- Reduced cycle time and improved productivity with fewer people means lower costs
- Time-box approach mitigates cost and schedule risk
- Customer involved throughout the complete cycle minimizes risk of not achieving customer satisfaction and business needs
- Focus moves from documentation to code (WYSIWYG).
- Uses modeling concepts to capture information about business, data, and processes.

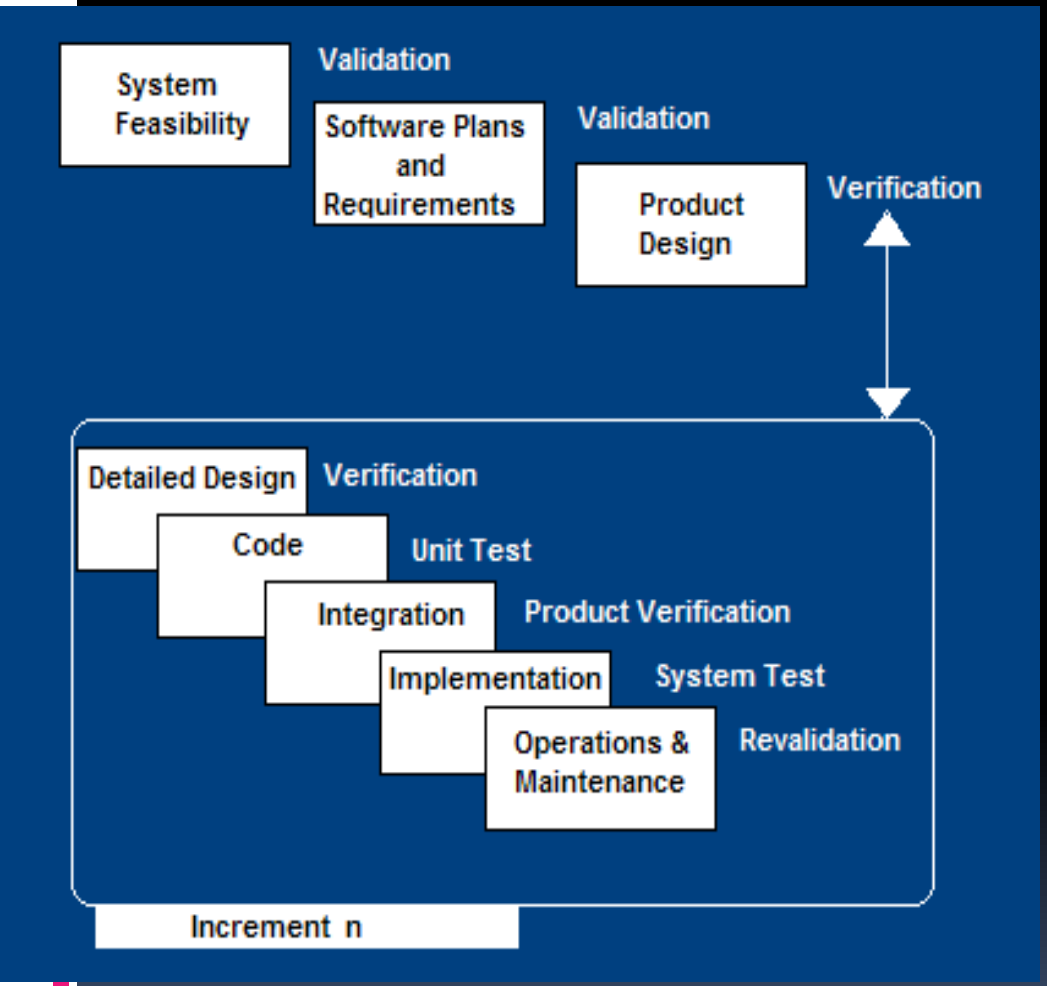
RAD Weaknesses

- Accelerated development process must give quick responses to the user
- Risk of never achieving closure
- Hard to use with legacy systems
- Requires a system that can be modularized
- Developers and customers must be committed to rapid-fire activities in an abbreviated time frame.

When to use RAD

- Reasonably well-known requirements
- User involved throughout the life cycle
- Project can be time-boxed
- Functionality delivered in increments
- High performance not required
- Low technical risks
- System can be modularized

Incremental SDLC Model



Construct a partial implementation of a total system

Then slowly add increased functionality

The incremental model prioritizes requirements of the system and then implements them in groups.

Each subsequent release of the system adds function to the previous release, until all designed functionality has been implemented.

Incremental Model Strengths

Develop high-risk or major functions first

Each release delivers an operational product

Customer can respond to each build

Uses "divide and conquer" breakdown of tasks

Lowers initial delivery cost

Initial product delivery is faster

Customers get important functionality early

Risk of changing requirements is reduced

Incremental Model Weaknesses

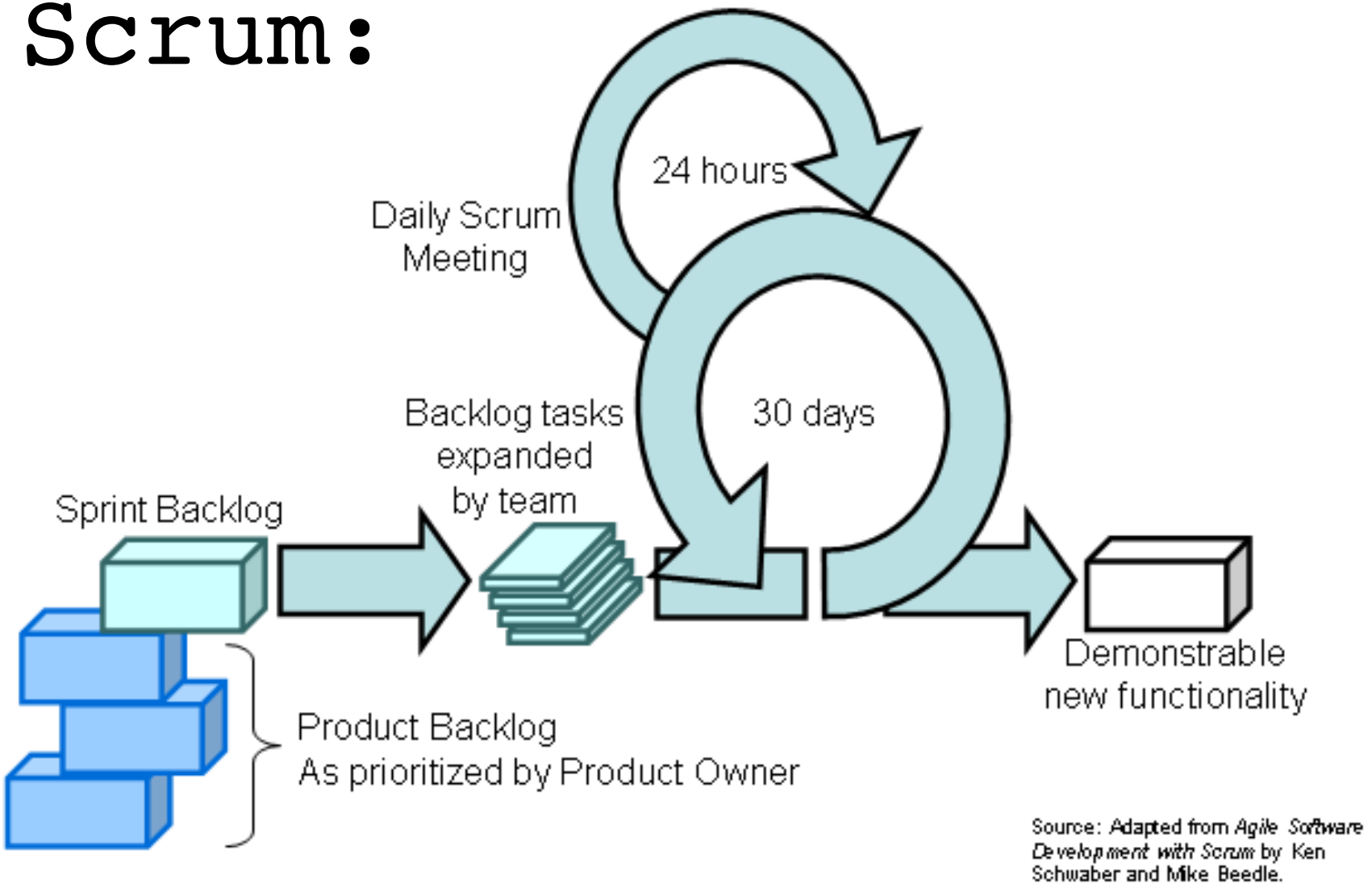
- Requires good planning and design
- Requires early definition of a complete and fully functional system to allow for the definition of increments
- Well-defined module interfaces are required (some will be developed long before others)
- Total cost of the complete system is not lower

When to use the Incremental Model

- Risk, funding, schedule, program complexity, or need for early realization of benefits.
- Most of the requirements are known up-front but are expected to evolve over time
- A need to get basic functionality to the market early
- On projects which have lengthy development schedules
- On a project with new technology

SCRUM

Scrum:



Source: Adapted from *Agile Software Development with Scrum* by Ken Schwaber and Mike Beedle.

Scrum in 13 seconds:

http://www.youtube.com/watch?v=9DKM9HcRnZ8&feature=related

Scrum in 10 minutes:

https://www.youtube.com/watch?v=XU0llRltyFM

More Scrum Slides

http://www.mountaingoatsoftware.com/system/presentation/file/129/Getting-Agile-With-Scrum-Cohn-NDC2010.pdf?1276712017

Scalability of scrum addressed on slides 33-35

Aside: User Stories

- Informal, general explanation of a software feature
- Written from perspective of the software user
  - Articulates how feature will provide value to the customer
  - *Not* software systems requirements

Thanks to: Max Rehkopf, “User Stories With Examples and Templates”
https://www.atlassian.com/agile/project-management/user-stories

Aside: User Stories

- User story effectively puts end user at the center of the development conversation
- Non-technical language provides context for the development team
  - The team learns why they are building a feature, what they are building, and the value it creates

User Story Template

"As a [persona], I [want to], [so that]."

"As a [persona]": Who are we building this for? We're not just after a job title, we're after the persona of the person. Max. Our team should have a shared understanding of who Max is. We've hopefully interviewed plenty of Max's. We understand how that person works, how they think and what they feel. We have empathy for Max.

User Story Template

"Wants to": Here we're describing their intent – not the features they use. What is it they're actually trying to achieve? This statement should be implementation free – if you're describing any part of the UI and not what the user goal is you're missing the point.

User Story Template

"So that": how does their immediate desire to do this fit into their bigger picture? What's the overall benefit they're trying to achieve? What is the big problem that needs solving?

User Story Examples

- As Max, I want to invite my friends, so we can enjoy this service together.
- As Sascha, I want to organize my work, so I can feel more in control.
- As a manager, I want to be able to understand my colleagues progress, so I can better report our sucess and failures.

When Team Decides to include story in a sprint…

- Discuss functionality and requirements the story requires
  - This is technical
- Requirements added to the story
- Often story scored on complexity
- Story broken into smaller pieces, if necessary, to fit in sprint
- Determine what “done” means, time to completion, etc.

Scrum advantages

Agile scrum helps the company in saving time and money.

Scrum methodology enables projects where the business requirements documentation is hard to quantify to be successfully developed.

Fast moving, cutting edge developments can be quickly coded and tested using this method, as a mistake can be easily rectified.

Scrum advantages

It is a lightly controlled method which insists on frequent updating of the progress in work through regular meetings. Thus there is clear visibility of the project development.

Like any other agile methodology, this is also iterative in nature. It requires continuous feedback from the user.

Due to short sprints and constant feedback, it becomes easier to cope with the changes.

Scrum advantages

Daily meetings make it possible to measure individual productivity. This leads to the improvement in the productivity of each of the team members.

Issues are identified well in advance through the daily meetings and hence can be resolved speedily

It is easier to deliver a quality product in a scheduled time.

Scrum advantages

Agile Scrum can work with any technology/ programming language but is particularly useful for fast moving web 2.0 or new media projects.

The overhead cost in terms of process and management is minimal thus leading to a quicker, cheaper result.

Scrum disadvantages

Agile Scrum is one of the leading causes of scope creep because unless there is a definite end date, the project management stakeholders will be tempted to keep demanding new functionality.

If a task is not well defined, estimating project costs and time will not be accurate. In such a case, the task can be spread over several sprints.

If the team members are not committed, the project will either never complete or fail.

Scrum disadvantages

It is good for small, fast moving projects as it works well only with small team.

This methodology needs experienced team members only. If the team consists of people who are novices, the project cannot be completed in time.

Scrum works well when the Scrum Master trusts the team they are managing. If they practice too strict control over the team members, it can be extremely frustrating for them, leading to demoralisation and the failure of the project.

Scrum disadvantages

If any of the team members leave during a development it can have a huge adverse effect on the project development

Project quality management is hard to implement and quantify unless the test team are able to conduct regression testing after each sprint.

Regression Testing

- Actually should be called (and rarely is) NON-regression testing
- Rerunning tests on previously developed and tested modules to ensure that they still perform after a change
  - If not, that is a regression