Software Models

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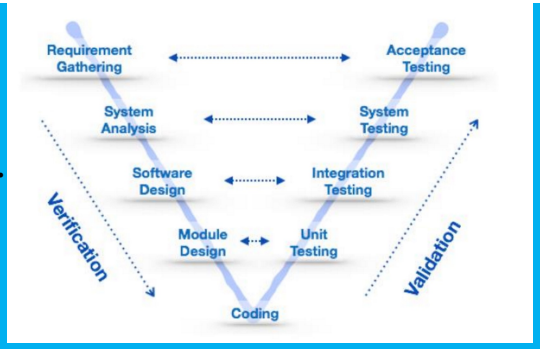
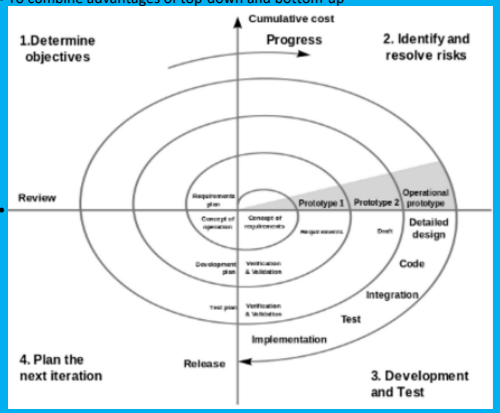
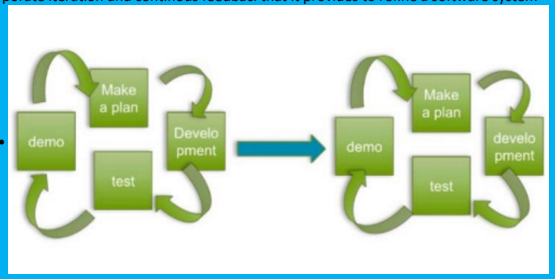
Model Type	Principles	Advantages/Most Appropriate	Disadvantages/Least Appropriate	When to use
Waterfall	1. System & Software Requirements: Captured in requirements documentation 2. Analysis: models, schema and business rules 3. Design: Software architecture is the result 4. Coding: Development, proving and integration of software 5. Testing: Structured discovery & debugging of defects 6. Operations: installation, migration, support, and maintenance of complete systems A more realistic model is the Waterfall Model with "iterative feedback loops" • Where after each step, you go back and check	• Project has clear objectives & solutions • Large and complicated • Requirements are unchanging • Required for formal approvals at designated milestones	• Large projects where requirements are not well understood or changing for any reasons • Event-driven systems • Real-time system • Can only move to next stage when previous are already completed	
Protoyping	• About creating incomplete versions of the software being developed • Basics are: • Not standalone, complete development methodology; rather an approach to try particular features in context of a full methodology • Attempts to reduce inherent risk to project by dividing it into smaller segments and ease-of-change during the development process • Client is involved during the development process; likelihood of acceptance increases of final iteration • Possible some cases to evolve from prototype to working system; some prototypes can be discarded	• Users are active in development • Working model of system is provided; user get experience with system being developed • Errors can be caught earlier • Quicker feedback is available; leads to better solutions • Missing functionality can be found easily • Confusing/difficult functions can be identified	• Leads to implementing, repairing way of building systems • Could increase the complexity of system as scope may expand beyond original plans • Incomplete application may cause app not to be used as the fully system was designed	• When desired system needs to have many interactions with end users • Online systems, web interfaces have high amount of interaction. Could take a while for system to be built that allows easy use and end user to not be trained • Ensures end users constantly work with system and provide feedback which is then implemented in the prototype to result in a useable system • Great for good human computer interface systems
Iterative & Incremental Development	• Combination of both iterative design or methods and incremental build model • Essential parts of modified waterfall models • **Incremental development** • Primary objective: reduce project risk by breaking it into smaller segments and providing more ease-of-change during the process • Three main variants 1. Series of mini-Waterfalls are performed, all Waterfalls are completed for portion of system before moving to next increment 2. Overall requirements are defined before evolving, mini-Waterfall development of individual increments of a system 3. Initial software concept, requirements analysis, design of architecture and system core are defined via Waterfall, followed by incremental implementation, which culiminates in installing final, working version	• Three benefits compared to Waterfall 1. Cost of changing customer requirements reduced. Redoing documentation & analysis less than waterfall method 2. Easier to get customer feedback on dev work; customers find it hard to judge progress from just documents 3. More rapid delivery & deployment of useful software to the customer possible, even if all it does not work; Customers able to use & gain value from software ealier than possible from waterfall	• Primary cause of difficulty: large organization wrapped up in bereaucratic red tap that evolved over time; may be a mismatch between procesdure & more informal iterative or agile process • Agile: aims at creating a "potentially shippable product"	
Reuse-oriented software engineering	• Good chunk of projects have some software reuse • Look for these, modify them as needed and corporate them into their system • Stages 1. Component analysis: Given requirements, components are searched for; usually no exact match so provide only partial functionality 2. Requirements modification: Components are analyzed, then modified to reflect available components; Where modifications are impossible analysis activity may be re started to search for alternative solutions 3. System design with reuse: Framework of system designed/existing framework is reused; components that are reused and organze the framework are catered; some new software may have be designed if resuable components are not available 4. Development & integration: Software that cannot be externally procurred is developed, and components and COTS systems are intergrated to create the new system			
The V-Model	• Means to be a testing improvement of waterfall model • Every stage, test plans and cases are created to verify product at current stage • Verification and Validation go in parallel	• Simple & Easy to use • Testing activities (planning, test designing) happen before coding; saves time	• Rigid and least flexible • Software is developed in implementation phase; no early prototypes are produced	• Small - Medium sized projects where requirements are clearly defined and fixed • When ample technical resources are

		• Proactive defect tracking; defects found early • Avoids downward flow of defects • Works well for small projects where requirements are easily understood	• Any changes midway, test documents along with requirement documents has to be updated	available with needed technical expertise • High confidence of customer is needed for choosing this model • No prototypes are produced; thus high risk in meeting customers expectations
SPIRAL	• Combines some key aspects of waterfall model and rapid prototyping • To combine advantages of top-down and bottom-up  • Radial represents cumulative cost incurred in finishing the steps to day; angular represents the progress made in completing each cycle of the spiral • Focus on risk assessment & minimize project risk by breaking project down • Evaluate risks & weigh whether project continuation throughout life cycle • Each cycle involves progression same sequence of steps for each part • Each trip around spiral traverses four quadrants 1. Determine objective, alternatives & constraints of iteration 2. Evaluate alternatives, identify and resolve risks 3. Develop & verify deliverables from iteration 4. Plan next iteration • Begin each cycle with an identification of stakeholders & "win conditions" and end each cycle with review and commitment	• Large amount of risk analysis • Good for large or mission-critical projects • Strong approval and documentation control • Additional functionality can be added at a later date • Additional functionality can be added at a later date • Software is produced early in the life cycle	• Can be a costly model to use • Risk analysis requires highly specific expertise • Project's success highly dependent on risk analysis phase • Doesn't work well for smaller projects	• When costs & risk evaluation is key • Medium to high risk projects • Long term 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

	• <table><tr><th></th><th>Risk Item</th><th>Risk Management Techniques</th></tr><tr><td>1.</td><td>Personnel shortfalls</td><td>Staffing with top talent, job matching; teambuilding; morale building; cross-training; pre-scheduling key people</td></tr><tr><td>2.</td><td>Unrealistic schedules and budgets</td><td>Detailed, multisource cost and schedule estimation; design to cost; incremental development; software reuse; requirements scrubbing</td></tr><tr><td>3.</td><td>Developing the wrong software functions</td><td>Organization analysis; mission analysis; ops-concept formulation; user surveys; prototyping; early users' manuals</td></tr><tr><td>4.</td><td>Developing the wrong user interface</td><td>Task analysis; prototyping; scenarios; user characterization (functionality, style, workload)</td></tr><tr><td>5.</td><td>Gold plating</td><td>Requirements scrubbing; prototyping; cost-benefit analysis; design to cost</td></tr><tr><td>6.</td><td>Continuing stream of requirement changes</td><td>High change threshold; information hiding; incremental development (defer changes to later increments)</td></tr><tr><td>7.</td><td>Shortfalls in externally furnished components</td><td>Benchmarking; inspections; reference checking; compatibility analysis</td></tr><tr><td>8.</td><td>Shortfalls in externally performed tasks</td><td>Reference checking; pre-award audits; award-fee contracts; competitive design or prototyping; teambuilding</td></tr><tr><td>9.</td><td>Real-time performance shortfalls</td><td>Simulation; benchmarking; modelling; prototyping; instrumentation; tuning</td></tr><tr><td>10.</td><td>Straining computer-science capabilities</td><td>Technical analysis; cost—benefit analysis; prototyping; reference checking</td></tr></table>		

RAD (Rapid Application Development)	• Favors iterative development & rapid construction of prototypes
	  • As opposed to construction of prototypes
	• Fast development & delivery of a high quality system at a relatively low invest cost
	• Attempts reduction in project risk by breaking into smaller segments & gives ease-of-change during development
	• Produce systems quickly through iterative prototyping, active user involevment, and computerized development tools
	• Emphasis on fulfilling business need; tech or engineering excellence is lesser importance
	• Project control involves focusing on dev and defining delivery deadlines or timeboxes
	  • If project starts to slip, requirments are reduced to fit timebox; not pushing deadline back
	• Includes Joing Application Design
	  • Where userrs are intensly involved in system design via consensus building in either workshops or electronically facillated interaction
	• Active user involvement is imperative
	• Iteratively produces production software, as opposed to throwaway prototype
	• Produces documentation necessary to facillitate futre development and mainteannce
	• Standard systems analysis and design methods can be fitting into this framework
		• Reduced development time
		• Increases reusability of components
		• Quick initial reviews occur
		• Encourages customer feedback
		• Integration from very beginning solves a lot of integration issues
			• Depends on strong team & individiaul performances for identifying business requirements
			• Only system that can be modualrized can be built using RAD
			• Requires highly skilled developers/designers
			• High dependency on modeling skills
			• Inapplicable to cheaper projects as cost of model and automated code generation is very high
				• When you need to make a modular system in 2-3months time
				• Should be used if high availability of designers for modeling
				• Budget high enough to afford their cost along with cost of automated code generating tools
				• Its SDLC should be chosen only if resources with high business knowledge are available and there is a need to produce the system in a short span of time

AGILE	• Uses iterative development as a basis
	  • But advocates a lighter and more people-centric viewpoint
	• Incorporate iteration and continous feedbacl that it provides to refine a software system
	• 
		• Rapid delivery of useful software brings customer satisfaction
		• People & interactions are emphasized instead of process and tools
		  • Customers, devs and testers constantly interact with eachother
		• Working software is delivered frequently
		• Face-to-face conversation best way to communicate
		• Close cooperation with business and dev
		• Continuous attention to technical excellence and good design
		• Regular adaptation to changing circumstances
		• Late changes in requirements are welcomed
			• Some deliverables (large ones) are difficult to asses the effort required at the start of the SDLC
			• Lack of emphasis on necessary desinging and documentation
			• Project can easily get off track id custom rep is not clear what final outcome they want
			• Only senior programmers are able at taking kind of decisions during dev process
			  • Hence no plan for newbie programmers, unless combined with exprienced resources
				• New changes are need to be implemented
				  • Cost little due to frequent new increments that are produced
				• Implement a new feature the dev need to lose only the work of a few days, or hours to roll back and implement
				• Unlike waterfall, limited planning is required
				  • Assumes end users' needs are ever changing
				• Both devs and stakeholder alike find they get more freedom of time and options than if software was developed in a more rigid sequential way