









But in what order? Isers?	returns/iterations/loops? Feedback fr
Construction	Modeling
	Communication
	Communication







Pros and Cons of Waterfall Model		
<ul> <li>+)</li> <li>Simple and clear</li> <li>Well-formalized</li> <li>Easy to monitor</li> </ul>		
<ul> <li><u>-</u>)</li> <li>No feedback from users (no involvement of users into SW D&amp;D)</li> <li>No flexibility in project activities</li> </ul>		
Bottom Line:		
<ul> <li>Real large-scale projects rarely follow this model because         <ul> <li>a) it requires ALL requirements to be known in advance;</li> <li>b) the working model will be available only at the very end;</li> <li>c) customers are not involved into process, etc.).</li> </ul> </li> <li>It works for <u>small-size routine projects</u> (nothing innovative in these projects)</li> </ul>		
It usually used by <u>very experienced</u> software developers		
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# The Incremental Model: Real World Example

- By September 1991, Linux version 0.01 was released. It had 10,239 lines of code.
- In October 1991, Linux version 0.02 was released. In December 1991, Linux 0.11 was released. This version was the first to be <u>self-hosted</u> Linux 0.11
- In December 1951, Linux of H was released. This version was the first to be <u>self-nested</u> Linux of H could be compiled by a computer running Linux 0.11.
  When he released version 0.12 in February 1992, Torvalds adopted the <u>GNU General Public License</u> (GPL) over his previous self-drafted license, which had not permitted commercial redistribution.
  In March 1992, Linux version 0.95 was the first to be capable of running X. This large version number jump (from 0.1x to 0.9x) was due to a feeling that a version 1.0 with no major missing pieces was improved to be computed to access the access of the computer version in the version of the computer version version of the computer version v jump (from 0.1x to 0.9x) was due to a feeling that a version 1.0 with no major missing pieces was imminent. However, this proved to be somewhat overoptimistic, and <u>from 1993 to early 1994, 15</u> development versions of version 0.99 appeared. On 14 March 1994, Linux 1.0.0 was released, with 176,250 lines of code. In March 1995, Linux 1.2.0 was released (310,950 lines of code). Version 2 of Linux, released on 9 June 1996, was followed by additional major versions under the version 2 header, including the following ones: 25 January 1999 - Linux 2.2.0 was released (1,800,847 lines of code). 18 December 1999 - IBM mainframe patches for 2.2.13 were published, allowing Linux to be used on entermise-class machines.
- •
- enterprise-class machines
- 4 January 2001 Linux 2.4.0 was released (3,377,902 lines of code).
   17 December 2003 Linux 2.6.0 was released (5,929,913 lines of code).
   9 June 2009 Linux 2.6.30 was released (11,637,173 lines of code).
- May 18, 2011 Linux 2.6.39 was released.

Note: In July 2009 <u>Microsoft</u> contributed 20,000 lines of code to the Linux kernel. The contribution consisted of <u>Hyper-V</u> drivers, which improve the performance of virtual Linux guest systems in a <u>Windows</u> hosted environment. Microsoft licensed its Linux Hyper-V drivers under the GPL.

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# **The Incremental Model:** Real World Example (linux)







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# **Desktop RAD Model Tools (examples)**

- Apple Xcode
- ++Build
- Clarion is a data-centric Advanced Rapid Application Development tool
- Code::Blocks Delphi
- Delphi for PHP
- Gambas Basic, Open source, Linux
- Gupta Team Developer / SQLWindows
- Microsoft Visual Basic Lazarus Pascal, Open Source, Multi-platform
- RADvolution Designer
- Runtime Revolut REAL software REALbasic
- Softwell Maker is a desktop IDE with a cross-plataform deployment component allowing publish application into almost any Java enable system. Thoroughbred OPENworkshop is a RAD for Windows, UNIX, Linux, and OpenVMS
- The Virtual Enterprise is an Interactive Voice Response (IVR) toolkit developed specifically for telephony and speech inside Microsoft Visual Studio.NET.
- /xDev-
- Microsoft Visual Foxpro
- .
- MX-Frame Business Application Framework

# **Database RAD Tools (examples)**

- ase One Foundation Component Library (BFC) is a RAD framework for building <u>.NET</u> applications using <u>SQL Server</u>, Dracle, DB2, Sybase, and MySQLdatabases.
- Clarion is a data-centric Advanced Rapid Application Development (ARAD) tool featuring roundtrip code generation. <u>uniPeas</u> (by <u>Maric Software</u>) is a database independent Rapid Application Tool for building traditional GUI applications as well as scaling enterprise-level websites. <u>IBM Rational Business Developer Extension</u> supports database application development for <u>IBM DB2</u>, <u>IBM Informix</u>, <u>Oracle database</u>, <u>Microsoft SQL Server</u> and other JDBC compliant relational databases.
- databases. IBM Rational Application Developer supports database application development for <u>IBM DB2</u>, <u>IBM Informix</u>, <u>Oracle</u> <u>database</u>, <u>Microsoft SQL Server</u> and other JDBC compliant relational databases -
- IBM Lotus Notes is a RAD environment for collaboration and document management tasks
- is code generator that builds database-driven web Web 2.0 applications for .NET. It generates application Web pages ASPX, user interface code and data access logic (C#, Visual Basic .NET; and SQL queries) without hand-coding.
- FileMaker is a cross-platform database application from FileMaker Inc. (a subsidiary of Apple Inc.)
- Sybase PowerBuilder is data-driven development tool for creating client/server, distributed, Web and Smart Clients applications for JEE, Win32, and .NET platforms.
- is an <u>open source</u> database-driven RAD development environment for building client (desktop) based applications. Kexi is an <u>open source</u> database-driven RAD development environment for building desktop applications. It is considered an alternative to Open Office Base in the Open Source environment and provides similar features to commercially available RAD development environments such as <u>FileMaker</u>, <u>Albha Five</u> and <u>Microsoft Access</u>.
- Oracle Forms Oracle Application Express (Oracle APEX) is software development environment based on the Oracle database. It allows a very fast development cycle to be achieved to create web based applications.
- Panther (and its open source version POSSL) is a cross-platform (Windows, Unix, Linux; TUI, GUI, Web), cross-database RAD toolset for development of C/S and n-tier database oriented applications.
- NConstruct is Windows and Web rapid enterprise application development tool and environment for .NET framework. It supports Oracle database, Microsoft SQL Server databases and Microsoft Access.
- EASYProcess is a .NET based RAD for the creation of web portal interfaces, work flows, data integration, reporting and web services largely focused on the JD Edwards community.
- Softwell Maker is a ultra RAP data-centric IDE with a cross-platform deployment component allowing publish application into almost any Java enable system.
- -WinDev

# Web-Based RAD Tools (examples)

- Active Agenda's code generator is a RAD development framework using XML specification files and the PHP development language. Alpha Five is a commercial RAD development environment for both client and web-server based database driven applications. This tool is typically classified with commercial packages such as <u>Microsoft Access</u> and <u>FileMaker</u>. Axiom Stack is an open source web application framework designed to foster rapid development through the use of <u>ECMAscript</u> (<u>JavaScrint</u>) and <u>Java</u>. Tools such as the <u>Axiom CMS</u> and <u>Inspector</u> are written to aid in application development. <u>BFC</u> is a RAD framework for both client and server-side development in the .NET environment. <u>CalaePHP</u> is a RAD development framework using the <u>PHP</u> development language. is a visual RAD development menvironment for web-based database driven application development. places emphasis on code generation technology to provide ASP. <u>PNT</u>, <u>PHP</u>. <u>9</u>, <u>8</u>, Servlets, <u>ColdFusion</u> and <u>Perl</u> language support. Zand <u>Framework</u> is an open source, object-oriented web application framework licensed under the New BSD License. <u>Diango</u> is an open source, object-oriented web application framework licensed under the New BSD License. <u>Diango</u> is an open source, object-oriented web application framework licensed under the New BSD License. <u>Diango</u> is an open source, object-oriented web application framework licensed under the New BSD License. <u>Diango</u> is an open source, object-oriented web application provide ASP explexies. <u>Diango</u> is an open source web application framework, HPUX, AJX, System z and System 1 <u>NConstruct</u> is Windows and Web rapid enterprise application development tool and environment for .<u>NET framework</u>.
- NConstruct is Windows and Web rapid enterprise application development tool and environment for .<u>NET framework</u>. <u>muBuilder</u> is an open source browser based database development tool which stores all forms, reports, data and any custom code in MySQL and displays the content dynamically.

- MySQL and displays the content dynamically. Oracle Application Development Framework uses Oracle's JDeveloper a FREE IDE that supports ADF's J2EE based framework. Panther (and its open source version POSSI) is a cross-platform (Windows, Unix, Linux; TUI, GUI, Web), cross-database RAD toolset for development of C/S and ralie; database oriented applications. Pylons is an open source web application framework, written in Python, which makes extensive use of the <u>Web Server Gateway Interface</u> (WISGI) standard to promote re-usability and to separate functionality into distinct modules. <u>Radioore</u> is a RAD development framework using the <u>PHP</u> development language. It is for building administrative web applications, not web sites, and includes a Role Based Access Control (RBAC) system, Audit Logging system (without database triggers), Data Dictionary Thoroughtwed T-WEB is a Web RAD tool <u>Web2py</u> is a RAD framework for web-based database dayoe events of
- Web20y is a RAD framework for web-based database driven applications with key features including in-browser coding support, admin/design interface, DAL (database abstraction layer), and translation support.
- VebDev Vavemaker Visual Ajax Studio is an open-source, browser-based IDE based on Dojo, Spring and Hibernate. Volf Frameworks is a 100% AJAX, XML & .NET based Platform for designing and delivering cross platform web applications using a

- browser. Visual WebGul Visual WebGul (VWG) is an open-source rapid application development (RAD) framework for AJAX & Silverlight GUIs. The platform presents a new approach to applying desktop usability to the web by viewing it as an extension to a desktop rather than web cateAspap an online rapid development tool with WYSIWVG SQL editor and framework based on CakePHP. <u>Wavemaker</u> Visual Ajax Studio is an open-source, prowser-based IDE based on Dojo, Spring and Hibernate. is a web based development and design tool for designing forms and pages for mobile and hand-held devices as well as delivering cross platform web applications using a standard internet browser.

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# **Cross-Platform RAD Tools (examples)**

- Boa constructor is a cross-platform, <u>wxPython</u> based <u>Python</u> RAD IDE <u>Code</u>: <u>Blocks</u> is a cross-platform C/C++ RAD IDE using wxWidgets; the latest developmental builds have a built-in form designer wxSmith, so it's similar to Borland C++ Builder and Microsoft Visual C++/MFC now. <u>HyperNext</u> is a freeware cross-platform software development system for Macintosh OS X & OS 9, and Microsoft Windows XP & Vista. It has many similarities with <u>HyperCarcl</u> and can compile to both stand alone applications and stacks for the cross-platform HyperNext
- IBM Rational Business Developer Extension is a cross-platform. Rapid Application Development IDE for creating enterprise and web applications and services for Windows, Linux, Unix (Solaris, HPUX, AIX), System z and System i
- IBM Rational Application Developer is a cross-platform, Rapid Application Development IDE for creating enterprise and web applications and services for Windows, Linux and Unix (Solaris, HPUX, AIX)
- and services to evolutions, Linux and Unix (soulars, new, Ak) LANSA is a development environment for generating applications on multiple computer systems. The main feature of the LANSA environment is the ROML language. It is classified as a 4GL (4th generation computing language). It runs on many systems including MS Windows, Unix, and Linux. In its first release in 1987, the ROML language was known as lambda

- environment is the RDML language. It is classified as a 4GL (4th generation computing language). It runs on many systems including MS Windows, Unix, and Linux. In its first release in 1937, the RDML language was known as lambda Lazerus is a cross-platform IDE similar to Borland Delphi. m-Power is a Software Development tool which automates application development and rapidly creates enterprise-class Web applications over any database or platform. NulBeans is a cross-platform. RAD IDE for creating visual desktop, mobile, web, and SOA applications for Linux, Windows and Mac OS X. The IDE officially supports Java, Ruby, PHP, JavaScript and CIC++ programming languages. Omnis Studies is a cross-platform, RAD IDE for creating visual desktop, mobile, web, and SOA applications for Linux, Windows and Mac OS X. The IDE officially supports Java, Ruby, PHP, JavaScript and CIC++ programming languages. (OpenERP) is a RAD framework in python. OpenROAD is a cross-platform IDE for Linux/Unix, Windows with embedded SQL support Panther (and its open source version ROSSI) is a cross-platform (Windows, Linux, TUI, GUI, Web), cross-database RAD toolset for development of CIS and Inter database oriented applications for Windows, Linux and Mac OS X. Ritchbasig is a cross-platform IDE for creating desktop applications for Windows, Linux and Mac OS X. Ritchbasig is a cross-platform IDE for creating desktop applications for Windows, Linux and Mac OS X. Ritchbasig is a cross-platform IDE for creating desktop applications for Mindows, Linux and SO S X, Windows 98/Me/XPI/Vista, and various flavors of Linux. Web Dyname is SAP's RAD to create web applications connected to function modules in mySAP ERP. RadRalts is a cross-platform application development and deployment environment. Servey consists of a GUI designer, is event-driven and runs scripts through JavaScript, Servey allows applications. Servey Servey is a a cross-platform application development and deployment environment. Servey consists of a GUI designer, is eve
- pure HIML Web client from the same codebase and user interface WideStudies is an open source integrated development environment for desktop applications purely XVT is a cross-platform, Rapid Application Development IDE for creating enterprise and desktop applications in C/C++ on Windows, Linux, Unix (Solaris, HPUX, AIX), and Mac CA Plex, a software development tool that combines the techniques of model-based development, patterns and code generation to accelerate the delivery and maintenance of multi-platform, distributed business applications

# **RAD Model: Pros and Cons**

# Advantages of RAD Model:

- Fast software development.
- Reduced )probably, significantly) time-to-market (or, development time).
- Low cost (overall)
- It helps to identify the most (probably, several) perspective way of future developments.

# Disadvantages of RAD Model:

- In many cases, a low-cost D&D due to CASE tools ... but they usually generate not an optimal code.
- The process is too fast; as a result, proper Software Quality Assurance and Testing (especially security testing) may not be done. In many cases, software generated is of a "throw-away" type. In this case, if a new version of the software is needed, it is developed from scratch using the newest RAD techniques and tools.
- It requires extra resources (financial, human, technical, etc.)



# **Types of Prototyping Model**

- **Throwaway prototyping** (also called *close Ended Prototyping, or Rapid Prototyping*) refers to the creation of a model that will eventually be discarded rather than becoming part of the final delivered software.
- **Evolutionary Prototyping** (also known as *Breadboard Prototyping*) is quite different from Throwaway Prototyping. The main goal when using Evolutionary Prototyping is to build a very robust prototype in a structured manner and constantly refine it.
- **Incremental prototyping** In this case final product is built as separate prototypes. At the end the separate prototypes are merged in an overall design.
- Extreme prototyping -- Extreme Prototyping as a development process is used for developing especially web applications. Basically, it breaks down web development into three phases, each one based on the preceding one.
  - 1) The first phase is a static prototype that consists mainly of HTML pages.
  - 2) In the second phase, the screens are programmed and fully functional using a simulated sérvices layer.
  - 3) In the third phase the services are implemented.
  - The process is called Extreme Prototyping to draw attention to the second phase of the process, where a fully-functional UI is developed with very little regard to the actual services to be used.

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# **Prototyping Model: Pros and Cons**

- Advantages of Prototyping Model:

  Reduced time and costs: Prototyping can improve the quality of requirements and specifications provided to developers. Because changes cost exponentially more to implement as they are detected later in development, the early determination of what the user really wants can result in faster and less expensive software.
- proved and horeased user imvolvement. Prototyping requires user involvement and allows them to see and interact with a prototype lowing them to provide better and more complete feedback and specifications. The final product is more likely to satisfy the users size for look, feel and performance.

## Disadvantages of Prototyping Model:

- utificient analysis: The focus on a limited prototype can distract developers from properly analyzing the complete project. This can id to overlooking better solutions, preparation of incomplete specifications or the conversion of limited prototypes into poorly gineered final projects that are hard to <u>maintain</u>. Further, since a prototype is limited in functionality it may not scale well if the ototype is used as the basis of a final deliverable, which may not be noticed if developers are too focused on building a prototype as a

- prototype is used as the basis of a final deliverable, which may not be noticed if developers are too focused on building a prototype as a model. User confusion of prototype and finished cystem: Users can begin to think that a prototype, intended to be thrown away, is actually a final system that merely meeds to be finished or polished. (They are, for example, often unaware of the effort needed to add error, they for the system which a prototype may not have.) This can lead them to expect the prototype to accurately model the performance of the final system which a prototype may not have.) This can lead them to expect the prototype to accurately model the performance of the final system which a prototype to interval to easing the developers. Users can also become attached to features that were stable to require all understanding of user objectives: Developers may assume that users have their objectives (e.g. to deliver core functionality on time and within budget), without understanding wider commercial issues. For example, user persentatives attending final system without being told that this feature demonstrations of "transaction auditing" (where changes are logged and bialute care backwes be user requirements were requirements. The solution provider has committed delivery before the user requirements were requirements. But were they have made assumptions about the extent of user requirements. If the solution provider has committed derivers being because they have made assumptions about the extent of user requirements. The solution provider has committed to prototype. Developers can also become attached to prototypes they have as developers may suggest that throwawy prototyping is the fact that it is supposed to be done quick). If the solution provider has committed user the prototype. Developer attached to prototype is the offer to producing; this can lead to prototem like attempting to convert expression and a hard place, particularly if user management. This can lead to prototype. Developers are also beco



# **Spiral Model: Pros and Cons**

# Advantages of the Spiral Model

- Evolution of SW -- large-scale software products evolve as the software process progresses (no need to develop final product from the very beginning)
- Customer involvement into software process.
- Good risk management (with a good risk reduction rate).
- Good change management.
- Careful step-by-step ("spiral-by-spiral") development of SW project. It maintains a
  systematic stepwise approach like the classic life cycle model, but also incorporates
  an interactivity in order to reflect the real world.

# **Disadvantages of the Spiral Model**

- Time consuming process
- Demands considerable risk-assessment expertise.





# <u>Topic # 2:</u>

# Homework Assignment

- 1) This is REQUIRED HW assignment.
- 2) This HW is intended to help you to practice with a correspondence between SE Process Models and specific well-known commercial software systems. A hint: create a list of about 20 well-known software applications that you actively use, and try to classify them in accordance with learned SE Process Models.
- 3) There is NO NEED to email your results to instructor.
- 4) This HW is aimed at your preparation for In-Classroom Test next class.

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# Chapter 3: Agile Software Development

# **OPTIONAL**

(it is a very good idea to read and be aware about this emerging SE technology, and take CS593 course)





# **Agile Development: An Overview**

- Agile software engineering represents a reasonable compromise between to conventional software engineering for certain classes of software and certain types of software projects
- Agile development processes can deliver successful systems quickly
- Agile development stresses continuous communication and collaboration among developers and customers
- Agile software engineering embraces a philosophy that encourages customer satisfaction, incremental software delivery, small project teams (composed of software engineers and stakeholders), informal methods, and minimal software engineering work products
- Agile software engineering development guidelines stress on-time delivery of an
  operational software increment over analysis and design (the main idea: "the
  only really important work product is an operational software increment").





# Agile Process Models

- Extreme Programming (XP)
- Adaptive Software Development (ASD)
- Scrum
- Dynamic Systems Development Method (DSDM)
- Crystal
- Feature Driven Development (FDD)
- Lean Software Development (LSD)
- Agile Modeling (AM)
- Agile Unified Process (AUP)

