

Publishing Domain Specific Source Code for Reuse and Maintenance

<https://JimFawcett.github.io/Resources/PublishingSourceCode.pdf>

Jim Fawcett

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Publishing Code Topics

- Software Salvage and Reuse
- Web-based Publishing Code Components
- Repository Structure
- Quality Control
- Experiments
- Conclusions

Alternate View – briefer and denser - Site Story from StoryTeller:
<https://JimFawcett.github.io/StoryTeller.html>

Software Salvage and Reuse

- Software Components
 - Software package that has a single purpose, few dependencies, and is useful for building software systems – example: blocking queue
- Salvage (good)
 - Use existing components with minor modifications
 - That creates new components that must be configured and managed
- Reuse (better)
 - Reuse existing components with **no modification**
 - Use by composing, use as template argument, or use as base for derived classes
- Purpose
 - Improve productivity by building fewer lines of code
 - Avoid introducing new defects and performance issues

Software Reuse – Good news and bad news

- Reusing code from compiler libraries has been spectacularly successful
 - Each language defines a set of libraries that support building projects
 - Updated with each new standardization of the language.
 - Also applies to domain agnostic libraries like Boost
- Software reuse in the academic, industrial, and commercial domains has often been disappointing
 - Typical use is:
 - Grab the last relevant project(s)
 - Attempt to throw away unneeded parts
 - Sometimes we keep unneeded parts because too much breaks if we remove
 - That causes maintenance problems
 - Merge and add needed new parts
 - Spend a lot of time fixing breakage


Application Domain Targets – Candidates for Support?

- Academic Research: 5 – 10 code developers
 - Code life-time: 3 – 5 years
 - Example: Natural Language Processing (NLP)
- Academic Teaching: 1 instructor – 100 students
 - Code life-time: 5 – 10 years
 - Example: software examples for language and design courses
- Open Source Development: 1 – 300 active developers, many casual contributors
 - Code life-time: 10 - 20 years
 - Example: Linux
- Industrial and Commercial Development: 5 – 20 developers
 - Code life-time: 5 – 20 years
 - Example: Machine Tool Control
- Aerospace Programs: 5 – 200 developers
 - Code life-time: 20 – 30 years
 - Example: Submarine control, Area surveillance, ..

Supporting Software Reuse

- Purpose: to provide for application domain specific code the same advantages attained from compiler libraries
- For reuse a software component should be designed so that reusing in a new project is quicker and easier than creating from scratch
 - There are many good examples, e.g., the C++ Standard Template Library and Apache HttpComponents.
 - How to do that is a topic for another story.
- Components must be available
 - That implies some cloud-based repository
- Components need to be documented
 - Concept, use statement, use examples, design, status

Website Story Prologue

- This is a presentation of goals and features of a website designed to publish source code in support of domain specific software reuse.
 - <https://JimFawcett.github.io>  Take a quick tour
- The site is a second-generation facility based on experience with an academic website:
 - <https://ecs.syr.edu/faculty/fawcett/handouts/Webpages/fawcettHome.htm>
- I used that site for graduate software design courses taught at Syracuse University for many years.
 - Published lecture content
 - Provided access to code components students used for class projects

Publishing Code Components for (Re)use

- The goal of this site is to improve that first site's process by publishing code in an effective way
- Publishing some code artifact is the act of making it available, in usable form.
- Five main facets of publication:
 - Containment
 - Delivery
 - Location
 - Interpretation
 - Quality Control

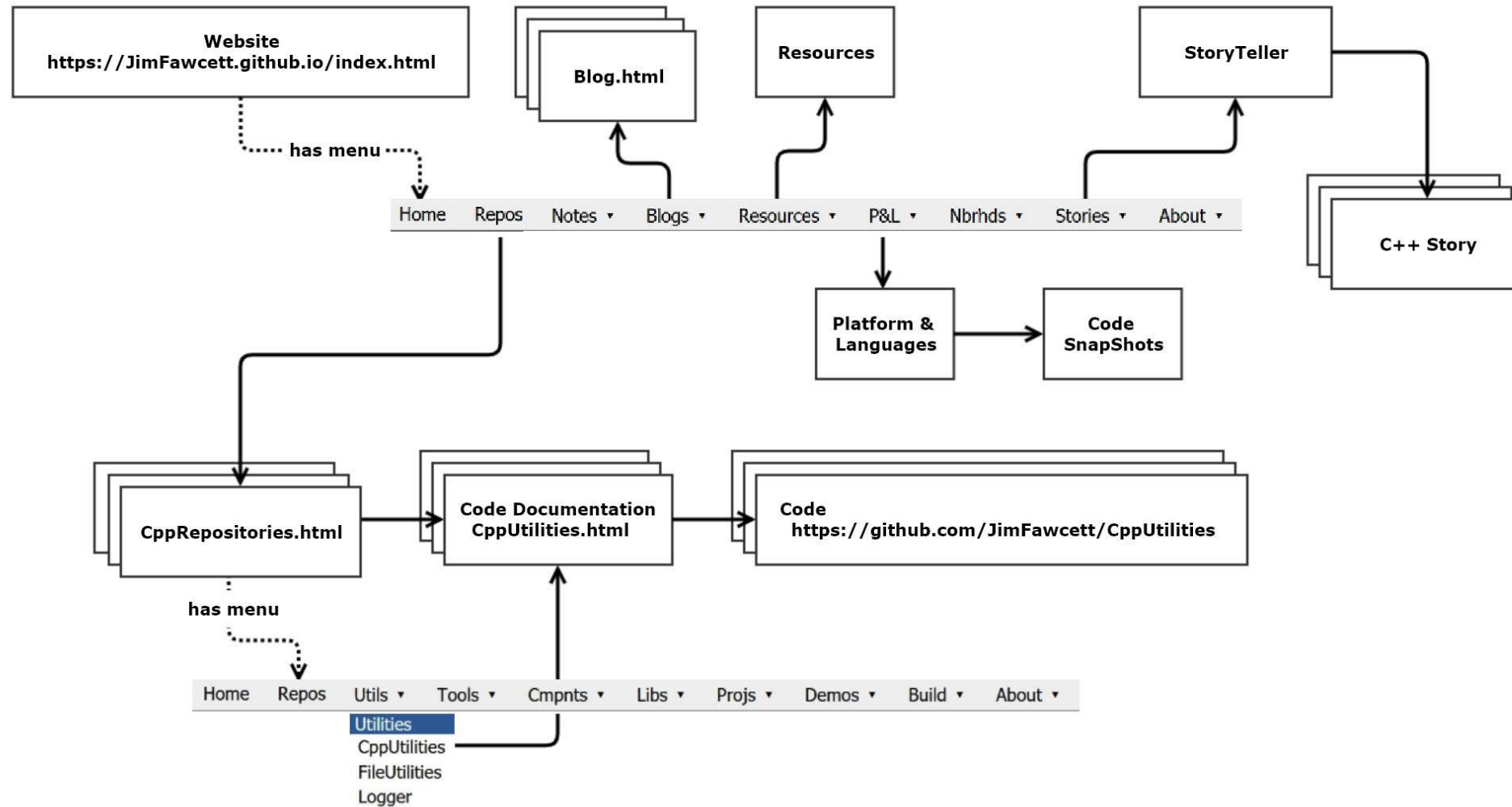
The Issues

- Source code containment and delivery are solved problems
 - Cloud-based facilities like github do that very well
- The issues are finding and understanding code relevant to a need
 - We want most code repository collections to be large – support broad reuse
 - How do we find, in a large repository collection, code that fills some need?
- A good option - website documentation, co-located with source code
 - To support both salvage and reuse, documentation needs to provide information about the component's concept, design, and typical use

Website for Publishing Reusable Components

- A site for publishing source code will need:
 - A structure for holding organized collections of code
 - An intuitive navigation process to find specific code and resources
 - Documentation for each component
 - Concept, Design, Usage, Status
 - Additional resources to help users understand relevant technologies
 - Language and platform references
 - Brief code snapshots with commentary, provided as webpages
 - Related blogs and opinion pieces
 - Code standards
 - Stories and Videos
 - Discussions, each focused on a single theme

Site Structure – <https://JimFawcett.github.io>

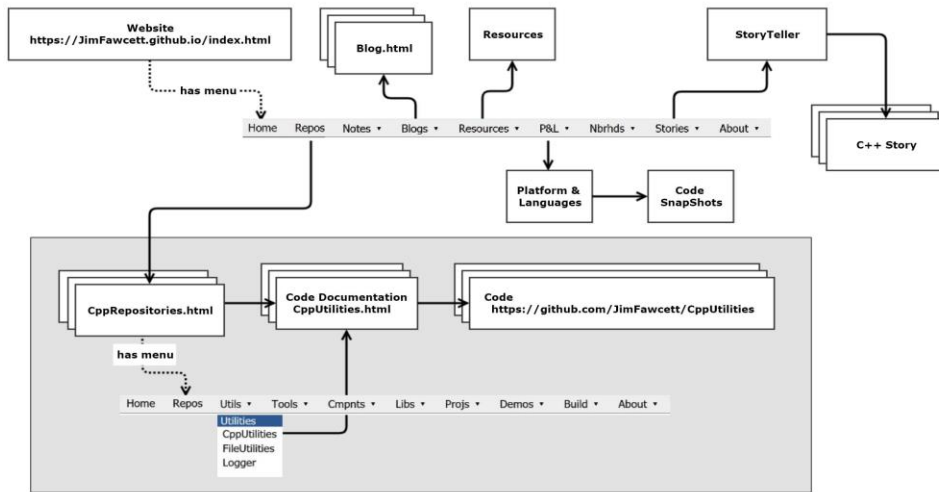


Definitions - Repository

- “A **software repository**, colloquially known as a "repo" for short, is a storage location from which [software packages](#) may be retrieved and installed on a computer. These repositories often house metadata about the packages stored in the repository.”
 - Wikipedia software Repository
- “A repository is like a folder for your project. Your project's repository contains all of your project's files and stores each file's revision history. You can also discuss and manage your project's work within the repository.”
 - GitHub Help
- Common use of the Repository name often implies the totality of all components served from one site. We follow github with a narrower definition, i.e., a place to hold one project from a site that may make many projects available.

Site Structure - Code Repos

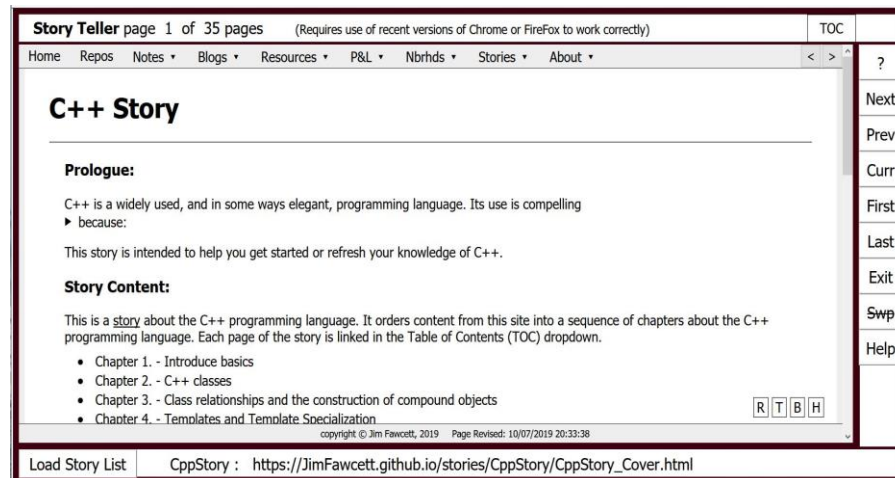
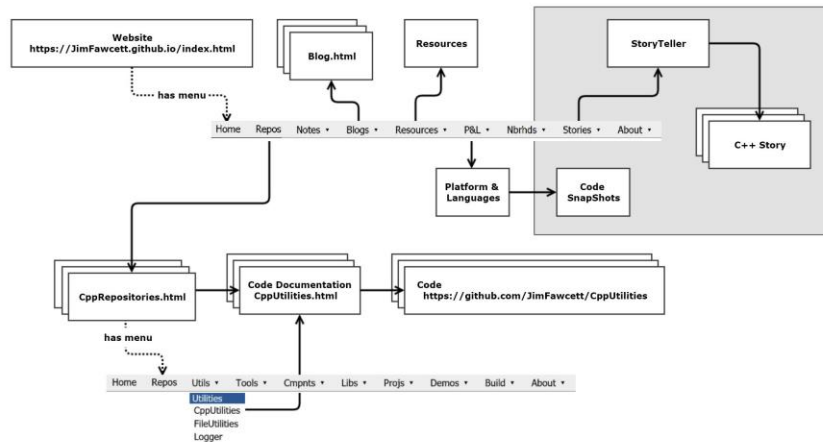
<https://JimFawcett.github.io/Repositories.html>



- Code Repositories are the most important part
- Goal is to have large collections to promote broad reuse
- Navigation is an issue. Solution:
 - Link from Home menu
 - Factor into (language or product specific) collections
 - Factor each collection into individual repositories (utilities, tools, ...)
 - Link first to documentation which then links to code folder

Site Structure – Stories

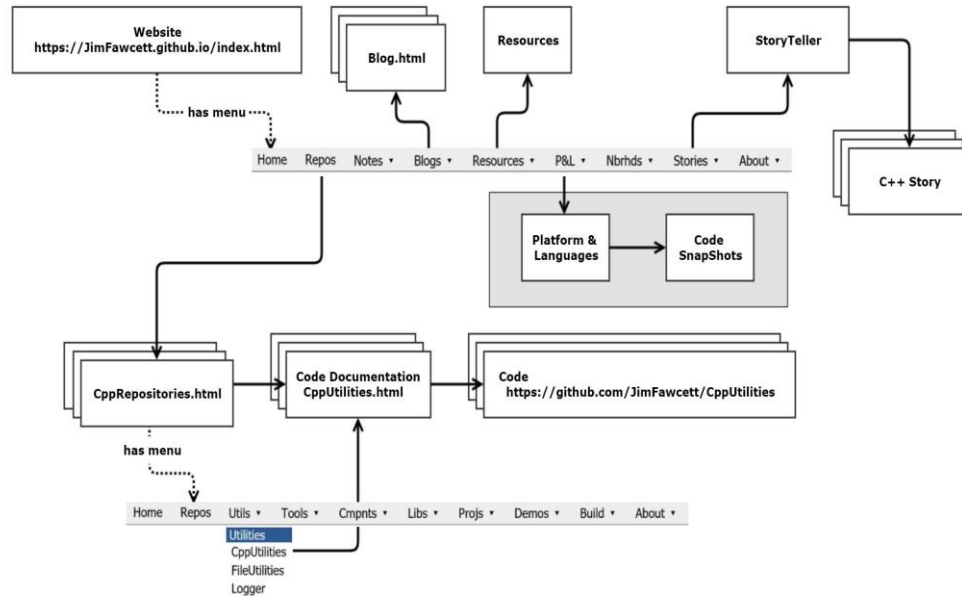
<https://JimFawcett.github.io/StoryTeller.html>



- Stories are organized collections of pages from the site that all focus on a single theme
- Intent is to help users grapple with site content
- Examples are:
 - C++ story – tutorial material
 - SiteStory – description of this site
 - MLiPS – guest story about ML
- Image to the left is StoryTeller interface

Site Structure – Code Snaps

<https://JimFawcett.github.io/LangCpp.html>



• CodeSnaps

- Source code converted to HTML page
- Provides quick access to views of important code fragments
- No need to download from repository to explore

The screenshot shows the 'LangCpp - C++ language feature discussions' website. The navigation bar includes 'Home', 'Repos', 'Notes', 'Blogs', 'Resources', 'C++ Lang', 'C++ Demos', 'Code Snaps', and 'About'. The 'Code Snaps' menu is open, showing a 'Quick View Code' dropdown with options: 'PointersAndReferences', 'ClassAnatomy', 'Strings', 'Inheritance', 'CompoundObjects', 'Templates', 'FunctionObjects', 'Lambdas', 'LambdaCapture', 'Converter', 'Properties', 'BlockingQueue', and 'TestUtilities'. The main content area is titled 'Syntax and Semantics:' and lists several links: 'C++ language - cppreference.com', 'FAQ - C++ classes and objects', 'C++ Synopsis', 'C++ Survival Guide - pdf', and 'C++ Type System'. A 'Code' section on the right lists 'Converter', 'BlockingQueue', and 'STL Containers'.

The screenshot shows a code snippet page with a navigation bar including 'Home', 'Repos', 'Notes', 'Blogs', 'Resources', 'C++ Lang', 'C++ Demos', 'Code Snaps', 'About', 'Prev', and 'Next'. The page title is 'Stack.h, Stack.cpp, Stack.txt, Code folder, Templates webpage'. The main content is a code snippet illustrating syntax for template classes. The code is as follows:

```
#ifndef STACK_H
#define STACK_H
// Stack.h - stack class derived from Effective C++, Scott Meyers //
// Note: inclusion model for templates requires all template //
// implementations be placed in header file. //
// Jim Fawcett, CSE687 - Object Oriented Design, Spring 2004 //
// template class
template<class T> class stack {
private:
    template <class U> friend class stack;
    struct stacknode {
        T data;
        stacknode *next;
        stacknode(const T& newdata, stacknode *nextnode)
            : data(newdata), next(nextnode) { }
    };
};
```

Quality Control

- Without quality control it's easy for repositories to become a sea of flotsam[1] and jetsam[2]
 - Some good content, but a lot of content that isn't ready for reuse
- To avoid that destination two things are necessary:
 - An effective structure for disclosing the contents of a repository
 - This site provides a candidate
 - Willingness of the site sponsor to invest in review and improvement
 - Standards – brief statements - components must meet to become candidates
 - Knowledgeable and productive person(s) to evaluate a component against the standards and admit or reject
 - Continuing background review activity – is this component still valuable?
- Note that github provides tools to help, e.g., wikis, charts, ...

[1] Flotsam - cargo that surfaces from a sunken ship

[2] Jetsam – cargo that is intentionally cast from a ship in distress.

Experiments

<https://JimFawcett.github.io/Tests.html> - Main menu > Resources > UI Widget Tests

https://JimFawcett.github.io/SiteStory_4.html - Main menu > stories > SiteStory

- Experiments to make the site's publishing process more effective are continuing:
 - Developing UI widgets to use webpage real estate effectively
 - User driven diagram resizer
 - Slide-in panels
 - Slide show
 - Code blocks for presentation
 - Photo styling
 - Navigation schemes
 - Dropdown menus
 - Page sequences (defined by hidden links)
 - Navigation buttons and key presses
 - Continuing to think about site organization schemes

Status and Conclusions

- Status - <https://JimFawcett.github.io>:
 - Most of the structure described is in place
 - More than 50 repositories of mostly C++ code are published
 - Several stories are published
 - Other resources and CodeSnaps are available from the site
- Plans
 - Install more code repositories
 - Install starter site
 - Start to add videos
- Conclusions:
 - Static sites seem like a good tool for publishing
 - Main issue is text or keyword searches not available with static sites
 - Can be addressed with local mirror and tools for synchronizing and local searching
 - Required effort is reasonable for the expected payoff
 - This site went from zero to current status in four months of my time
 - However, I've built a site like this before.

Appendix - Domains

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Open-Source Domain

Parts flow in, a product flows out

- Open-source projects like Linux
 - Locally developed code flows to the cloud
 - Local contributors push to remote development branch
 - A single large system flows from the cloud to local users
 - Download a distro
- Open-source applications like node.js
 - Developed by small group of contributors
 - Users download and install system with additional imports
- Open-source libraries like jQuery.js
 - Developed by small group of contributors
 - Users bind remote library to webpages with Content Delivery Network (CDN) links

- This domain already has a publishing model that has different goals than ours

Other Domains

Components installed, flow out to users

- Users search for a component to fill a current implementation need
 - Repository needs to be large, i.e., hold many components so there is a fairly good chance to find something useful
 - So search and interpretation need to be effective
 - For repositories with hundreds of components, that is not trivial
- The main issues are:
 - Developing a useful search process that is intuitive and quick
 - Helping users interpret a found component
 - What does it do?
 - How is it designed?
 - How to integrate with existing code?
- These domains appear to be good candidates for the publication process proposed here

Academic Research Domain

- Academic Research: 5 – 10 code developers
 - Code life-time: 3 – 5 years
 - Example: Natural Language Processing (NLP)
- An academic researcher may have 2 or 3 doctoral candidates working on related parts of a research project.
- She may collaborate with two or three colleagues, perhaps at different universities.
 - Each of those colleagues may have a similar team working on related projects.
- There usually is continuing work on the same or related research projects for many years.
- It is quite common that this work develops software tools for gathering and analyzing data. Sometimes software is part of the end product, e.g., compilers for a new language, an architecture for streaming or classifying content, ...
- These software developments are rarely maintained well. Often documentation is nothing but code and the papers that describe research results and mention the software as an aside.
- Our methods are applicable.

Academic Teaching Domain

- Academic Teaching: 1 Instructor, 2 TAs, 100 students
 - Code life-time: 5 – 10 years
 - Example:
- A language or design course needs non-trivial examples, in addition to exercises. For graduate courses the examples may be quite large – multipackage, multi-threaded, distributed prototypes.
- For project-based courses the instructor may wish to give starter components to allow students to build more ambitious projects than if they write all code themselves.
- An instructor who teaches a sequence of design courses over several years will need a place to store and organize design notes and sample code.
- It is quite important for students to have a clear path to the resources they need for their projects.
- It has been my experience that former students return to a teaching site to review notes and access sample code.
- Our methods are directly applicable.

Industrial and Commercial Development Domain

- Industrial and Commercial Development: 5 – 20 developers on a product team
 - Code life-time: 5 – 20 years
 - Example: Machine Tool Control
- Code base starts with an initial product
- New products start from that initial code
 - Has a common code baseline been defined?
 - Code reviews are held during development
 - At product completion is code reviewed and refactored into reusable parts and product specific code?
 - Is the organization willing to provide overhead effort to evolve the common code base?
- Microsoft is a commercial development domain with many products, some modernized versions of vintage products.
 - They have a well engineered code sharing platform: <https://github.com/microsoft>
 - That platform uses designs similar to those described here
- Our methods are applicable. A scaled down version is probably appropriate for some product teams.

Aerospace Domain

- Aerospace Programs: 5 – 200 developers
 - Code life-time: 20 – 30 years
 - Example: Submarine control, Area surveillance, ..
- Development is product oriented, starting with an initial contract, and continuing for possibly many years of enhancements and new contracts that build on the existing product technology
- An example is the development of area surveillance radar systems
 - Typical lifetime of a radar system is 20 years
 - The code has to be maintained over that lifetime, sometimes by the manufacturer, sometimes by the customer.
 - Once an initial contract has been successfully completed it is common for many contracts to be awarded for new versions.
 - Usually a large part of a new product is based on an existing one and will share a large fraction of its code
 - In most cases the new contract requires new features and enhancements – the customer looks at the original and decides how to embellish
- The Capability Maturity Model was developed beginning when the Air Force funded a study with the Software Engineering Institute. Its intent is to encourage DoD contractors to develop and maintain a consistent process for creation of software.
 - https://en.wikipedia.org/wiki/Capability_Maturity_Model
 - CMM provides guidelines, but it is a model and a yardstick for assessing capability of contractors
 - It does not provide specifics for tools and techniques that support reuse
- Our methods apply for individual product teams. Unknown how that would scale to corporation level.

That's all Folks!