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Agile Embedded Software Development a Renaissance

Embedded Systems Conference
Boston October 2008 -- ESC 206

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www.RenaissanceSoftware.net

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What are your burning software development issues?

Software Development is Easy!

- Just like this *Black Diamond*

We never have any problems like

- Late Delivery
- Poor Quality
- Burnout
- Missed Customer Expectations

Software Development is Easy!

Like this Cliff!

We Make Our Problems

Vague Requirements

↓

Unrealistic Plan

↑

Unplanned Activities

↑

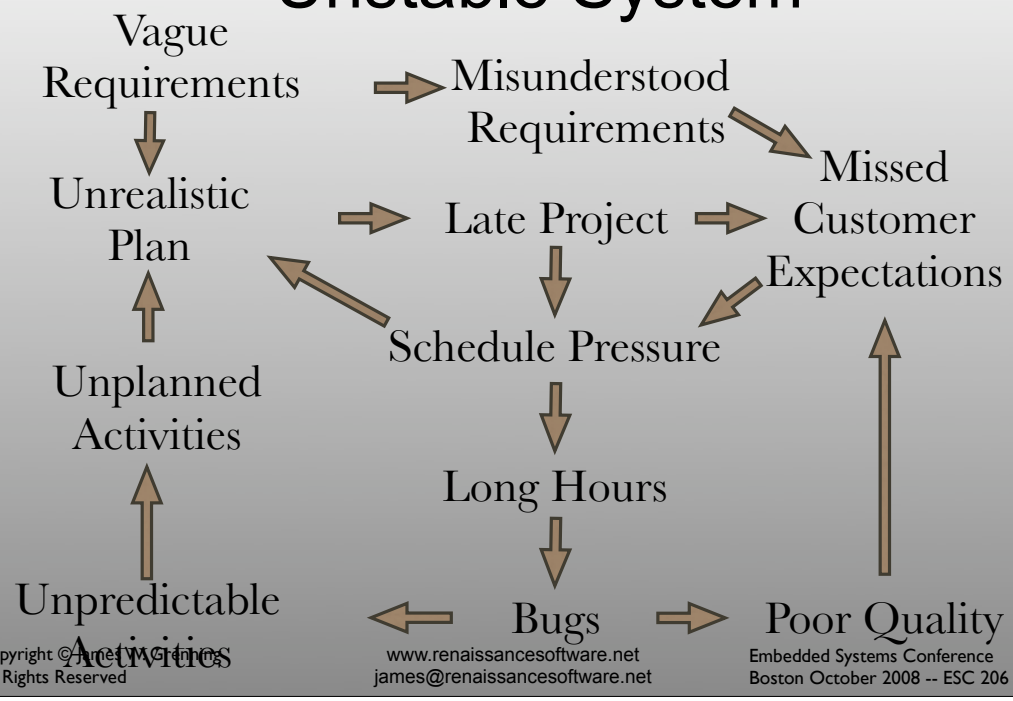
Unpredictable Activities

→ Late Project → Missed Customer Expectations

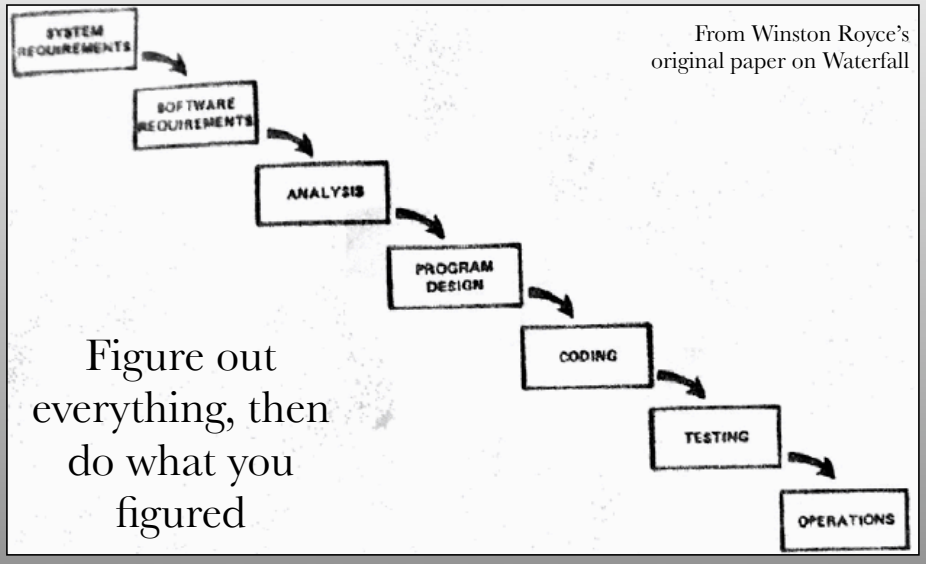
↑

Poor Quality

Positive Feedback Unstable System



Can Projects be Managed Better?



From Winston Royce's original paper on Waterfall

Figure out everything, then do what you figured

Waterfall -- The Experience

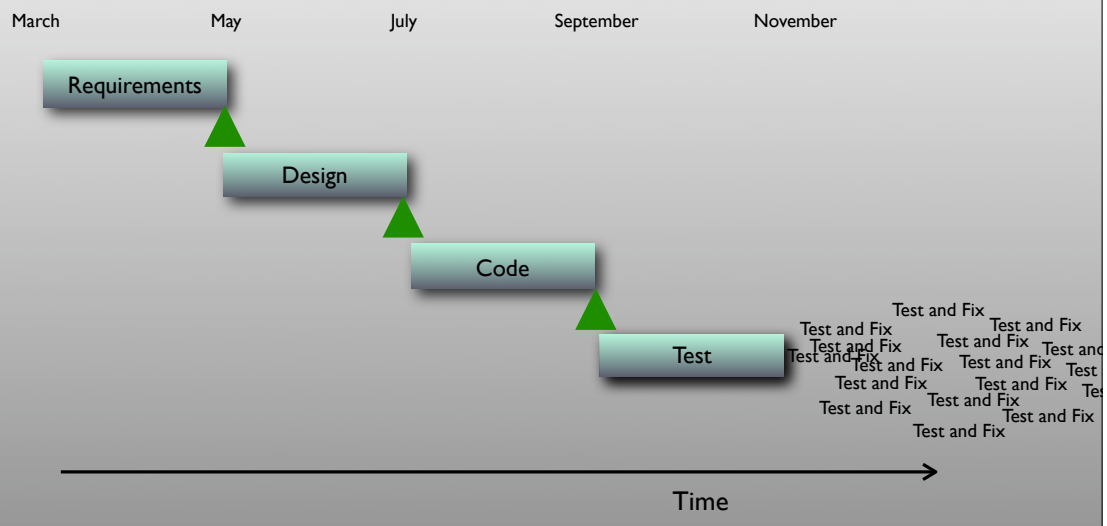
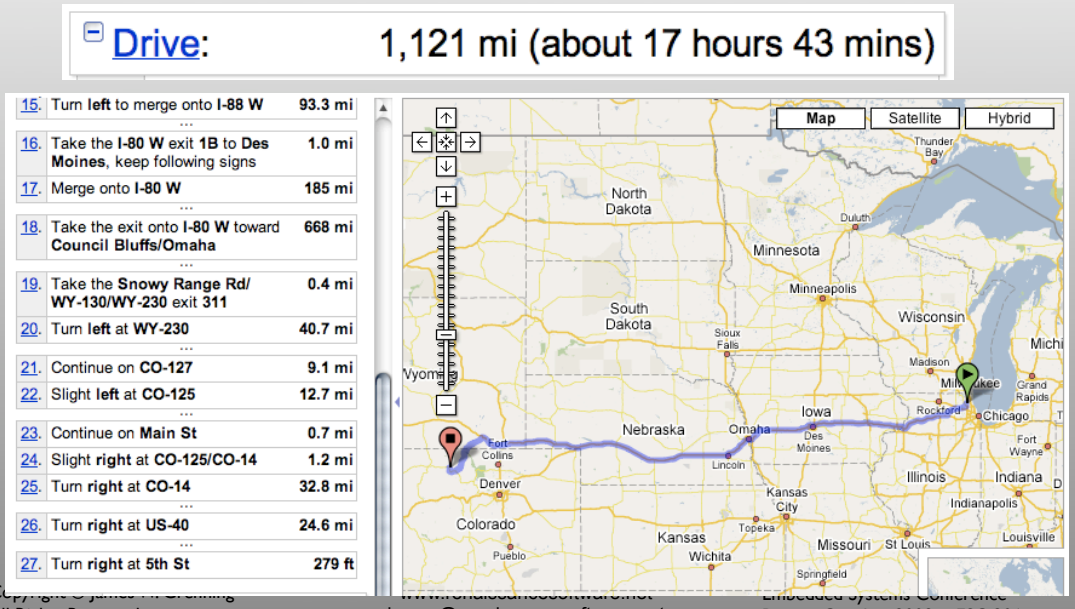
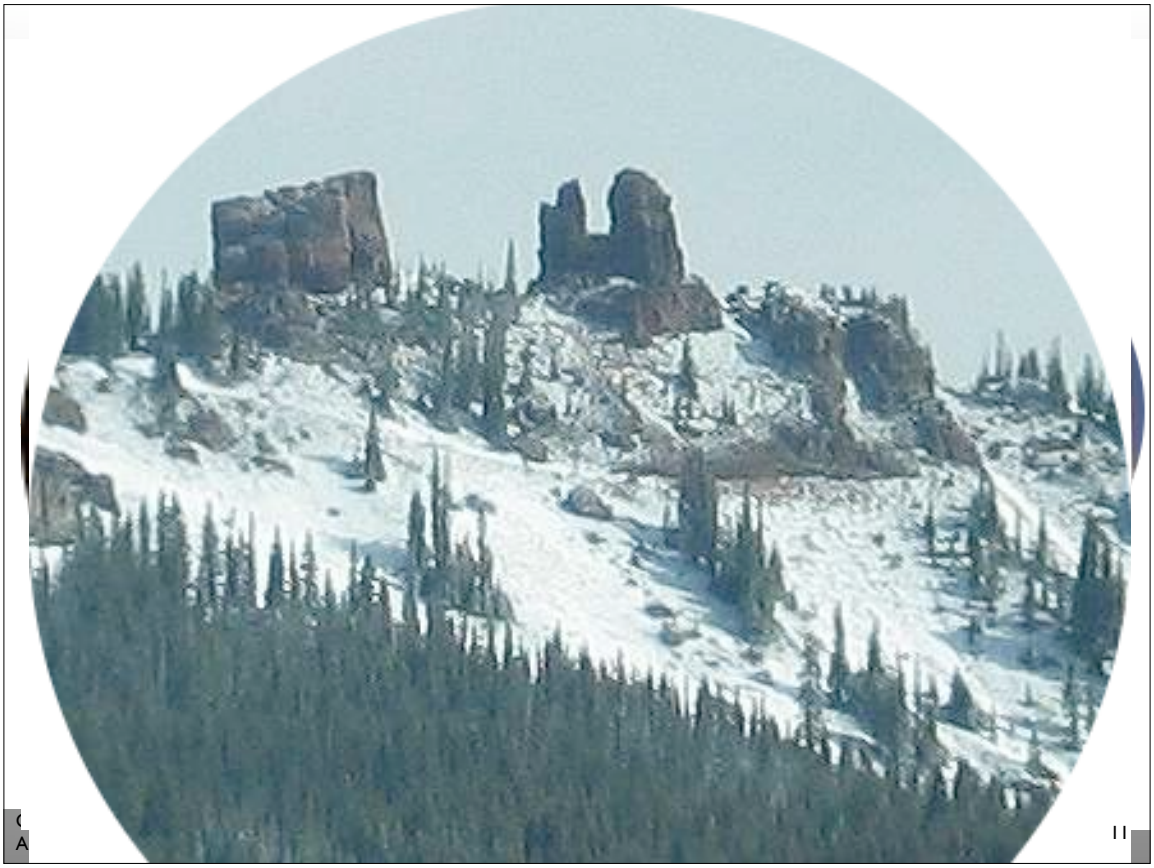


Figure it All Out, Then Do It



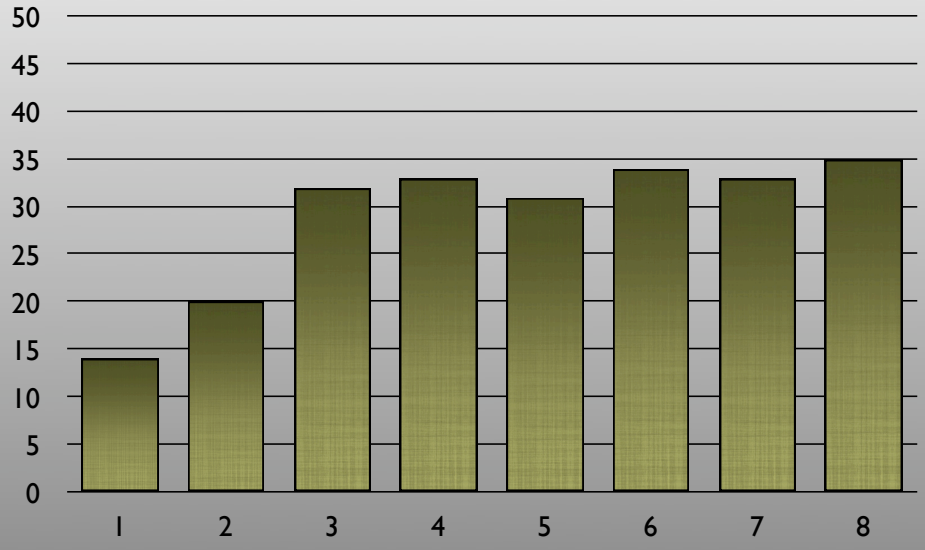


Why Consider Agile?

- Manage with data
- Improve Predictability
- Improve Quality
- Improve Productivity

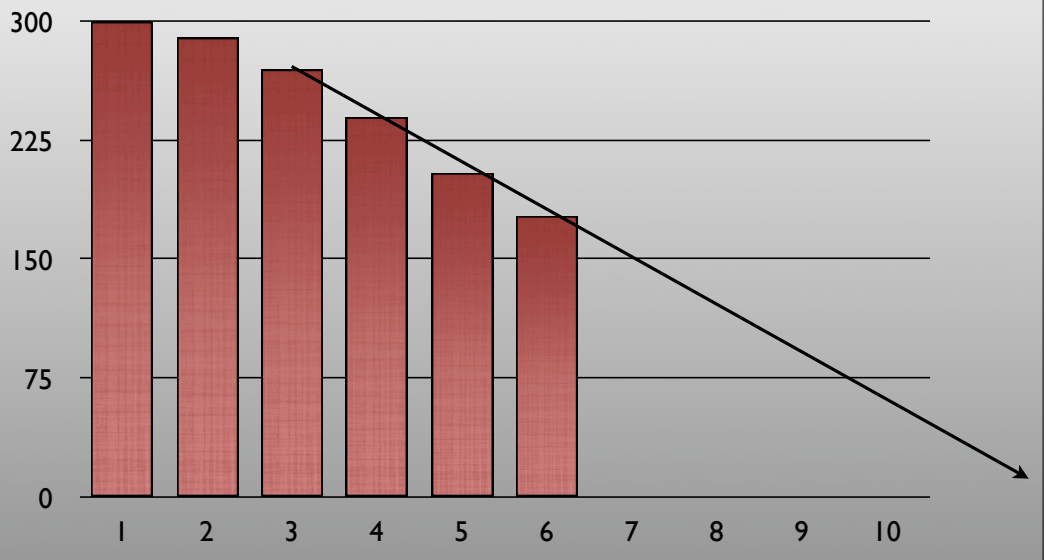
Velocity

Completed work per Iteration

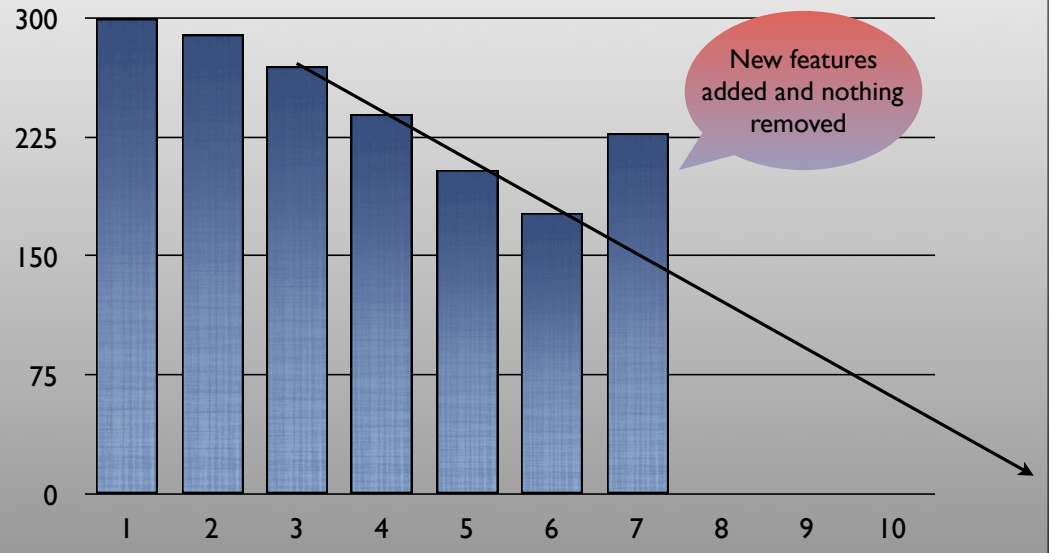


Product Burn Down Chart

Work to be Completed



Change Becomes Visible



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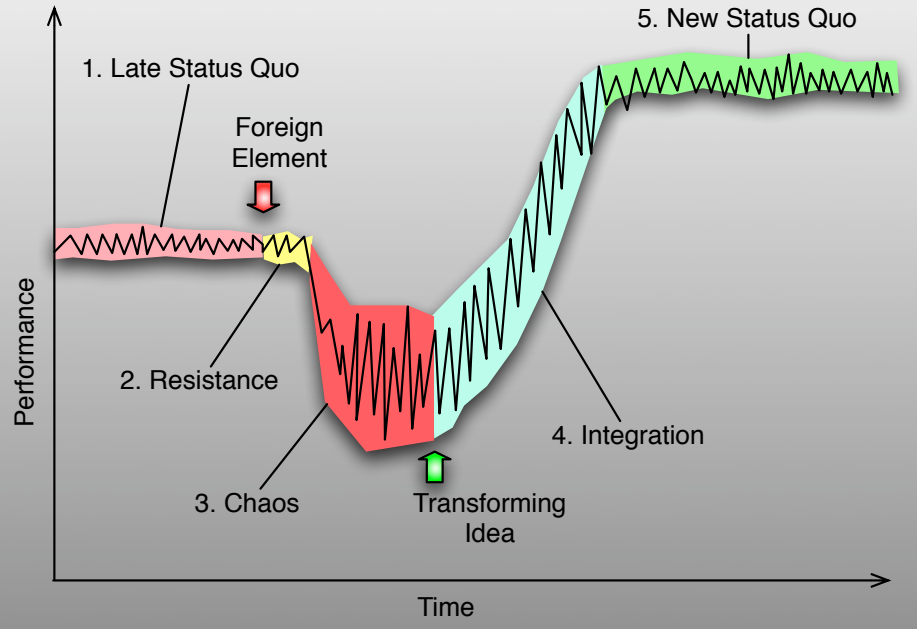
But Change is Hard!

Organizational Change



Virginia Satir Change Model

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What is Agile?

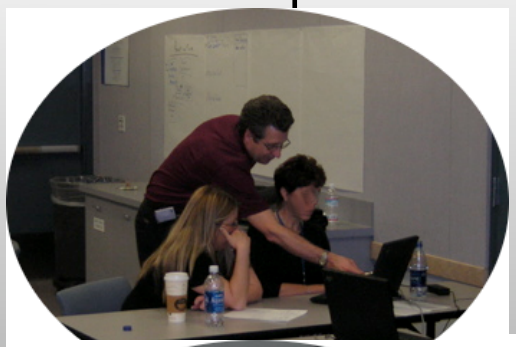
What is Agile?

- *Agile software development is a conceptual framework for undertaking software engineering projects.*
  -- wikipedia
- a.k.a. Extreme Programming, Scrum, Feature Driven Development, DSDM, Crystal Clear, Agile Unified Process

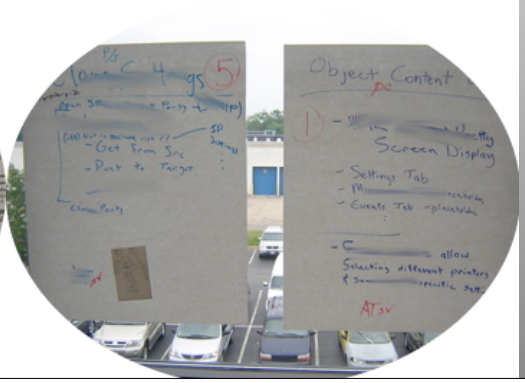
www.agilemanifesto.org

Individuals and Interactions
over Processes and Tools

Working Software
over Comprehensive Documentation



- Each team has different needs
- Less formal documentation might work.
- Prefer executable Documentation

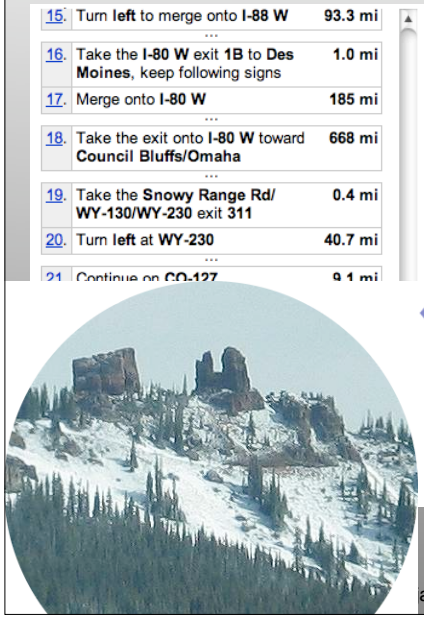


Customer Collaboration
over Contract Negotiation

Responding to Change
over following a plan

Drive: 1,121 mi (about 17 hours 43 mins)

15.	Turn **left** to merge onto **I-88 W**	93.3 mi
16.	Take the **I-80 W** exit **1B** to **Des Moines**, keep following signs	1.0 mi
17.	Merge onto **I-80 W**	185 mi
18.	Take the exit onto **I-80 W** toward **Council Bluffs/Omaha**	668 mi
19.	Take the **Snowy Range Rd/ WY-130/WY-230** exit **311**	0.4 mi
20.	Turn **left** at **WY-230**	40.7 mi
21.	Continue on **CO-127**	9.1 mi



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Em
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Agile Practices Support the Iterative Model

- Iterative and Incremental Development
- Concurrent Engineering
- Teamwork
- Continuous Planning/Tracking
- Fine-Grain Scope Control
- Evolutionary Design
- Automated and Continuous Testing

Feedback

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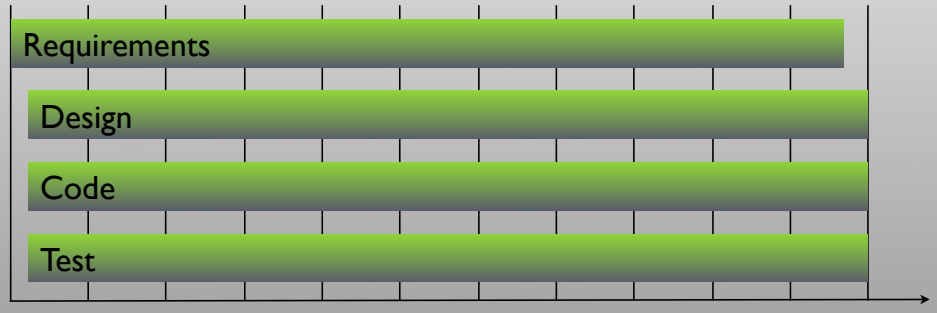
Iterative and Incremental Development

Projects end, products don't (hopefully)

Requirements analysis is never done
Design is never done

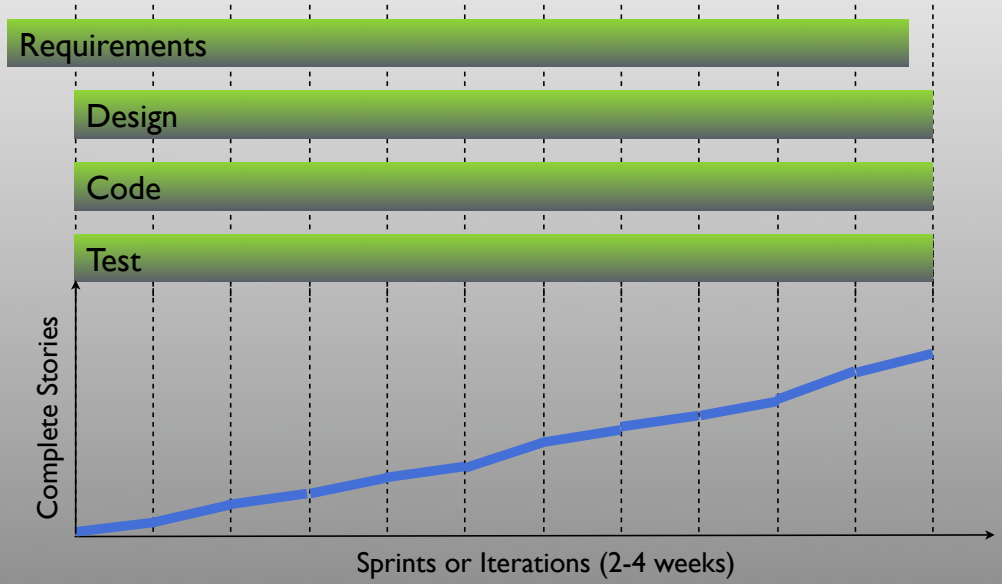
Iterative and Incremental Development

Parallel instead of Serial



Working software delivered each iteration.

Track Projects Based on Functionality Built and Tested



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Teamwork

Teamwork

- Shared workspace (lab)
- Collaborative development
  - Pair programming
- Accessible customer
  - Usually an internal customer
- Shared code ownership
- Continuous Integration

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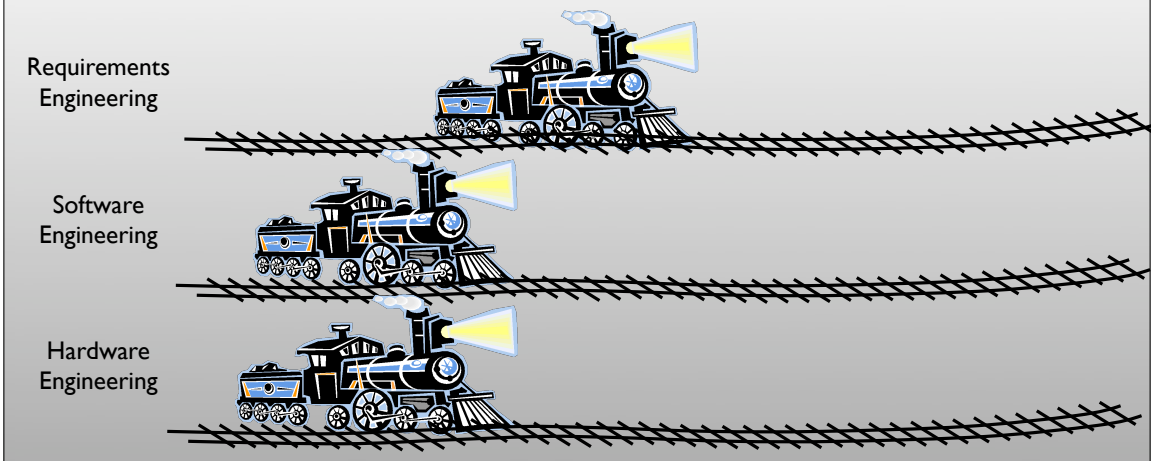
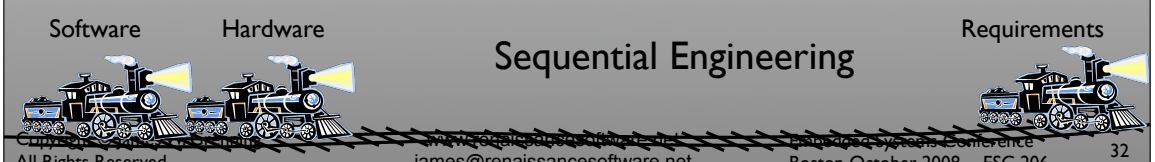
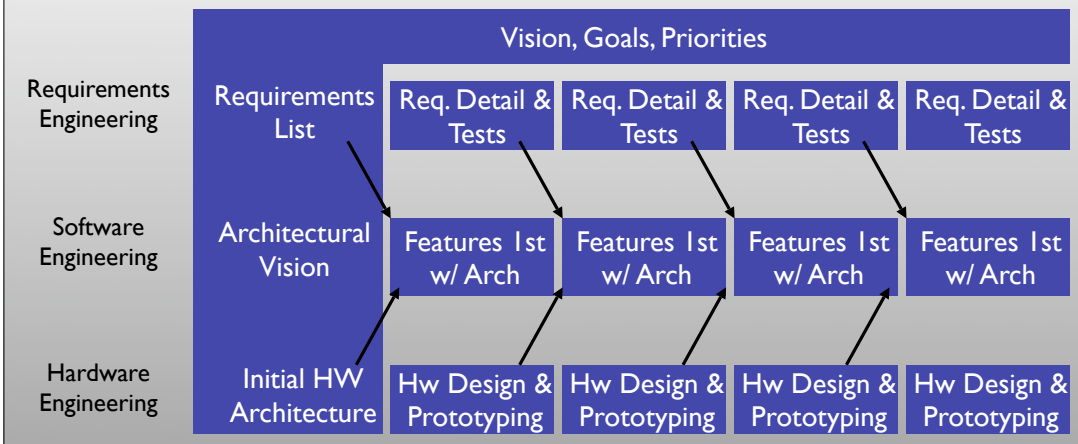
Concurrent Engineering

Concurrent Engineering





Concurrent Engineering



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Fine Grained Scope Control

Fine-Grain Scope Control

- Story
  - Something the system must do
  - Like a use case, part of a use case, or scenario
- Stories
  - Provide value
  - Demonstrate progress
  - Reduce risk
  - Can be estimate
  - Can be tested
  - Many fit into an iteration

Stories and Acceptance Tests

- Stories lack detail
- Details are provided in automated acceptance tests
- The test are like executable use cases
- Test either pass or fail

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Getting Technical

Evolutionary Design

- All designs evolve
- Change is a fact of life
- Team works towards an Architectural Vision
- Details are worked out JIT in code
- Good designers needed hands-on
- Designs evolve using Refactoring techniques
- Bigger teams need more formality

Automated Testing

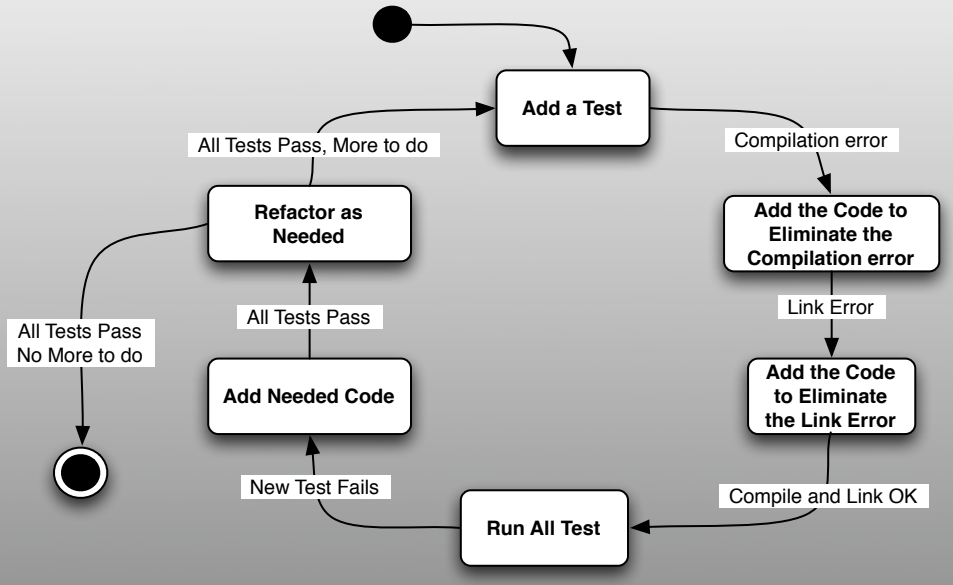
- Key to evolutionary design is keeping the cost of retest low
- 25% of defects are introduced while changing existing code
- Automated tests keep that cost low
- Test are run with every change

Where is the Time Going?

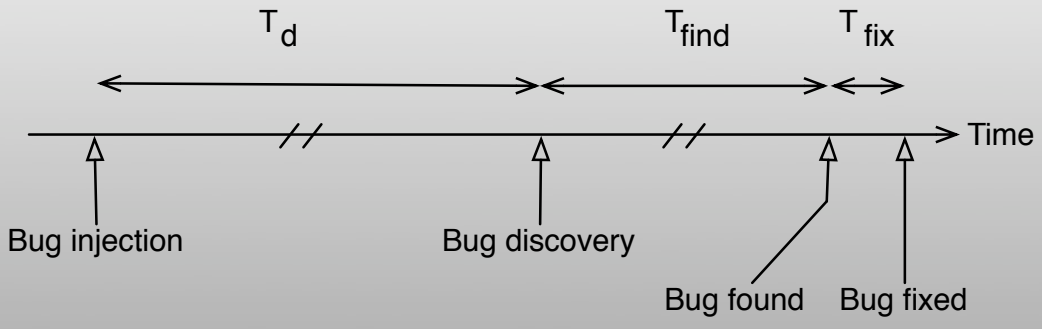
- 50% to Debug is commonly claimed
- 25% of all defects are introduced while changing and fixing code [R.B Grady, Software Process Improvement]

- One messed up project…
  - 5 months in requirements
  - 3 months development
  - 6 one month test and fix cycles

TDD Unit Testing State Machine

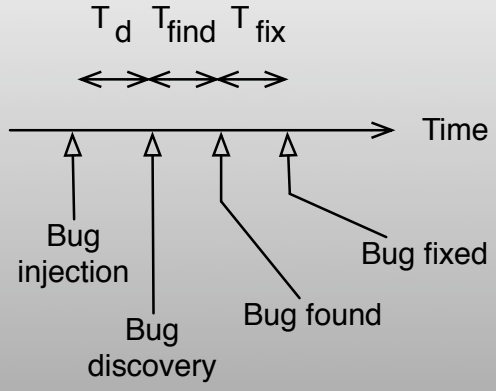


The Physics of Debug Later Programming (DLP)



- As T_d increases, T_{find} increases dramatically
- T_{fix} is usually short, but can increase with T_d

The Physics of Test Driven Development



- When T_d is short T_{find} is short
- It is so short that it is not even considered a bug

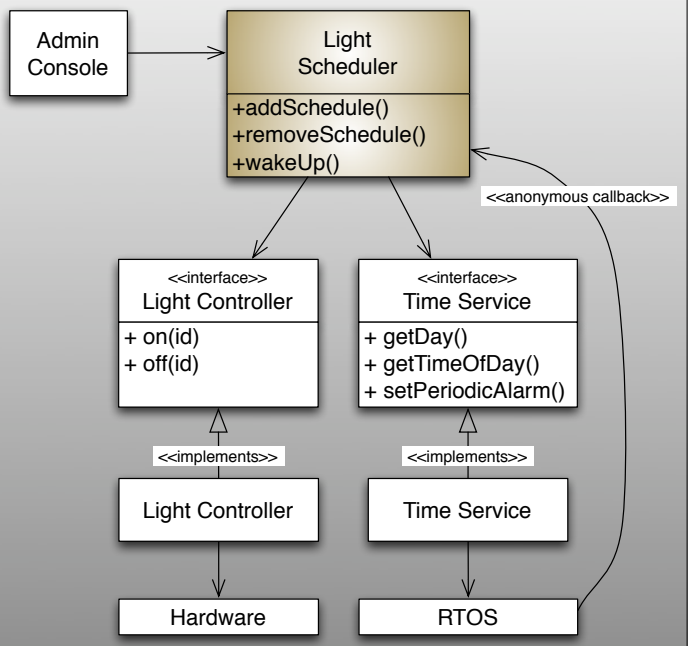
Example Automated Test - sprintf()

```
TEST(sprintf, formatString)
{
    char buffer[20];
    memset(buffer, 0xaa, sizeof(buffer));
    LONGS_EQUAL(12, sprintf(buffer, "%s\n", "Hello World"));
    STRCMP_EQUAL("Hello World\n", buffer);
    BYTES_EQUAL(0xaa, buffer[13]);
}


TEST(sprintf, formatInt)
{
    char buffer[20];
    memset(buffer, 0xaa, sizeof(buffer));
    LONGS_EQUAL(12, sprintf(buffer, "i=%i\n", 10));
    STRCMP_EQUAL("i=10\n", buffer);
    BYTES_EQUAL(0xaa, buffer[7]);
}
```

Program to Interfaces

- Separate interface and implementation as separate entities.
- This design has good separation of responsibilities

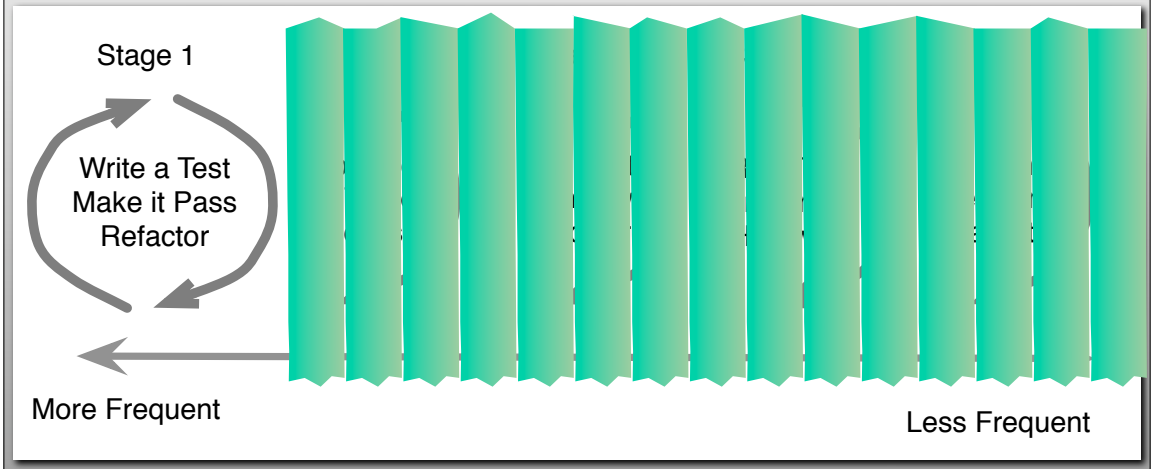


Automated Test Example - Scheduler

```
TEST(LightScheduler, ScheduleWeekdayItsSunday)
{
    LightScheduler_ScheduleTurnOn(3, WEEKDAY, 1200);
    FakeTimeService_SetDay(SUNDAY);
    FakeTimeService_SetMinute(1200);
    FakeTimeService_MinuteIsUp();
    LONGS_EQUAL(-1, FakeLightController_getLastId());
    LONGS_EQUAL(-1, FakeLightController_getLastState());
}

TEST(LightScheduler, ScheduleWeekdayItsMonday)
{
    LightScheduler_ScheduleTurnOn(3, WEEKDAY, 1200);
    FakeTimeService_SetDay(MONDAY);
    FakeTimeService_SetMinute(1200);
    FakeTimeService_MinuteIsUp();
    LONGS_EQUAL(3, FakeLightController_getLastId());
    LONGS_EQUAL(1, FakeLightController_getLastState());
}
```

TDD Adaptation for Embedded Development



Specific Benefits for Embedded

- Reduce risk by verifying code independent of hardware
- Reduce long compile/link/load cycles
- Reduce debugging on target
- Isolates and models HW/SW interactions
- Improves design by isolating hardware dependencies
- Improves portability
- Develops a test safety net

More Embedded TDD Resources

- TDD in C Exercise
  - Please send me an email.
- www.renaissancesoftware.net/blog
  - TDD device driver example
  - Others
- Previous ESC presentations on my website
- yahoogroups.com/AgileEmbedded

Continuous Testing

- Testing starts on day one
- Tests provide the specification of what is to be developed
- QA/System Test moves upstream.

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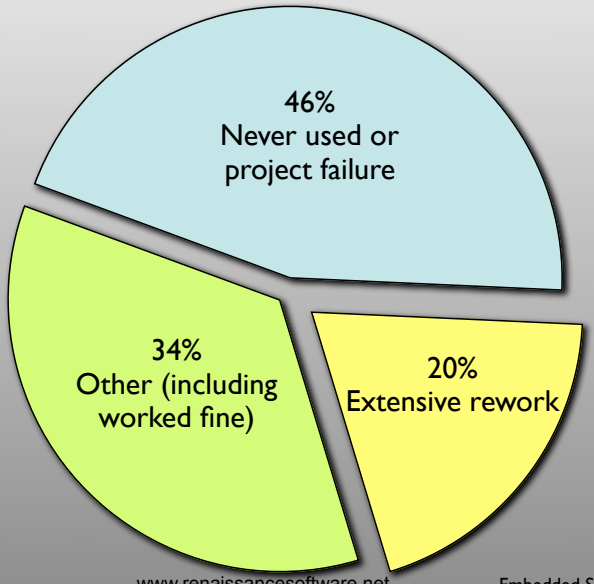
What's Wrong With Waterfall?

Why Change? What's Wrong with Waterfall?

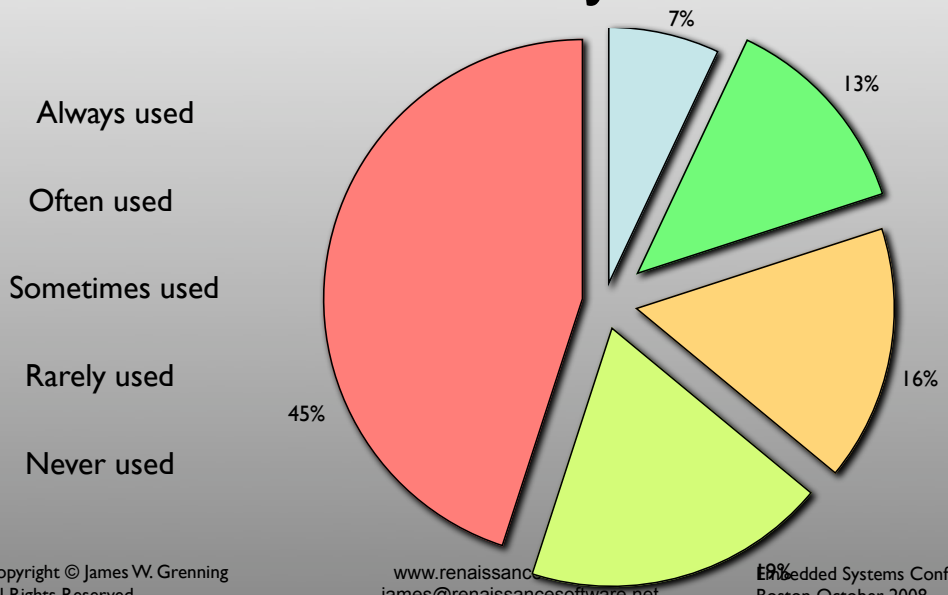
- Recommended Reading
  - Iterative and Incremental Development: A Brief History [LARMAN]

Waterfall Projects Fail at a High Rate

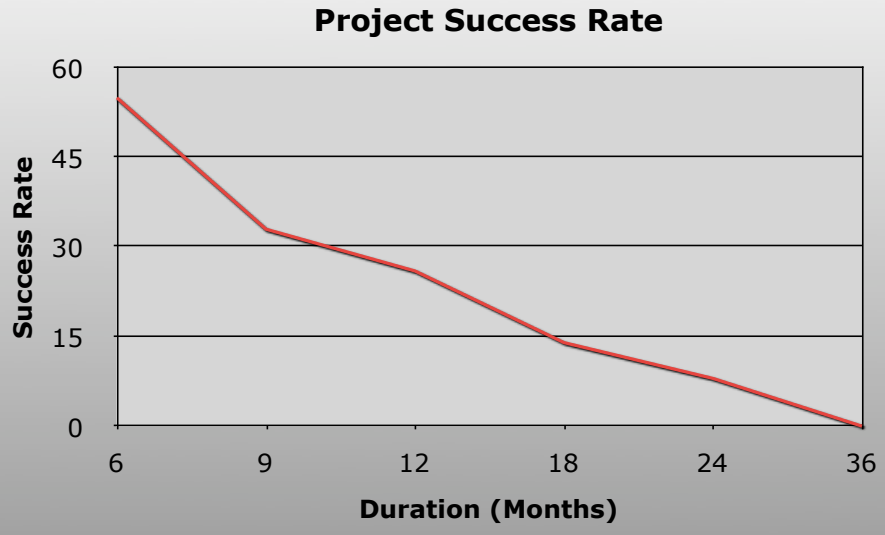
Jarzombek99 Study - Project Success/Failure



What Happens when the Requirements are Committed Too Early?



Long Projects Fail



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What's Right about Iterative?

Why Iterative?

- A system's users seldom know exactly what they what and cannot articulate all they know
- … There are many details we can only discover once we are well into implementation
- … as humans we can only master only so much complexity
- … external forces lead to changes in requirements…

[LARMEN]

Iterative is Not new

Iterative is Not New

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Agile is the name of the *Renaissance* that software development is experiencing.

Review Questions and Comments

- Agile Practices Support the Iterative Model
  - Iterative and Incremental Development
  - Concurrent Engineering
  - Teamwork
  - Continuous Planning/Tracking
  - Fine-Grain Scope Control
  - Evolutionary Design
  - Automated and Continuous Testing

Feedback

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