PRICE®

COST ESTIMATION SOLUTIONS

Estimate with Confidence™

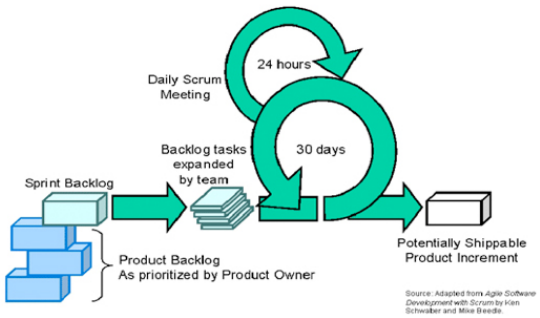


Agile Estimation for Space Software

Agenda

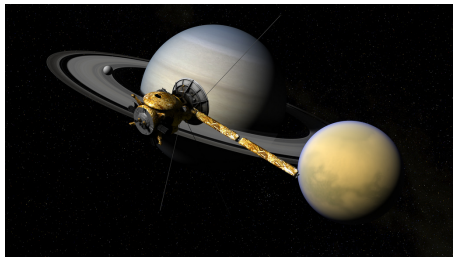
- Introduction
- Agile Software Development
- Agile in Space
- Size and Cost Estimation for Agile Software Development
- Wrap Up

Agile and Scrum Process



Introduction

- **Agile development practices have enabled organizations to deliver quality software that optimizes customer satisfaction**
  - But is agile for every type of project
- **Space and other mission critical software have high reliability, fault tolerance requirements with strict safety and performance criteria**
- **Organizations developing space based software are looking for ways to do development faster, better and cheaper**
- **Can agile development practices facilitate this requirement**



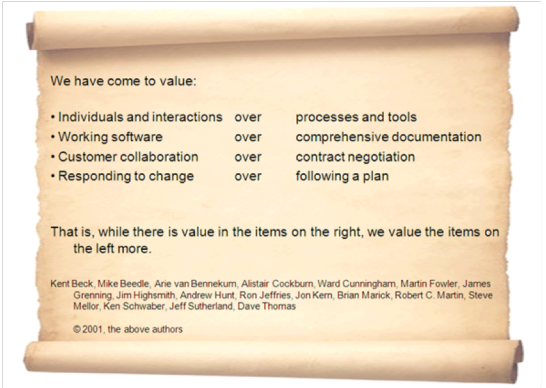
Introduction

- Back in the day … Complexity of applications was overshadowed by the logistics of implementation
- Technology improved … today software solves increasingly complexity problems
- The so called ‘software crises’ (mid 60’s to 80’s) resulted in many ‘silver bullet’ type solutions
- Lots of smart software development professionals began looking for more lightweight methods to address complexity in achievable chunks

Agile Software Development

Agile Manifesto

- We are discovering better ways of developing software by doing it and helping others do it
  - Individuals and interactions over processes and tools
  - Working software over comprehensive documentation
  - Customer collaboration over contract negotiation
  - Responding to change over following a plan
- All agile projects adhere to this manifest
- All agile projects share a common set of principles
- Each agile project uses a unique set of agile practices to implement these principles
- Successful estimation for an agile project is like software estimation for any project – you need to understand the project properties and the practices employed


We have come to value:

• Individuals and interactions	over	processes and tools
• Working software	over	comprehensive documentation
• Customer collaboration	over	contract negotiation
• Responding to change	over	following a plan

That is, while there is value in the items on the right, we value the items on the left more.

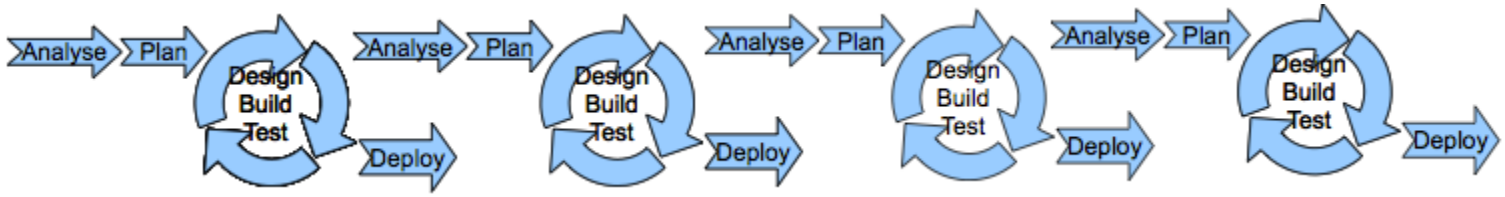
Kent Beck, Mike Beedle, Arie van Bennekum, Alistair Cockburn, Ward Cunningham, Martin Fowler, James Grenning, Jim Highsmith, Andrew Hunt, Ron Jeffries, Jon Kern, Brian Marick, Robert C. Martin, Steve Mellor, Ken Schwaber, Jeff Sutherland, Dave Thomas

Traditional Software Development

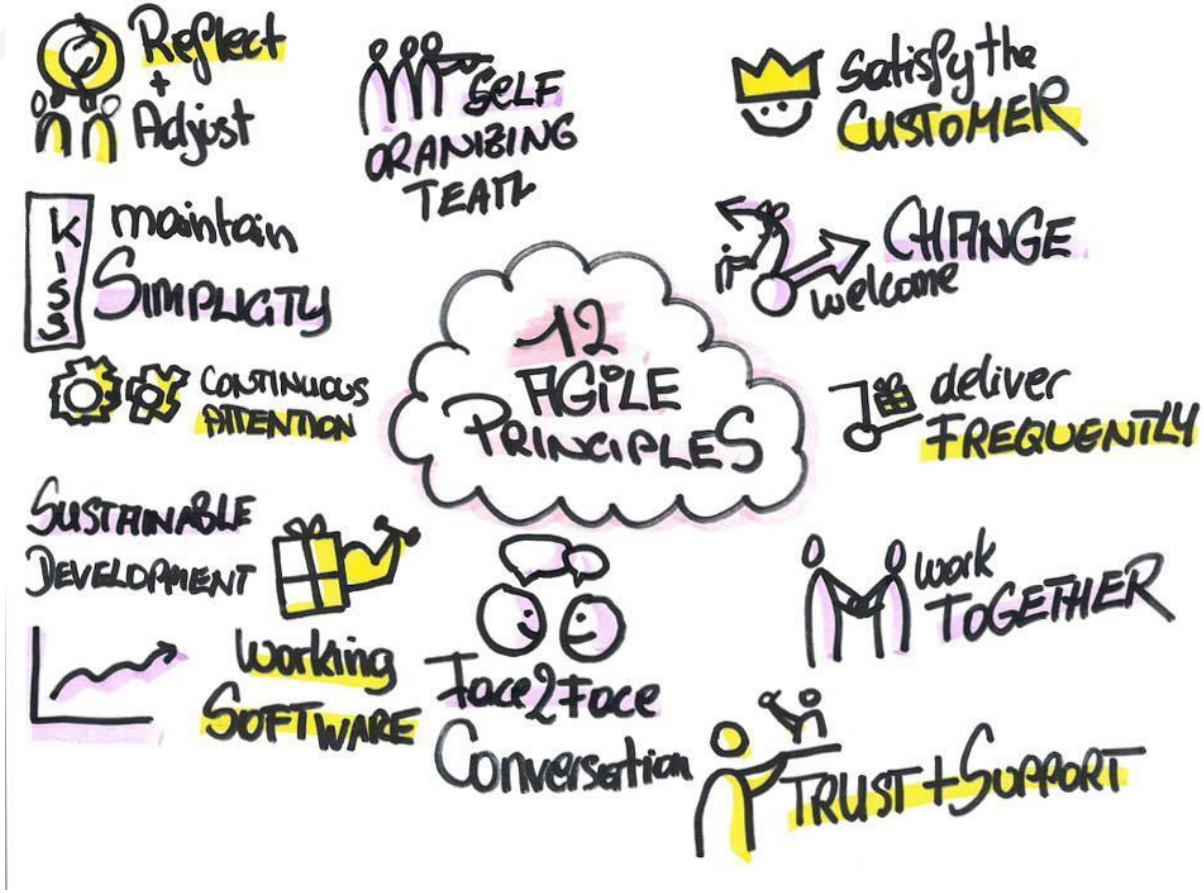
- Requirements are analyzed
- Architecture and design are created
- Requirements are implemented, tested and delivered
- Months (or longer) occur before there is usable software for the customer to evaluate

Agile Software Development

- Usable chunks of software are developed in short periods of time (sprints, iterations, etc.)
- Requirements are translated into user stories and become the project backlog
- User stories deliver business value and are small enough to complete in an iteration
- Customer works with team and reviews software regularly
- Each iteration focuses on the user stories that are currently the highest priority of the customer
- Priorities may shift from iteration to iteration
- Agile teams expect and embrace change

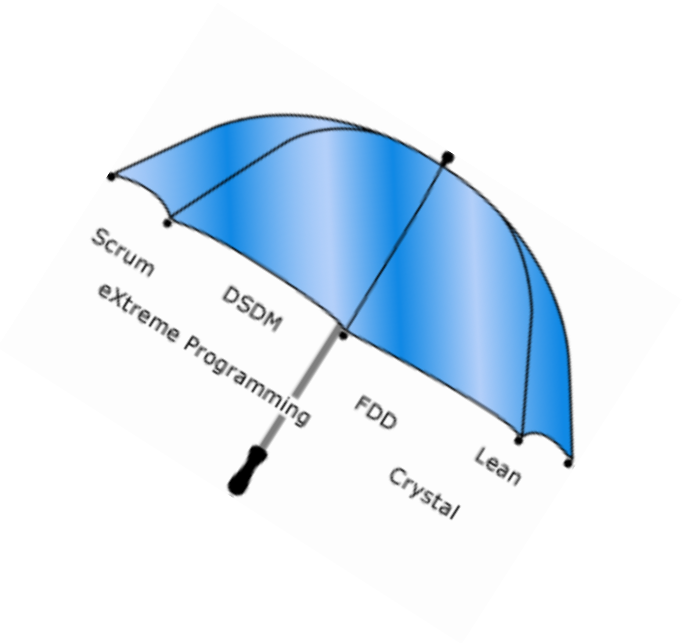


12 Guiding Principles for Agile Development



Common Agile Practices

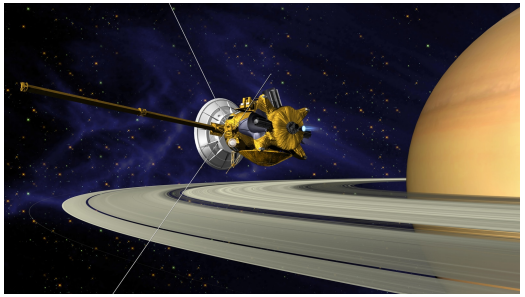
- Pair programming
- Continuous integration with automated testing
- Test driven development
- Daily stand up meetings
- Co-located teams
- Code refactoring
- Small releases
- Customer on team
- Simple design



Agile in Space

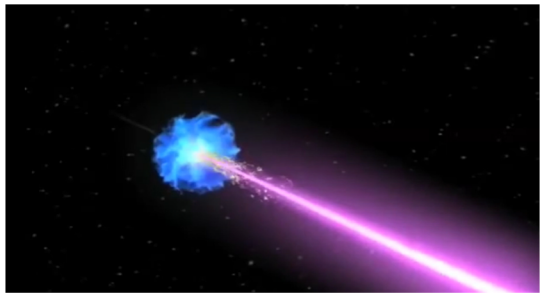
Agile in Space

- **"NASA was agile before agile was a common term"**
  - Jim Highsmith – one of the 17 original authors of the manifesto – worked for NASA at one point
- **In 1962 – John Paup was a senior NASA manager planning part of the Apollo program**
  - First thing every morning all key people reported to his office for a stand up meeting
- **NASA Ames – Mission Control Technologies**
  - Adopted a hybrid agile solution – segregating activities constrained by mission criticality from those more standard development activities
- **Cassini Mission**
  - 2015 (more than 10 years after the mission started) – the maintenance team has adopted a hybrid agile process for software changes
- **Software Probe Plus – built by JHU/APL**
  - Several of the ground system software module teams are adopting agile practices



Challenges to Being Agile in Space

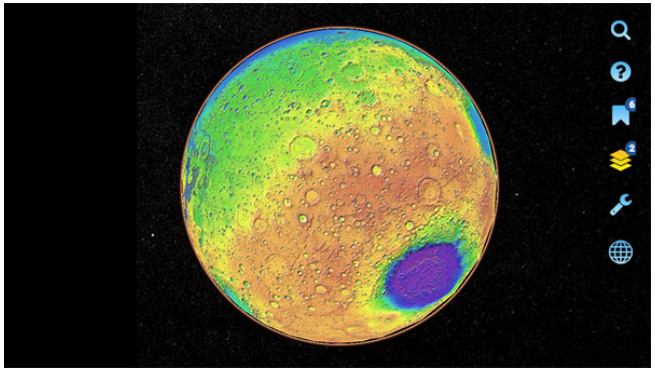
- **Requirements for Compliance to industry standards and sponsor requirements**
  - CMMI
  - AS9100
  - NASA Software Engineering Requirements (NPR 7150.2B)
  - European Cooperation for Space Standardization (ECSS)



- **Requirements for detailed documentation**
- **Requirements flexibility (or lack there of)**
- **Detailed up front planning**
- **Requirements for specialized capability (as opposed to agile teams composed of generalists**
- **Formalized customer interfaces**

But agile is a philosophy not a development process

- **Hybrid applications make the most sense for space systems**
- **Agile practices that make sense**
  - Small teams evolving product in small visible steps
  - Daily stand up meetings
  - Pair programming
  - Continuous automated testing
  - Test driven development
  - Collaborative planning (including the customer)
- **Agile practices less likely to make sense**
  - Evolving requirements
  - No formal up front planning
  - Little to no documentation
  - Refactoring



Agile Cost Estimation

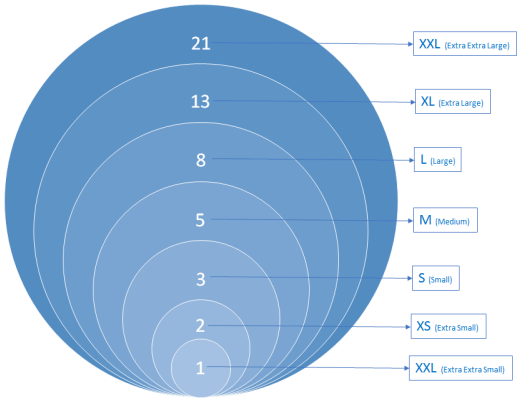
Agile estimation

- **Frequently asked questions**
- **How to estimate size for an agile project when the team is working with Story Points?**

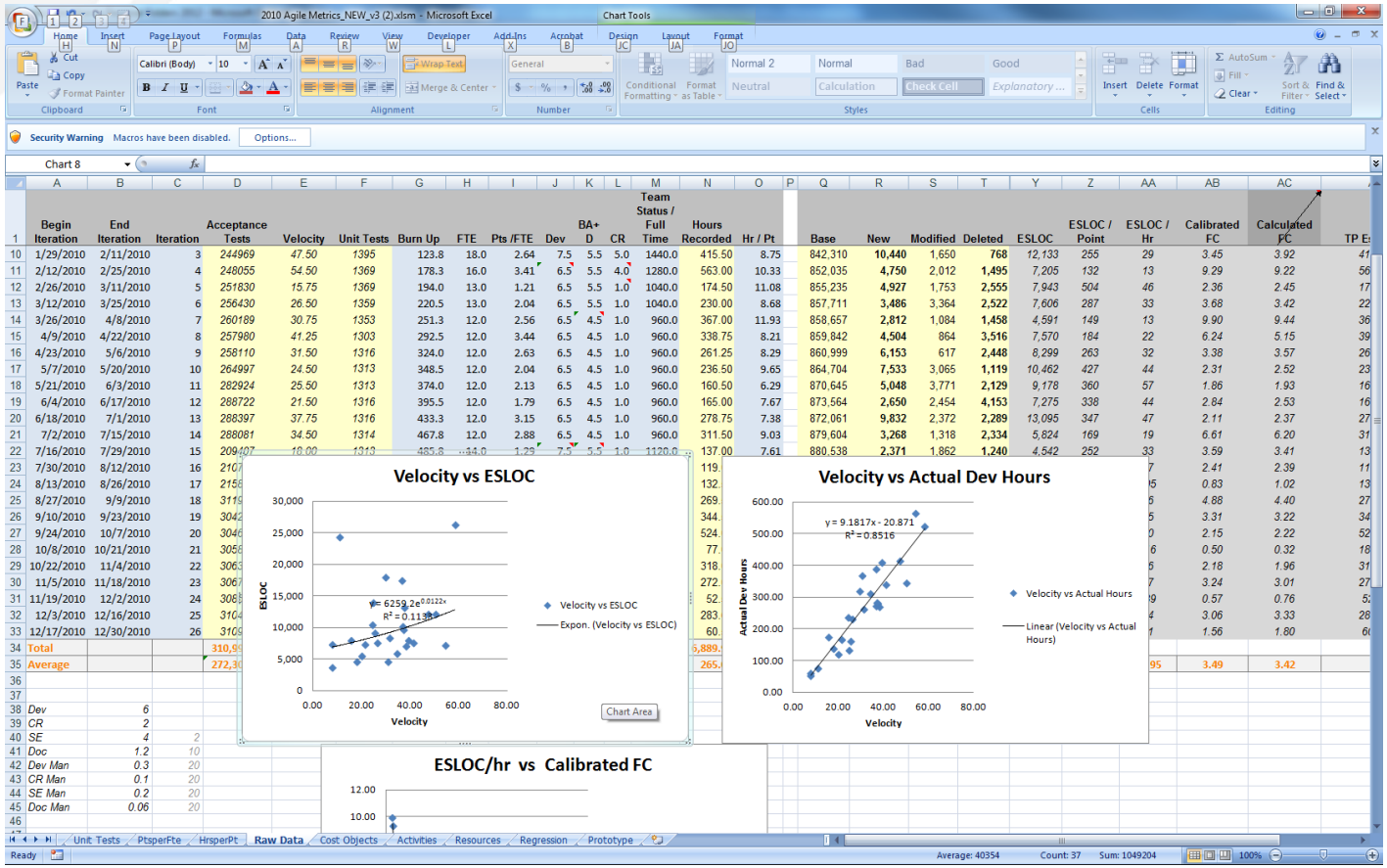
- **What other cost drivers are indicated for an agile development project?**

Agile Size Estimation

- **Agile teams do a lot of their own estimation**
- High level estimation as the backlog is created in the beginning of a project (Sprint 0)
- **Estimates are notional and only make sense to the team**
- Story points
- T-Shirt size
- **Estimators challenge is to translate the teams knowledge into a size measurement that relates to their Cost Estimating Relationships (CERs)**
- **In the context of a parametric model – agile size measures actually combine two typical cost drivers**
    - Size
    - Complexity

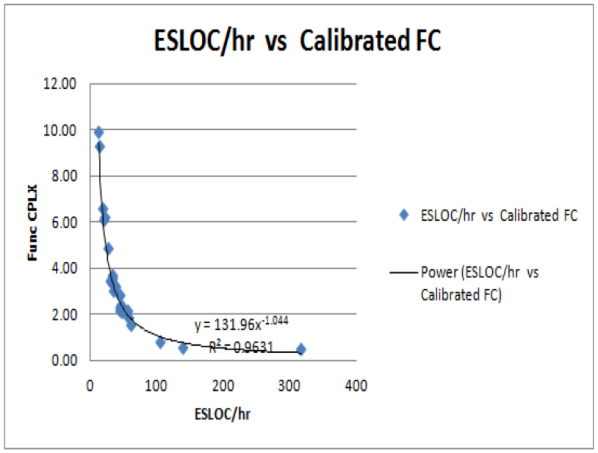


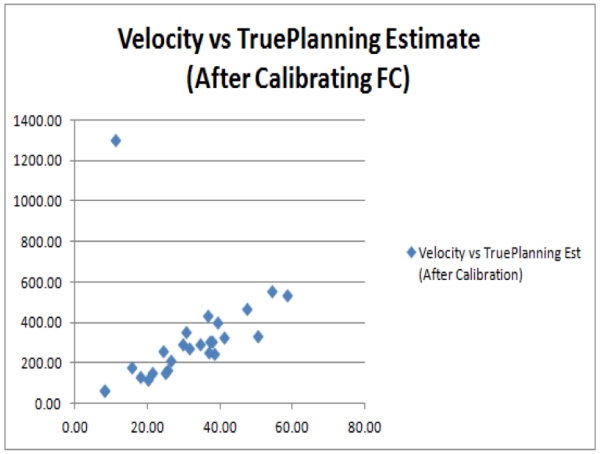
Fortunately agile teams collect lots of metrics



Agile Size Estimation

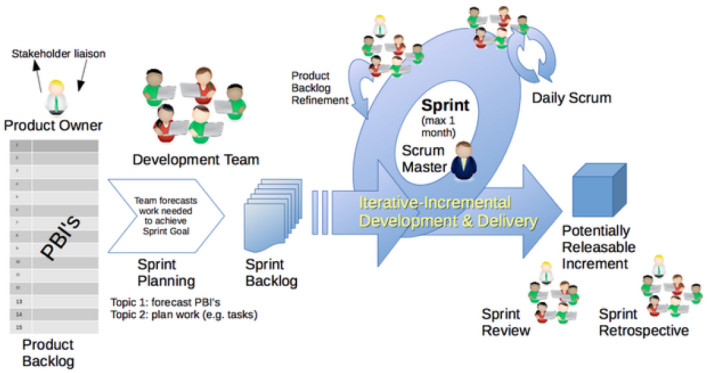
- Study of PRICE's agile data found no correlation between story points and software size or effort
- Did fine a significant relationship between software size and complexity (Functional Complexity in the PRICE model) pairs and effort.





Agile Cost Drivers

- The fact that your project is agile is not a cost driver
- There are potential cost implications to adopting agile practice
- Estimation team needs to determine which agile practices apply



Agile Cost Drivers

- **Agile teams tend to be highly skilled**
- Hard to be a slacker in an agile environment
- Working closely with high skilled team members, learning curve for new members is quick
- Input parameters to your model indicating team experience would be affected
- **Agile teams tend to have tool sets that are quite sophisticated**
- This would be especially true on teams working with space systems as it would greatly facilitate compliance to standards
- Input parameters around tools or automation would be affected

Agile Cost Drivers

- **Co-location of teams should improve team productivity**
- Culture of interruption
- Questions answered in real time
- Team cohesion increases
- Co-locating stakeholders and SMEs with development team creates a real time IPT
- Well run stand-up meetings increase productivity and quality
- Cost drivers indicating distribution of team and communication practices would be affected

Agile Cost Drivers

- **Continuous integration with automated testing should increase delivery productivity**
- Important in space systems to maintain safety critical compliance requirements.
- Code is checked in frequently and builds are run and test regularly before developers forget what they changed
- Red tests raise red flags – team fixes them right away
- Since little code is changed, errors are east to track down
- Fixes occur quickly
- Cost drivers focused on integration test complexity would be affected

Conclusion

- **While not all agile practices make sense for space systems development, there are many that can (and have) improved the ability to deliver high quality space system software**
- **A hybrid version of agile is most appropriate for safety critical software**
- **NASA has been successfully employing agile on many programs for many years**
- **Estimating an agile program is no different that estimating any other software**
- Understand the program and the process being employed
- Study data from previous similar programs
- Discuss project particulars with the delivery team