Model Driven Software Development,  
A Case Study 
The Good, the Bad and the Ugly

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# Report Documentation Page

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MDSD Case Study: Agenda

- The Good, the Bad and the Ugly
- Model Driven Software Development – The Basics
- Case Study Scope and Method
- The Raytheon System
- The MDSD Components
- MDSD Summary Results
- MDSD Consultants
- Shortcomings of MDSD Program Use
- Advantages of MDSD Program Use
- New Technology Adoption Factors
- Towards a Culture of Change
- Suggested Improvements
The Good, The Bad, The Ugly

- **The Good**
  - *Model Driven Software Development (MDSD) reduced development time, staffing and cost*

- **The Bad**
  - *Model Driven Software Development was not fully embraced by the development and integration teams*

- **The Ugly**
  - *Model Driven Software Development has not gained the adoption we would like to see*

There are many sides to the MDSD story
Model Driven Software Development – The Basics (1 of 3)

Traditional Software Development

Model Driven Software Development
Model Driven Software Development – The Basics (2 of 3)

- Model-Driven Software Development is the term used for defining systems, including behavior, in models, and then using the models to generate deliverable code.

- Platform Independent Model (PIM) of an application’s functionality and behavior.

- Developers mark up the PIM with platform specific notations.

- Models transformed to code using standardized mappings for specific target platforms (can be provided by mature tool such as PathMATE by Pathfinder Solutions).


- Design and code are always synchronized.

MDSD raises the level of abstraction.
Case Study Scope and Method

■ Why:
  – Uncover the pros and cons of MDSD use on a program
  – Provide insight to how we can improve MDSD deployment
  – Communicate to engineers and managers

■ What:
  – A retrospective of the deployment of MDSD on one Raytheon program
  – Interviews with 12 people:
    • Architects
    • Software Developers
    • Integrators
    • Program and Software management
  – Productivity and defect density metrics were collected from a Six Sigma project

Information in this presentation is from the interviewees and Six Sigma Report
The Raytheon System

System Description:

- A weapon system used against:
  - cruise missiles,
  - unmanned aerial vehicles (UAVs)
  - fixed-wing and rotary-wing aircraft
- The system integrates surveillance, command and control, fire-direction, fire distribution and engagement capabilities
- The system is currently delivered
The MDSD Components

- The Communications Architecture. Two of the message handlers (in green) were generated with MDSD
- The existing interfaces were reused from another contract

![Diagram of MDSD Components]
MDSD Summary Results

■ Positives:
  – Generally considered a success by managers and engineers
  – The customer was extremely happy with working components developed under budget, on time with lower defect densities
  – Under ran budget

■ Negatives:
  – Abstract development approach reduces understanding of system details
  – Harder to find the origin of a defect during integration
  – Extensive involvement from Pathfinder Solutions consultants

The Customer: “The Software Organization beat the budget – a refreshing change”
MDSD Summary Results Metrics

**Calculation approach:**
- Raytheon measures for productivity and defect density are based on Source Lines of Code (SLOC)
- MDSD code generation typically results in greater SLOC than traditional hand coding
- MDSD generated SLOC count was decreased by 50% to normalize measures which reduces productivity and defect density results
- MDSD Consultant costs and Developer training are embedded in Design, Code and Unit Test program costs

**Measures:**
- Planned for traditional coding approach. Only used 65% of planned developers
- Design, code, unit test and integration (DCTI) **productivity** for both Message Handlers was at least 44% **greater** than standard
- **Defect Density** (defects per KSLOC) was 1/3 **business average**
MDSD Consultants

- Pathfinder Solutions (vendor of PathMATE) highly recommends the use of consultants to get a project off on the correct path

Pros:
- High caliber consultants
- Available for quick fixes to PathMATE (pro & con)
- Provided training and mentoring on architecture methodology, OO design and PathMATE specifics

Cons:
- If the tool were more stable, there was better documentation or Raytheon had more expertise, there would be less need for consultants
- Use of consultants side by side with developers calls productivity into question
- The use of consultants may not be scalable for deployment to Raytheon
Shortcomings of MDSD Program Use

Tool:
- Debugging during integration is more complex
- Need fairly extensive experience with the toolset to make it work properly
- Training and mentoring was required for success when developers preferred to write code
- Very simple changes may require knowledge of multiple tools rather than just a programming language and compiler
- VxWorks integration was immature

People:
- Not all engineers adapt well to new methods and levels of abstraction
- Hands-on training is best for comfort with new tools
- Mentors must be available
- MDSD is built on OO. Therefore, a solid OO foundation is beneficial
- Lots of communication is required
Advantages of MDSD Program Use

- Trivial task to make some global changes
  - Changed 72-word message format to and 80-word message format for hundreds of messages in 1.5 weeks
- Application code generated by MDSD resulted in lower defect density
- Design and code are always in sync
- Method enforced common vocabulary and design guidelines
- Collaborative approach to architecture and design

Program Office Quote “The customer was so impressed that for a year the MDSD success was mentioned in their viewgraphs”
New Technology Adoption Factors

- Risks and opportunities must be communicated
- The advantages and disadvantages must be communicated
- Expect challenges with technology when it is new to the development team
- Not every engineer is ready for the challenge
- Hands on training for all team members is key
- Mentors/consultants need to be available
- Must communicate successes (productivity and quality) to team

The Defense industry and its partners are risk averse – we still need to make forward progress with new technologies
Towards a Culture of Change

- At a Corporate level, Raytheon realizes that new technologies drive better productivity and products.
- Raytheon has been adopting more technology-based development paradigms (Agile, Lean, MDSD, Domain Specific Languages, Software Factories).
- Raytheon software management respects and rewards technology adoption.
Suggested Improvements for Technology Deployment

- Select teams based on their experience and willingness to engage with new technology
- Ensure effective training for all engineers no matter when they join the project
- Existing processes and measures do not always neatly map to new technologies. New processes and measures need to be incorporated to foster wider adoption
- Continue to investigate new MDSD tools and technologies
- Encourage engineers and managers to understand MDSD benefits and pitfalls
- Provide feedback on productivity, schedule and quality status to developers
Summary

Methods  Tools  Training  Communication  SUCCESS
Acronyms

- **MDSD** – Model Driven Software Development
- **OO** – Object Oriented
- **SLOC** – Source Lines of Code
- **UML** – Unified Modeling Language