Architecting Algorithms with Mathematica

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Outline

- Background on ScienceOps
- Project based Algorithm Development
- ScienceOps projects and Mathematica
- Algorithm Development in Mathematica
- Conclusions
ScienceOps Background

- Founded in December 2001
- First client - Blue Origin
  - Jeff Bezos space company
  - www.blueorigin.com
- Business model
  - Algorithm expertise applied across industries
  - Vertical technology applied horizontally across industries
  - Team of experienced Ph.D. scientists
  - Using the right tools (Mathematica)
  - Small and medium business
  - Client owns all Intellectual Property (IP) developed
Project based Algorithm Development

- Scoping study first
- Firm fixed price contract
- Heavy emphasis on documentation
  - Client must fully understand
- Using the right tools (Mathematica)
- NDA
SciCode Process
ScienceOps projects using Mathematica

- Blue Origin – Aerospace
- *High Tech Comat – Lumber industry*
- *BAE Systems – Aerospace*
- Phoenix Learning – Scheduling algorithm
- *Warmly Yours – Industrial*
- IRRI REML – Agriculture in 3rd World
- Roche Molecular Systems – Cluster Analysis
ScienceOps projects using Mathematica (cont.)

- Follett HEG – Book store inventory prediction
- Right Media – Internet ads
- NIH – SBIR, Optical Mapping of DNA
- **DARPA – Space physics**
- NASA – Space Tether systems
- TideWorks Technology – Hazardous Material handling
High Tech Comat – Lumber industry

- Finding optimal center line of log
- Constrained spline developed in Mathematica
Validation of guidance algorithms for IR missile counter measures
Examined all specifications
Developed independent Mathematica models
Developed webMathematica interface to allow for their QA
Warmly Yours – Industrial

- In floor electrical heating system
- www.WarmlyYours.com
- Given an arbitrary room with product connection constraints, how best to fit
- Mathematica designed algorithms
- Mathematica used to render XML solutions
- In production creating over half their designs
- Final form of algorithm in C#
Warmly Yours – Room #1 Layout
Warmly Yours – Room #1 Solution
Warmly Yours – Room #2 Layout
Warmly Yours – Room #2 Solution
Warmly Yours – Room #3 Layout
Warmly Yours – Room #3 Solution
Warmly Yours – Room #4 Layout
Warmly Yours – Room #4 Solution
DARPA – Space physics

- Remediation of Van Allen Belt with Electro-static space tether systems
- Seedling funded by DARPA
- Mathematica used for all modeling of system interactions with Van Allen Belt
  - Optimally designed system performance
- Nominated by SPO for DARPA technical achievement award at DARPA Tech 2004
- Article in Space.com
- Threat topic covered in Scientific American Jun 2004
HiVolts System
HiVolt Remediation

![Graph showing flux distribution and pitch angle over time.](image-url)
Approach to Algorithm Development

- Mathematica notebooks record of key analysis
- Test candidate algorithm analysis
- Structured approach
  - Module
  - Testing section
- Sharing results
  - OS independent
- Handling large projects
- Validation during QA
Conclusions

- Mathematica is key to ScienceOps success
  - Quickly finding the best algorithm for client
- Clients typically are not aware of Mathematica
  - Are impressed with results (time and quality)
- ScienceOps plans to use Mathematica as a computational engine
- Most of our clients have a real need for Mathematica based analysis and solutions (80%+)
- Enterprise market is hugely untapped for use of Mathematica