NASA GMAT
Space Mission Design for Everyone

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Overview

Mission Design
  What is it?
  How do we do it?

GMAT
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  Getting Started

The Bigger Picture
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The Bigger Picture

Why are we here?
To tell you what we’re doing, and to let you tell us how to do it better.
Mission Design: What is it?

Intuitively, mission design answers the question:

How do we get from point A to point B (in space)?

Mathematically, it solves the equation:

\[ F = ma \]

Usually there are many possible answers. We want to find the one that is:

Fastest;
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Usually there are many possible answers. We want to find the one that is:

Fastest; Cheapest; Safest; Best
Mission Design’s Greatest Hits

Apollo

free-return trajectory
Mission Design’s Greatest Hits

Cassini

gravity assists
Mission Design’s Greatest Hits

SMART-1

low thrust
Mission Design: How do we do it?

With lots of math.

\[ F = ma \]

Forces: simple gravity, non-spherical gravity, third-body gravity, solar radiation pressure, atmospheric drag, propulsion, general relativity

Algorithms: numerical integration, differential correction, optimization

Infrastructure: coordinate systems, time systems, state representations, physical constants, file formats, graphics
Mission Design: How do we do it?

And lots of software.

- STK
- FreeFlyer
- MATLAB
- Copernicus, Pyxis, MALTO, SPICE, CHEBYTOP, VARITOP, OTIS, Mystic, SBC, LTOC, MAnE, ...
- Self-written tools in Perl, Python, C/C++, VB, Java, ...
The Problem

Last year the Navigation and Mission Design Branch (size: 33 engineers) spent $800k on software licenses alone.

Software that we can’t examine, modify, debug, or learn from.
GMAT: The General Mission Analysis Tool

- Cross-platform desktop application (Windows, Mac, Linux)
- Domain-specific scripting language
- Written in C++ with wxWidgets
- Extensive force models, differential corrector, optimizers, estimators
- Graphics: 3D OpenGL, 2D plotting, 2D mapping
- Extensible via plugins, native functions, MATLAB functions
- Automation via C, TCP/IP, MATLAB
Major Features

- Developed by a team of private industry and NASA civil servants, led by Goddard Space Flight Center
- Contributions from NASA centers, other agencies, academia, industry, international users
- Open source, released under NASA Open Source Agreement (NOSA)
- Developed in public on SourceForge
Demos

Demo 1: ISS Simulation

Demo 2: OSIRIS-REx Design
Now Try it Yourself

GMAT ships with nearly 40 example mission scripts:

- Geostationary
- LCROSS
- MMS
- Mars transfer
- Lunar transfer
- Libration points

These and more are available on our wiki:
gmat.ed-pages.com/wiki/MissionLibrary
How do I get started?

Download the app:
sf.net/projects/gmat

Read through the docs:
gmat.sf.net/docs

Check out the wiki:
gmat.ed-pages.com/wiki

Ask on the forum:
gmat.ed-pages.com/forum

Follow the blog:
gmat.sf.net/blog
How can I help?

For experts...

- Look through our algorithms, math spec, design documents
- Recreate an interesting mission and post it to our library

If you can code...

- Help improve code quality
- Submit, verify, and quash bugs
- Follow our dev blog: gmatplugins.sf.net/blog

If you care about what we’re doing and just want to help...

- Hang out on the wiki and forum
- Help improve our documentation
- Share with your friends

Now, the bigger picture...

NASA has a history of supporting open source.

- NASA Open Source Agreement (NOSA)
- WorldWind: over 20 million downloads since 2005
- opensource.gsfc.nasa.gov (46 registered projects)
- opensource.arc.nasa.gov (23 registered projects)
- 2011 NASA Open Source Summit

nasa.gov/open
Thank you