Undergrad Research Opportunities in ASDL MBSE Branch

MBSE = Model-Based Systems Engineering

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Undergrad Research Opportunities (p1/2)

Example Projects

- Example projects & external collaborators:
  - NASA MBSE Pathfinder initiative (*see Project 1 below*)
  - US Navy (NAVAIR) Model-Centric Engineering (MCE) – UAV testbed (*see Project 2 below*)
  - NASA JPL: model-based systems engineering (MBSE); model-based wikis; embedded s/w; …
  - Boeing: MBSE model complexity & health management
  - Other emerging projects and sponsors
  - Most of our projects (but not all) require US Persons (US citizens or permanent residents)
  - Multiple potential position types (depending on interests) – see next slide

- 2013-2018 results for students for MBSE/SysML-related jobs:
  - Summer internships at Boeing, various NASA centers (ARC, GRC, JPL, JSC, LARC), Aerojet Rocketdyne, Harris Corp, No Magic Inc, Orbital ATK, …
  - Full-time hires (after graduation) at Boeing, various NASA centers (JPL, LARC), Lockheed Space Systems, US Navy contractors, …

NOTE: Our normal policy is that (a) first-semester 1st-year students and (b) new last-semester seniors are *not* eligible for these positions.

IMPORTANT: See also GPA requirement on slide #10.
Undergrad Research Opportunities (p2/2)  

Position Types & Timeline

- **Position Type1** desired skills (System Modeling Using SysML):
  - Strong interests in learning and applying SysML (see overview below)
  - A key requirement is an interest in SysML (no prior SysML experience required) and a willingness to learn and explore

- **Position Type2** desired skills (SysML & OOP Interfacing):
  - Strong interests in programming, especially object-oriented programming (OOP)
  - Experience with object-oriented languages (Java, python)
  - A key requirement is an interest in SysML (no prior SysML experience required) and a willingness to learn and explore

- **Position Type3** desired skills (Parametric CAD/CAE and Computing):
  - NOTE: We typically require that Type3 be combined with an interest in Type1 or Type2 per above.
  - Strong interests in parametric CAD/CAE and engineering computing in general
  - Experience with CAD parametric modeling, and/or CAE/analysis/simulation, etc.
  - Mostly we use the NX CAD tool by Siemens PLM Corp. Prior NX experience is helpful but not required (as long as you have a willingness to learn and explore). That said, at least some type of CAD experience is required (ideally including some parametric CAD experience, but not essential).

- **Position Type4** = combinations of two or more positions above

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**Normal Timeline**

**Semester 1**
- Learn SysML basics
- Apply in team project

**Semester 2 & Beyond**
- Increase SysML skills
- Apply in Sponsor projects

**After Semester 1**
- Seek internships that are MBSE/SysML-related

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SysML = The Systems Modeling Language  
www.omgsysml.org
Position Type1: System Modeling w/ SysML
Creating SysML models for examples similar to below (pg 1/2)

SysML Curriculum History & Formats
Statistics as of Dec 2014 — www.pslm.gatech.edu/courses (p1/2)

Georgia Tech Academic Courses

- Traditional grad/undergrad courses (full-semester)
  - ISYE / ME 8813 & 4803: Since Fall 2007 (~40-60 students per year)
  - Primary instructors: Profs. Leon McGinnis and Chris Paredis

- Georgia Tech professional masters degree courses
  - Professional Masters in Applied Systems Engineering
    www.pmase.gatech.edu (initiated 2009)
    » Blended distance learning and face-to-face format
    » Two-year program (~30 students per cohort)
  - ASE 6005: SysML-based MBSE course: each Spring (Peak, et al.)
    » Content = SysML 101/201 & 891/892, plus more homework etc.
  - ASE 6006: Systems Engineering Lab: each Fall
    » SysML-based system design project:
      SMAD/FireSAT++/EyasSAT (satellite mission)
  - ASE 6xxx: [most PMASE courses thereafter utilize SysML]

Team Advanced Projects (TAPs)

<table>
<thead>
<tr>
<th>Team</th>
<th>Short Name</th>
<th>System-of-Interest (SOI)</th>
<th>May-Jun 2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>GT60</td>
<td>GT60 Commercial Microturbine CHP (power generation equipment - gas turbine; CHP=combined heat power)</td>
<td></td>
</tr>
<tr>
<td>S2</td>
<td>SGS</td>
<td>Smart Grocery System Product Line 2013 (smart grocery system)</td>
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</tr>
<tr>
<td>S3</td>
<td>SPlane</td>
<td>Solar Plane (solar panel)</td>
<td></td>
</tr>
<tr>
<td>S4</td>
<td>DropX</td>
<td>DropX.1, Site-To-Store-To-You (unmanned aircraft system delivering site-to-store orders to customers)</td>
<td></td>
</tr>
<tr>
<td>S5</td>
<td>Hybrid Boat</td>
<td>Eco Power Boat Product Line 2013 (plug-in hybrid leisure boat)</td>
<td></td>
</tr>
<tr>
<td>S6</td>
<td>GMM</td>
<td>Green Mean Machine To Go (off-grid renewable energy system)</td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Team</th>
<th>Short Name</th>
<th>System-of-Interest (SOI)</th>
<th>Mar-Apr 2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>Fit-Er</td>
<td>Fit-Er Product Line 2014 (wearable computing device: fitness tracking monitor)</td>
<td></td>
</tr>
<tr>
<td>S2</td>
<td>Jurassic Park</td>
<td>SmartGen’s Jurassic Park (material &amp; supplies logistics system - food/water/etc. for dinosaurs &amp; humans)</td>
<td></td>
</tr>
<tr>
<td>S3</td>
<td>WFAP</td>
<td>Wildfire Firefighter Assistant and Protector (UAV-based monitoring &amp; communications system)</td>
<td></td>
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<tr>
<td>S4</td>
<td>HEMS</td>
<td>Home Energy Management System (residential alternative energy mgmt. system: monitoring &amp; cost optimization)</td>
<td></td>
</tr>
<tr>
<td>S5</td>
<td>TacCOM</td>
<td>Tactical Cellular Communication Network (mobile battlefield communications system)</td>
<td></td>
</tr>
<tr>
<td>S6</td>
<td>E-Pedigree</td>
<td>Ollie’s E-Pedigree System (pharmaceutical serialization, authentication, and tracking system)</td>
<td></td>
</tr>
</tbody>
</table>
Position Type1: System Modeling w/ SysML
Creating SysML models for examples similar to below (pg 2/2)

<table>
<thead>
<tr>
<th>Team</th>
<th>Short Name</th>
<th>Project Title &amp; System-of-Interest (SOI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>NDV</td>
<td>Next-Gen Delivery Vehicle</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(hybrid commercial vehicle for the local home/business delivery industry – e.g., UPS)</td>
</tr>
<tr>
<td>S2</td>
<td>MiDi</td>
<td>Migraine Diary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(wearable biometric device for migraine mgt.; interfaces with remote medical professionals)</td>
</tr>
<tr>
<td>S3</td>
<td>EATS</td>
<td>Evaluating Aspects of Traveling Sustenance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(food truck industry – mobile food service operations and financial model)</td>
</tr>
<tr>
<td>S4</td>
<td>DeathStar</td>
<td>DeathStar: The Other 364 Days</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(space station materials &amp; supplies logistics system - food/water/meds/etc.)</td>
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</tbody>
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Position Type 1/2: SysML & OOP Interfacing

Primary Associated Project/Stakeholder: NASA JPL

Utilizing Cameo Simulation Toolkit
(state machines, executable activities, ...)

Interfacing with Simulations
(Unity, Ergo/Jack, STK, ...)

Interfacing with Physical Systems

Communications Link Simulation between Satellite and Ground Station
(a) Link with ground station at t=t1
(b) Link with ground station at t=t2
(several orbits after t1)
(c) Link broken with ground station at t=t3
(~10 minutes after t2)

SysML = The Systems Modeling Language
www.omg.sysml.org
Position Type3: Parametric CAD/Simulation

Primary Associated Project/Stakeholder: Boeing

Creating New CAD Models, and Parameterizing Existing Models (for Design/Analysis ...)

NOTE: Type3 normally needs to be combined with interests in Positions Type1 or 2

Building Models for CAE and SysML (Matlab/Simulink, ModelCenter, Jack, FEA, ...)

Jack (Environment for Ergonomics Simulation)
Ex. Project: NASA MBSE Pathfinder

Students worked on Team Nx with NASA engineers & fellow students (Nx=1, 2, 3, 4 or 5)

**MBSE Pathfinder Focus Areas**

- Team N1: Mars Colony ISRU
- Team N2: Space Habitat
- Team N3: LOX/Methane Rocket Engine
- Team N4: Launch Vehicle Payload Attach Fitting & Mfg
- Team N5: Mission Lifecycle Sounding Rocket

**MBSE Pathfinder Product/Work Activities**

- Lox and/or Methane Farm Development Trades
- Characterization of Components
- Concept of Operations
- Space System Requirements Decomposition
- Systems level optimization trades
- Engine Requirements to include Analysis (ROCETS) & Test V&V
- Configuration Management of Design (CAD)
- Flow from CAD to Additive Manufacture (CAM)
- Testing and Additive Manufacturing (LSM)
- PAF Requirements to include Analysis (CLA) & IDD Generation
- Configuration Management of Design (CAD)
- Flow from CAD to Composite Manufacture (CAM)
- Testing and Composite Manufacture
- Addition of discipline analysis to existing MBSE mission models
- Includes both programmatic and technical (DoD partnering)
- 20+ Flights per year for shadowing and validation
**Overall objective:**
Develop and demonstrate next-gen MCE capabilities (MCE = model-centric engineering)

**Sponsor:**
NAVAIR (Pax River, Maryland) – US Navy

**Collaborators:**
SERC (DoD-sponsored systems engineering research consortium = ~20 universities), specifically Stevens Institute of Technology and U. of Maryland

**Approach:**
Extend/apply model-based techniques (ala ASDL JPL E2E project, etc.)

**Testbed:**
UAV design and advanced trade studies
If you are interested ... do this asap:
Follow these instructions carefully (as attention to detail is important for all positions):

- Sending from your gatech email address, email your resume’ to Russell.Peak@gatech.edu using
  - Email Subject: ASDL URA interest - last name, first name
  - Include citizenship info & GPA (see Note 2 below)
  - Include expected graduation date & level (1st year, 2nd year, etc.)
  - Indicate which position type(s) you are interested in (including priority, if you have multiple interests):
    - Position Types 1, 2, 3, 4 (per above slides)
- After that, we will contact the best-fit candidates:
  - Determine if this is a good mutual fit
  - Finalize setup before the class registration deadline

- Note1: Our normal policy is that (a) first-semester 1st-year students and (b) new last-semester seniors are not eligible for these positions. And we give priority to students interested in a multi-semester URA position.
- Note2: Our normal policy is we prioritize for a GPA of at least 3.5 (and absolute minimum GPA = 3.2). Normally we have so many applications that the cut-off GPA is 3.5 or above.
MBSE Branch Overview

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2015-04a
MBSE Branch Overview
Branch Chief: Russell.Peak@gatech.edu

MBSE: Model-Based Systems Engineering
SysML: The Systems Modeling Language

- SysML – graphical language for system structure, behavior, requirements, ...  
- Unified, complete, consistent, verifiable
- Enables MBSE vs. “doc/ppt-engineering”
- Rapidly growing usage in diverse fields

Academic & Professional Education

- Academic & professional masters courses
- MBSE/SysML short course series
- Delivered over 187+ hands-on courses for 3320+ professionals to date
- Public offerings & onsite contract courses
- Ex. Industry, NASA (ARC, GRC, JSC, JPL ...) DoD (ARDEC, DISA, MDA, NSWC ...), Sandia

MBSE/SysML Research

- Next-gen spreadsheets++
- Traceability graphs / impact analysis
- DoDAF/UPDM interfaces
- V&V patterns and automation
- Simulation interoperability
- Execution & interfacing with things
Summary

- **MBSE & SysML are critical and growing trends**
  - Quantified benefits: cost estimates, error reductions, ...
  - Broad usage across many industries & applications
  - Defining the present and the future

- **Guiding your organization’s destiny**
  - Kick start & enhance your MBSE effort
  - Develop MBSE/SysML adoption roadmap
  - Define & manage your tool ecosystem
  - Provide short courses for your organization
  - Engage consulting & project support
  - Foster research & advanced studies