Multidisciplinary Senior Design
Project Readiness Package

Project Title:	Residency Rotational Scheduling Graphical User Interface
Project Number: (assigned by MSD)	P##xxx (P/ending year/project #, e.g. P15001 finishes in 2015 and is project number 001)
Primary Customer: (provide name, phone number, and email)	Ruben A. Proano, 585-475-4236, rpmeie@rit.edu
Sponsor(s): (provide name, phone number, email, and amount of support)	
Preferred Start Term:	e.g., Fall 2016
Faculty Champion: (provide name and email)	Ruben Proano, rpmeie@rit.edu
Other Support:	This project is part of a research project originally funded by RGHS
Project Guide: (assigned by MSD)	

Ruben Proano	08/04/16
Prepared By	Date
Received By	Date

Items marked with a * are required, and items marked with a † are preferred if available, but we can work with the proposer on these.

Project Information

* Overview:

Prior to practice medicine independently medical students must undergo a three-year rotational program that requires them to do supervised medical practices in different hospital units. The duration of a rotation in each unit varies by unit, as well as the number of residents of year 1, 2 or 3 needed to schedule a rotation. Furthermore, there are units that must have residents in rotation in every week. Residents are also appointed to an outpatient clinic that must be serve as their permanent post during the three years in the program. However, residents will do rotations in other units for four weeks and then they must return to their clinic post for a one week rotation. To ensure continuity of care all residents have been divided in groups and at least a member of each clinic group must be assigned to a clinic rotation in every week.
The weekly schedule is planned over a 52-week time span and then it must be used to schedule shift and daily rotations within each unit. The size of a real-size residency scheduling problem easily exceeds the tens of thousands of the decision variables, and the hundreds of thousands of constraints.
We have developed a series of optimization models that determine the best schedule for residents in an Internal Medicine rotational program and allow the solution of real-size problems in minutes. This senior design project has two objectives (A, B):
A) to develop a graphical interface that could be used by hospital schedulers to: (1) input information necessary to run the optimization algorithms in a friendly manner, (2) display solutions in an interpretable way, (3) facilitate the comparison of alternative schedules.
B) to translate the optimization models developed and implemented using commercial application packages to implementations based in open-source packages.

Design components: graphical interface, usability tests, adaptation to current optimization implementation, translate implementation to open source code, usage process design.

* Preliminary Customer Requirements (CR):

CRs and ERs for

- User interface that allows input data required by the scheduling model in a 'error-proof' manner
- Design an interface that relies on system that detects data inconsistencies
- Design an interface that relies on a system that automatically runs the optimization model for residency scheduling and outputs its results in a format that facilitates their use by chief residents and planners
- Design an interface that relies on a system that facilitates the comparison of alternative output schedules.

† Functional Decomposition (will not be given to the students, but will be provided to the team's guide for reference):

N/A

* **Preliminary Engineering Requirements (ER)**:
Include both metrics and specifications. Each ER should map to one or more CRs (see above).

(This section does not fit to projects requiring the design of decision-support systems or mathematical models.)

Metrics:

- Metrics for the GUI interface would be based on the level of errors in inputing and interpreting solutions generated by the Optimization Scheduling module

Specifications:

- Not relevant to this project

* **Constraints:**
- GUI should run in open-source systems and must be designed to be portable and implemented in multiple platforms (Windows, Mac, and Linux)
- GUI must be designed considering that multiple users would access the tool simultaneously for inputing data, scheduling rotations, and most often to analyze resulting schedules.

† **Potential Concepts:** (will not be given to the students, but will be provided to the team's guide for reference):
Generate a short list of potential solutions, along with the disciplines that may be required to realize each. This helps to ensure that projects are feasible.

- The GUI will have to translate user data into an AMPL (or Pyomo) data file formats. This file will used in the execution of the model code that generates the optimal rotation schedules.
- The GUI will then read the results and convert them into a format (excel spreadsheet, or html output) that facilitates its assessment by the chief residents.
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* **Project Deliverables:**

- All design documents (e.g., concepts, analysis, detailed drawings/schematics, BOM, test results)
- working prototype: Models and scripts
- technical paper: report
- poster
- All teams finishing during the spring term are expected to participate in ImagineRIT

Additional required deliverables:

- List here, if applicable

† **Budget Information:**

No major costs anticipated for this project

* **Intellectual Property:**
There is no restriction on the intellectual merit of this project. The optimization codes have already been developed and published. Intellectual property on the GUI should ensure open-access.

Project Resources

† **Required Resources (besides student staffing):**
Describe the resources necessary for successful project completion. When the resource is secured, the responsible person should initial and date to acknowledge that they have agreed to provide this support. We assume that all teams with ME/ISE students will have access to the ME Machine Shop and all teams with EE students will have access to the EE Senior Design Lab, so it is not necessary to list these. Limit this list to specialized expertise, space, equipment, and materials.

Faculty list individuals and their area of expertise (people who can provide specialized knowledge unique to your project, e.g., faculty you will need to consult for more than a basic technical question during office hours)	**Initial/ date**
Ruben A. Proano,	RP 08/04/16
Environment (e.g., a specific lab with specialized equipment/facilities, space for very large or oily/greasy projects, space for projects that generate airborne debris or hazardous gases, specific electrical requirements such as 3-phase power)	**Initial/ date**
No specific environment is required for this project.	RP 08/04/16
Equipment (specific computing, test, measurement, or construction equipment that the team will need to borrow, e.g., CMM, SEM,)	**Initial/ date**
The team will be provided with the current optimization scheduling model and scripts as well as with one year of input data.	RP 08/04/16
Materials (materials that will be consumed during the course of the project, e.g., test samples from customer, specialized raw material for construction, chemicals that must be purchased and stored)	**Initial/ date**
Professional optimization software licenses (AMPL, GUROBI, CPLEX, Knitro, R, Pyomo)	RP 08/04/16
Other	**Initial/ date**

† **Anticipated Staffing By Discipline:**
Indicate the requested staffing for each discipline, along with a brief explanation of the associated activities. "Other" includes students from any department on campus besides those explicitly listed. For example, we have done projects with students from Industrial Design, Business, Software Engineering, Civil Engineering Technology, and Information Technology. **If you have recruited students to work on this project (including student-initiated projects), include their names here.**

Dept.	# Req.	Expected Activities
BME		
CE	2	GUI programming
EE		
ISE	1-2	Managing the optimization process, testing schedules, and validating GUI use
ME		
Other	1	Physician Assistant student to interact with residents and test tool, Software Engineering student to design usability tests for the GUI

*** Skills Checklist:**

Indicate the sills or knowledge that will be needed by students working on this project. Please use the following scale of importance:

1 = must have
2 = helpful, but not essential
3 = either a very small part of the project, or relates to a "bonus" feature
blank = not applicable to this project

Biomedical Engineering

	BME Core Knowledge		BME Elective Knowledge
	Matlab		Medical image processing
	Aseptic lab techniques		COMSOL software modeling
	Gel electrophoresis		Medical visualization software
	Linear signal analysis and processing		Biomaterial testing/evaluation
	Fluid mechanics		Tissue culture
	Biomaterials		Advanced microscopy
	Labview		Microfluidic device fabrication and measurement
	Simulation (Simulink)		Other (specify)
	System physiology		
	Biosystems process analysis (mass, energy balance)		
	Cell culture		
	Computer-based data acquisition		
	Probability & statistics		
	Numerical & statistical analysis		
	Biomechanics		
	Design of biomedical devices		

Computer Engineering

	CE Core Knowledge		CE Elective Knowledge
	Digital design (including HDL and FPGA)		Networking & network protocols
	Software for microcontrollers (including Linux and Windows)		Wireless networks
	Device programming (Assembly, C)		Robotics (guidance, navigation, vision, machine learning, control)
X	Programming: Python, Java, C++		Concurrent and embedded software
	Basic analog design		Embedded and real-time systems
	Scientific computing (including C and Matlab)		Digital image processing
	Signal processing		Computer vision

	CE Core Knowledge		CE Elective Knowledge
	Interfacing transducers and actuators to microcontrollers		Network security
			Other (specify)

Electrical Engineering

	EE Core Knowledge		EE Elective Knowledge
	Circuit Design (AC/DC converters, regulators, amplifies, analog filter design, FPGA logic design, sensor bias/support circuitry)		Digital filter design and implementation
	Power systems: selection, analysis, power budget		Digital signal processing
	System analysis: frequency analysis (Fourier, Laplace), stability, PID controllers, modulation schemes, VCO's & mixers, ADC selection		Microcontroller selection/application
	Circuit build, test, debug (scope, DMM, function generator		Wireless: communication protocol, component selection
	Board layout		Antenna selection (simple design)
	Matlab		Communication system front end design
	PSpice		Algorithm design/simulation
	Programming: C, Assembly		Embedded software design/implementation
	Electromagnetics: shielding, interference		Other (specify)

Industrial & Systems Engineering

	ISE Core Knowledge		ISE Elective Knowledge
X	Statistical analysis of data: regression	X	Design of Experiment
	Materials science	X	Systems design – product/process design
	Materials processing, machining lab		Data analysis, data mining
	Facilities planning: layout, mat'l handling		Manufacturing engineering
	Production systems design: cycle time, throughput, assembly line design, manufacturing process design		DFx: manufacturing, assembly, environment, sustainability
	Ergonomics: interface of people and equipment (procedures, training, maintenance)		Rapid prototyping
X	Math modeling: OR (linear programming, simulation)		Safety engineering
	Project management		Other (specify)
	Engineering economy: Return on Investment		
	Quality tools: SPC		
	Production control: scheduling		
	Shop floor IE: methods, time studies		
	Computer tools: Excel, Access, AutoCAD		
X	Programming (C++)		

Mechanical Engineering

	ME Core Knowledge		ME Elective Knowledge
	3D CAD		Finite element analysis
	Matlab programming		Heat transfer
	Basic machining		Modeling of electromechanical & fluid systems
	2D stress analysis		Fatigue and static failure criteria
	2D static/dynamic analysis		Machine elements
	Thermodynamics		Aerodynamics
	Fluid dynamics (CV)		Computational fluid dynamics

	ME Core Knowledge		ME Elective Knowledge
	LabView		Biomaterials
X	Statistics		Vibrations
	Materials selection		IC Engines
			GD&T
			Linear Controls
			Composites
			Robotics
			Other (specify)