TEAM MARYLAND
PROJECT MANAGEMENT PLAN
March 31, 2016

TEAM STRUCTURE

The Faculty Team leaders consist of co-PIs **Raymond A. Adomaitis, Michael Binder and Garth Rockcastle.**

Ray Adomaitis is a professor of Chemical Engineering with a joint appointment in the Institute for Systems Research at the University of Maryland (ISR). He also holds positions in the University of Maryland Energy Research Center (UMERC) and the Maryland NanoCenter. His research interests focus on thin film processing for solar energy applications, and his teaching interests on systems engineering approaches to incorporating renewable power sources. He is a Fellow of the American Institute of Chemical Engineers.

Michael Binder is a lecturer in the University of Maryland School of Architecture, Planning and Preservation (MAPP). He has played an integral role in the 2005, 2007, and 2011 University of Maryland Solar Decathlon teams. His work at MAPP revolves around green residential design and sustainable societies.

Garth Rockcastle is professor in the University of Maryland School of Architecture, Planning and Preservation. He is a Fellow of the American Institute of Architects and served as Dean of the School of Architecture at the University of Maryland. Prior to that, Prof. Rockcastle was head of the Architecture Department of the University of Minnesota. His work focuses on cultural facilities, sustainability, and adaptive reuse of existing buildings. Currently, he leads a design team constructing a 20 MW solar array that is uniquely integrated into the community for which it will provide power.

The Student Team consists of approximately 70 students from the School of Architecture and the College of Engineering. As the task groups coalesce, a Student Leadership Team will form as well. We are current recruiting additional student and faculty team members from the Business, Landscape Architecture, Plant and Physical Sciences, Library Sciences and Journalism programs.

We are also recruiting advisors from Industry, including systems engineers through our Institute for Systems Research (ISR) contacts, home manufacturers and representatives of various building products industries.

APPROACH TO COMPETITION

UMD's 2017 Solar Decathlon (SD) Team has set several Project Goals related to technical innovation and demonstration, market development, systems engineering applications, construction innovation, student professional development, and public education.

Technical Innovation and Demonstration – improve the performance, reliability and affordability of components and systems that provide renewable energy, thermal insulation,

climate control including dehumidification, water efficiency / reuse, and waste reduction / reuse. Systems engineering design methodologies will be crucial to achieving these goals, particularly with respect to providing a rational framework for the solar home design. The systems science techniques of real-time optimization and model-based control will be used extensively in our SD home energy management.

Market Development – integrate pioneering technical systems with innovative architectural design to deliver a finished product (the dwelling) that ignites consumer interest in sustainable design. The dwelling will be a prototype for commercially available dwellings that are beautiful, comfortable, healthy, efficient and affordable.

Construction Innovation – collaborate with innovative housing manufacturers to utilize component and modular prototyping and *Lean* (no waste) construction technologies while exposing students and public to the beneficial means and methods of constructing more affordable, flexible, efficient and environmentally sensitive housing.

Student Professional Development – the 2017 Solar Decathlon, like its predecessors, will provide a unique educational experience that shapes our students' life-long academic and professional interests. This project will also provide student participants with the technical and professional skills to lead the sustainable revolution currently unfolding.

Public Education – beyond the goal of creating market demand for sustainable homes, this 2017 UMD Solar Decathlon house will provide many opportunities and resources for expanding the public's awareness of environmental issues and viable solutions. Our goal will be to inspire hope and resolve not only in our students, but also in the thousands of visitors to the competition and our website.

Mechanical System Design

Systems science and model-based systems engineering (MBSE) concepts are to be used extensively to achieve our project's energy management and performance optimization goals. Systems science refers to quantitative tools used for physically based modeling of engineered systems and their environment, optimization and real-time control, and distributed sensing, communication, and actuation. MBSE focuses on engineered system concept development, stakeholder identification, requirements definition, detailed engineering design, subsystem integration, performance validation, and product deployment. Model-based SE provides a rational path to defining understanding the SD project lifecycle. It provides a framework for generating functional requirements from the competition requirements, decomposing the project design elements in a hierarchical manner while simultaneously defining validation criteria to be tested in the project realization and integration phases.

Mechanical system design elements include the PV panels, solar thermal components for heating and hot water, a liquid desiccant absorption and regeneration units, evaporative cooling including potential integration with the desiccant system, battery storage, thermal storage including phase-change materials, solid-phase absorption cooling technologies, the potential for thermoelectric systems for cooling and energy scavenging, building-integrated PV particularly

dye-sensitized PV window panels and transparent luminescent solar concentrators, and hybrid systems for splitting the solar spectrum to take advantage of solar energy conversion technologies optimized for a portion of the irradiance spectrum. Of course, the integration of HVAC, solid-state lighting, and appliances in the context of the energy system design problem must be addressed.

Control System Design

Our systems-based approach is driven by the need to integrate the temporally varying and heterogeneous energy sources (e.g., thermal and PV) and sinks (HVAC, appliances, occupants). This requirement points to the need for distributed sensing and physically based (predictive) modeling of our home. Anticipating potential changes in Decathlon rules that would permit battery storage the 2017 competition, have begun to develop a stochastic dynamic optimization design strategy to determine the optimal combination of PV power generation and battery storage capacity. We propose to implement real-time control within a model-predictive control (MPC) framework. MPC uses mathematical models of the system to be controlled and past measurement data to predict and optimize (in real time) the system response. The overall effect of our simulation and control approaches is that the house will be self-adapting, easing the transition from construction and development in MD to the competition location. We will be capable of simulating and programing ahead for the entire SD2017 competition.

Beyond Energy

Thinking beyond energy to address other important environmental and social issues, the 2017 UMD Solar Decathlon team will explore the development of market-ready prototypes including: rainwater capture, graywater reclamation, innovative building materials and structural systems new materials for exterior and interior finishes, high performance thermal insulation modular home-scaled food production systems (hydroponics, aquaponics, aeroponics, etc.), and waste composting technology.

Integrated Design Process

Integrated Design Processes represent another area of innovation that Maryland intends to advance and implement. Integrated tools for design and analysis are becoming more common in large commercial projects, but are still considered beyond the scope of most single-family residential design markets. Fluid integration of design and analysis tools with the model-based system engineering design, analysis, construction and testing process can improve not only the performance of the house, but also its affordability.

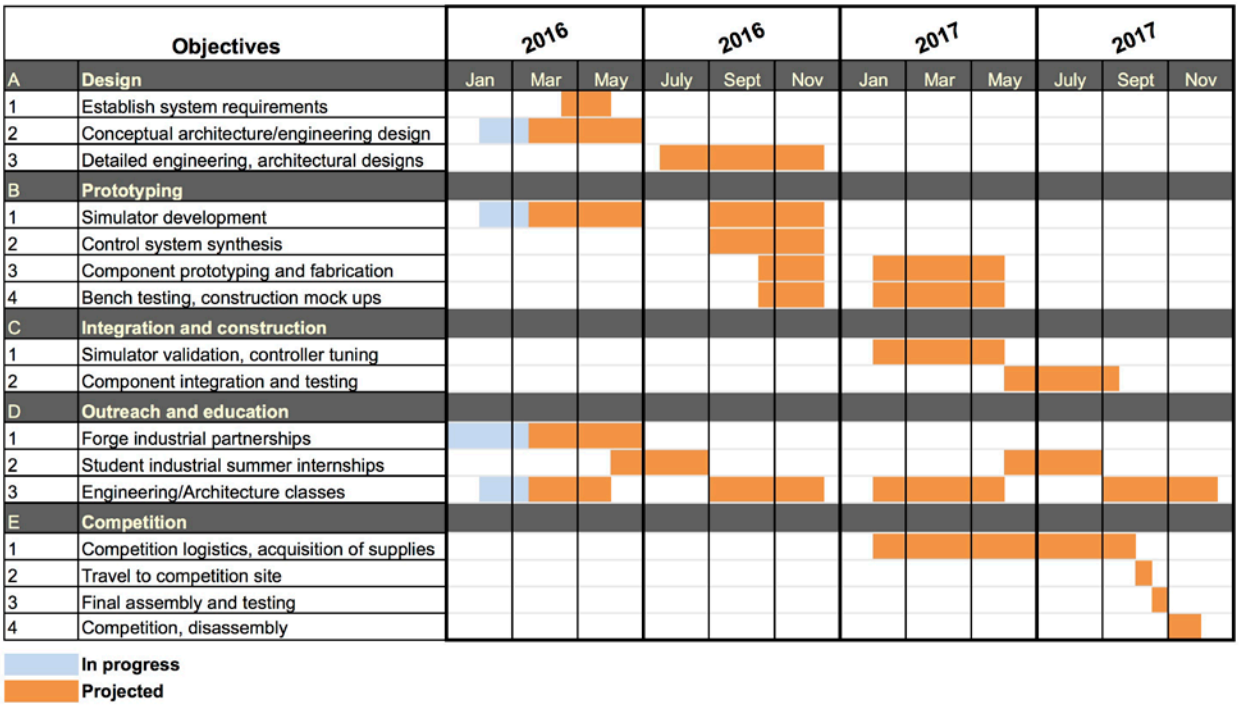
Lean Construction and “Just-in-Time” Processes

Lean Construction, as advocated by the Lean Construction Institute (LCI), seeks to extend to the construction industry what the Lean Production revolution did to transform modern-day manufacturing two decades ago: efficiency, zero waste and humane work environments. While it may on first impression the typical Solar Decathlon submission, a tradition of “one-off, custom” prototypes, would have little in common with matters of

construction productivity, Team Maryland in 2017 will be seeking to work closely with chosen panelizing and modular construction partners to address the most replicable, innovatively flexible, and readily adaptable features to their submission. It is the wish of Team Maryland 2017, to find more of its innovations readily absorbed into wider and immediate use.

UMD will explore the application of rapid prototyping and Computer Aided Manufacturing in concert with Lean Construction the Integrated Design Process discussed above. In particular, we plan to use the Clark School of Engineering's Makerbot Innovation Center that includes a significant number (see "Equipment and Facilities" later in this proposal) of 3D printers that support printing of a wide range of materials and large-scale objects, as well as 3D scanners that facilitate fabrication of these SD home elements.

GENERAL WORK SCHEDULE



Additional Milestones:

- Preliminary Design – September 2016
- Design Development – November 2016
- Construction Documentation – February 2017
- Communications, Marketing and Public Education – September 2016 – July 2017.
- Prototype Fabrication – November 2016 – June 2017
- Final Fabrication – March 2017 – July 2017
- Operational Logistics Planning – November 2016 – June 2017
- Transportation to the Competition Site – September 2017
- Final Assembly & Operation – October 2017 (?)

During Summer 2016, Team Maryland will complete the conceptual design and computer models for control and systems integration. Fundraising activities will also be initiated.

COURSE INTEGRATION

To facilitate a collaborative multidisciplinary design process, the University of Maryland will create parallel courses in Engineering and Architecture programs. Parallel courses have begun and will continue through the Fall of 2017. Summer classes (which may include independent study) or summer internships will be used to keep students engaged in the Solar Decathlon project during the Summer sessions of 2016 and 2017, when student contributions will be most critical.

FUNDRAISING SCHEDULE

Meetings have been held with University Development to identify early prospects for fundraising and solicitation. Several proposals for student and faculty support. Meetings with University Administration have been held to identify sources of internal support. After completion of concept design in Summer of 2016, a more definitive fundraising plan will be developed.