

Watson Capstone Projects Master Statement of Work

2019-2020 Version

Scope

In Watson Capstone Projects (WCP), we emphasize the program management Iron Triangle of Scope, Cost, and Schedule as students begin the transition to practicing engineer. This document describes the expectations for project sponsors, faculty advisors, industry mentors, client representatives, students, and course instructors participating in these capstone design projects.

The Watson School's Electrical and Computer Engineering Department runs Watson Capstone Projects as part of its Senior Design Projects course. Through arrangements between course instructors, some of the Biomedical Engineering, Computer Systems, Industrial Systems Engineering, Mechanical Engineering, and General Engineering Minor seniors also participate in these projects.

This document tends to use industrial and contractual-type language for educational purposes. The reality is that our sponsors are supporting the students and their projects, with no assurance of successful projects or usable deliverables. Indeed, some of the best learning opportunities come from significant challenges, with not all completely overcome. This can also benefit the sponsors, especially those that include management of a capstone project as part of their own engineering leadership development program.

Desired Project Aspects

Projects should start at the beginning of the design cycle, as it is desired that students gain experience with problem definition, conceptual design, detailed design, prototyping, fabrication integration, and testing. Projects should also require the students to consider professional design concepts such as ergonomics, cost, manufacturability, tolerances, codes and standards, ethics, and product life cycle.

Intellectual Property

Our customary practice is for the students' project work to be placed in the public domain.

Should a corporate partner share proprietary or competition sensitive information with us in the course of these projects, Binghamton University and Watson Capstone Projects will take reasonable precautions to keep it confidential and not divulge it to third parties unless required by law or legal process.

Publicity

The student projects and their sponsors will be publicized in Binghamton University media. Material produced by the student teams, such as a project experience video, will be subject to review by their project sponsors prior to submission by the students. Please contact a Watson Capstone Projects course instructor with any restrictions or concerns, and note them in the project proposal.

Project Customers and Advisors

Each team will have a project faculty advisor, who acts a mentor to the team in weekly meetings, critiques the team's work products, and evaluates the students' individual performances. The term "project advisors" is used to mean a team's Faculty Advisor, and if applicable, their Industry Mentor as well. A project team's industry mentor, client, or faculty advisor will act as their customer, in that order of precedence.

Project Deliverables

Project results from student teams are very dependent on the nature of the project, team capabilities, degree of customer interaction, and many other variables. Deliverables include:

- Engineering documents and drawings,
- Presentations, videos, and demonstrations, and
- Prototype hardware, firmware, and software.

Each project team will deliver these major engineering documents and presentations and other minor ones, as specified in the *WCP Common Data Requirements List*.

Fall Semester

- Project Specification
- Conceptual Design Briefing
- Design Report
- Design Presentation

Spring Semester

- Integration and Test Plan

- System Verification Procedures
- Project Experience Video
- Project Report
- Project Presentation

Some projects may also deliver other documents pertinent to their project, such as prototype user guides, software design reports, and preliminary installation or maintenance manuals. Some project sponsors and clients may, at their discretion and responsibility, adapt the students' prototype system for use in private or public situations.

Development Process

Each project team should execute the following development steps in sequence, with overlap permissible, in order to meet course deadlines and complete their project. Figure 1, a generic high-level project schedule, illustrates these development phases and related documents and presentations. The timing and sequencing of the steps may be varied to better suit the project, subject to approval of the team's Faculty Advisor and the WCP Director.

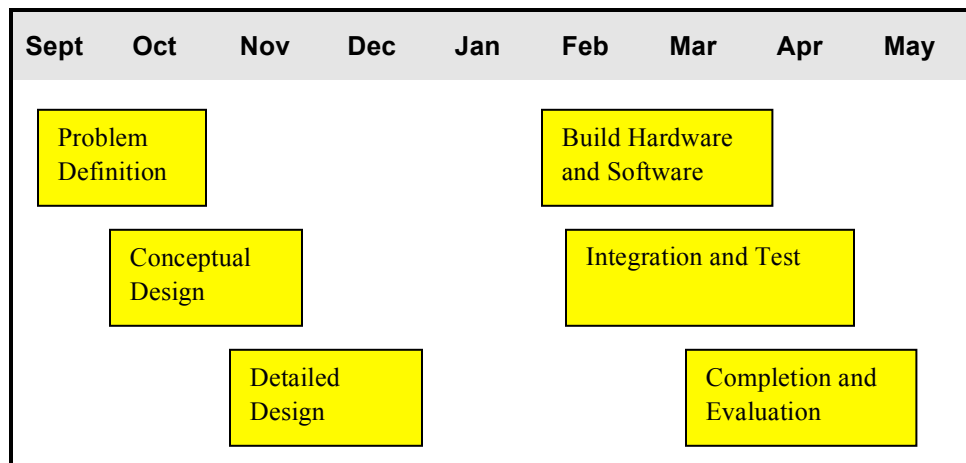


Figure 1 High-level Project Schedule

Problem Definition

Project teams begin their Problem Definition by meeting, as applicable, with their project industry mentor, client, and faculty advisor. They then start a technical review of the project's problem domain and relevant technologies.

Teams must refine, restate, discover, and/or amplify the project requirements as necessary to ensure that they, their advisor(s), and instructors have a mutual understanding of the project's scope. This defines exactly what their project device must do for them to be able to declare success at the end of the spring semester. A context diagram shall be created that shows the environment in which the project "system" will operate. The Requirements Analysis effort

should explicitly define the system's external interfaces, and may produce some design constraint requirements, but should not include any actual design work.

During their problem definition effort, teams may negotiate their project's system requirements with their customer and advisors. The results should be:

- Required features and attributes for the new project system that any reasonably competent and committed team should be able to accomplish.
- Stretch goals for the new project system that an exceptionally competent and committed team may be able to accomplish.

The teams then gather these requirements and diagram(s) into Project Specifications for review and approval by their project advisors.

Conceptual Design

Project teams next create conceptual designs by:

- Continuing their technical review of the project's relevant technologies,
- Brainstorming and producing potential design alternatives,
- Evaluating these alternative designs against their system requirements,
- Producing a system-level design with hardware, firmware (e.g., field-programmable gate arrays), and software allocations,
- Creating a functional system block diagram, supplemented as appropriate by a physical layout drawing, a software architecture diagram, etc.,
- Defining major hardware subassemblies or devices, firmware components, and software components,
- Defining, at an abstract level, all interfaces between major subassemblies, firmware components, and software components,
- Creating a project budget to allocate available funding to major expense items and areas,
- Making informal hardware, firmware, and software development environment plans, and
- Beginning modeling and simulation efforts, circuit breadboarding, and the like, in order to reduce risk in critical areas of the system design.

The final system design information is to be packaged into a Conceptual Design Briefing for informal review and approval by the project advisors, clients, and Watson School technicians.

Detailed Design

The teams finish the design process by:

- Completing modeling, simulation, and critical prototyping efforts,

- Making parts lists and procurement plans,
- Drafting hardware drawings,
- Creating electrical schematics, printed circuit board layouts, and wiring diagrams,
- Defining all software units that will make up the software components, and the interfaces between them,
- Writing pseudo code for the software and firmware units,
- Planning efforts required for completion, with tasks allocated to individual team members in a detailed schedule for the rest of the project, and
- Meeting with the Watson School technicians for a Makeability Review.

This detailed design information, along with a summary of the problem definition and a description of the conceptual design, is to be packaged into a Design Report for review and approval by the project advisors. A Design Presentation that summarizes and illustrates this information is to be presented for review and critique by the project advisors, and then presented to a review panel.

Building Hardware and Software

Teams create their project's lower-level hardware, firmware, and software units by:

- Buying components, machine stock, etc.,
- Machining and 3D printing parts,
- Coding firmware and software modules, and
- Testing those units individually.

The unit test requirements may be system-level requirements allocated to individual units, or requirements derived from the system design.

Teams prepare for the next phase by developing a plan for their Integration and Test efforts. This is submitted for review and approval by the project advisors.

Integration and Test

As applicable to their project, teams will integrate their system into subassemblies and then into a complete system, testing each increment as they proceed.

They will also write detailed procedures for their system-level tests that are to prove their system meets all its requirements. These system Verification Procedures are submitted to their project advisors for review and approval. When the project system is completely built and working, teams "dry run" their verification tests, making corrections to the system as necessary.

Final Tests and Conclusions

Teams complete their projects by:

- Performing their system verification testing for their Faculty Advisor,
- Performing system verification testing for their Industry Mentor and Client Representative (if applicable),
- Delivering the prototype system to a Sponsor or Client (if applicable), and
- Documenting
 - The system build process,
 - Any design modifications made during build, integration, and test efforts, and
 - The results of the system acceptance testing,
- Dispositioning any residual project assets per WCP guidelines.

This information, along with an updated version of that in the Design Report, is to be packaged into a final Project Report for review and approval by the project advisors. A final Project Presentation that summarizes and illustrates this information is to be presented for review and critique by the project advisors, and then presented to a review panel.

Responsibilities

Industry Mentor and Client Representative Responsibilities

The most critical factors to a successful project are communication and commitment. A successful capstone project requires that the sponsoring organization assign a motivated individual to oversee and interact with the students throughout the project duration. An hour a week is sufficient on a typical project. This sponsor's Industry Mentor and the Client Representatives are asked to do the following:

1. Provide more detailed information for the team beyond the initial project proposal.
2. Facilitate visits by the students to the sponsor's and client's locations. One or two visits by the students to the sponsor site during the project are typical; more are expected at the client's location.
3. Meet with the students regularly (at least twice a month, either at the sponsor's and/or client's site, at Binghamton University, or via telecommunication).
4. Review documents to provide feedback from a customer's point of view (e.g., progress reports, project proposal, design analysis, design guide, etc.).
5. Evaluate students' individual performances and provide feedback to their faculty advisor.
6. Demand professionalism and a high level of performance from the students.

7. Attend the project presentations during the last week of the fall and spring semesters.
8. Supply any necessary physical resources that are not already available at the university. Should additional resources or equipment be needed to complete the project, students are expected to justify them by written proposal to the sponsor.

Student Responsibilities

Each student team is tasked with these main responsibilities to their customers:

1. Visit the project customer at their location, and meet with them regularly.
2. Provide periodic status presentations to the project customer.
3. Provide about one workday of project effort by each team member each week.
4. Gather more detailed information about the project requirements, reach agreements and make commitments with the project customer, develop a project plan, work to that plan, maintain good customer communications, meet those commitments, and deliver a product and other deliverables that meets the requirements.
5. Avoid disclosing the sponsor's proprietary or competition sensitive information, and refrain from using the sponsor's trademarks and logos without their sponsor's permission.
6. Provide a report about the project during the penultimate week of the Fall and Spring semesters.
7. Provide a project presentation during the last week of the Fall and Spring semesters.

The student teams will also provide weekly team status presentations supplemented with individual status reports to their faculty advisor and course instructors.