

*Major Qualifying Project (MQP) Manual
for the
Industrial Engineering Program*

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1. Goals and Expected Outcomes of the MQP

This manual was developed to:

- Help you find and complete an MQP that will satisfy both the IE program's and your own educational objectives. In IE, the MQP should satisfy the requirement for a capstone design experience.
- Describe the elements of the MQP experience, which can be used by both faculty and students as a standard for setting expectations and evaluating outcomes.

What are the outcomes (or objectives) that we have for your MQP? The MQP is described in the Undergraduate Catalog as:

The Major Qualifying Project should demonstrate the application of skills, methods, and knowledge of the discipline to the solution of a problem which would be representative of the type to be encountered in one's career.

Your MQP is expected to be an experience that will help you to begin the transition from undergraduate academic life to the commercial world or graduate school. As a capstone design experience, your project will involve developing a system, component or process to meet a desired need. What this means is that you will be creating, rather than only studying, something and you will work with a client who defines a need. Most IE MQPs are sponsored by organizations external to WPI, but your client may also be an internal WPI group. The project is an opportunity to strengthen technical, communication, interpersonal, and project management skills. Specifically, we expect that the project experience will provide you with the opportunity to learn and demonstrate the following outcomes:

- An ability to design and improve integrated systems of people, materials, information, facilities and technology.
- An ability for creative thinking.
- An ability to apply core industrial engineering concepts, using updated techniques, skills and tools.
- An ability to incorporate realistic constraints (if appropriate) such as safety, reliability, sustainability, ethics and social impact.
- An ability to analyze data and draw supported conclusions
- An ability to formulate an engineering problem and generate alternatives.
- An ability to develop problem objectives and criteria for judging solutions.
- An ability to take the initiative.
- An ability to plan and organize work.
- An understanding of professional and ethical responsibility.
- An ability to gather data from a wide variety of sources (books, journals, the internet).
- An ability to apply knowledge not likely obtained from prior coursework

Because it is equivalent to three courses, your MQP is an important part of your IE degree requirements. The MQP provides you with the opportunity to deepen your understanding of the theory you've been exposed to in courses by applying it in a real-world setting. You should expect to learn (in many cases, on your own) subject matter not covered in courses as well as to experience frustrations when you encounter constraints.

2. Getting Started

The Projects and Registrar's office maintains a website dedicated to projects (<http://www.wpi.edu/Academics/Projects>) which contains additional information about project requirements and getting started on projects.

Topic

To help choose a project and to help you assess whether or not it will meet your educational objectives, ask yourself the following questions:

- 1) Out of the IE, basic science, and mathematics course that you have taken, which did you enjoy the most? Which did you not enjoy? When answering these questions, try to identify project areas in which you would be willing to invest three terms of intensive work.
- 2) What do you want to do when you graduate? What type of company are you interested in working in? Try to be specific! Try attending local IIE meetings and student chapter meetings to find out more about what practicing IEs do. If you cannot specify what you want to do, try starting by figuring out what you are not interested in doing.
- 3) What do you want to learn while you work on your MQP? Your MQP is the equivalent of three courses and should let you explore new areas of interest and/or pursue in greater depth a topic you've addressed in coursework. If you tell your MQP advisor what you want to get out of your MQP, it is often possible to structure the project to emphasize those areas of interest.
- 4) Who do you want your project partners to be? Working with your best friend may either be the best or the worst decision you could make. Think about people who you have worked well with on group projects in classes and why they made good partners. Your partners' should complement your own, particularly if the project requires diverse abilities.

Process

Most IE MQPs are sponsored by an organization external to WPI. You can find out about project topics by visiting IE faculty to find out about the areas they advise projects in and any current projects they have proposed. In addition, you can check out the Directory of Available Projects at <http://www.wpi.edu/Academics/Projects/available.html>

You can also propose an MQP topic, perhaps sponsored by an organization where you completed a co-op or summer internship. If you do this, you need to first develop a clear idea of the educational goals and objectives of the project (it must be distinct from any work you have done as part of the co-op or internship). What makes you believe that your idea would be a good project? What would you learn? Prepare a short description of the project (1-2 pages), which describes specific objectives and the general approach that will be used to attack the problem. Present your proposal to a faculty member to try to enlist them as an advisor.

Calendar

Because your choice of an MQP topic may influence your course selection and schedule for your senior year, you should plan to find an MQP in C- or D-term of your junior year if you are planning to start the project in A- or B-term. If you are going on co-op or plan to be at a project center to complete your IQP, you may need to work through project partners or select a project before you leave campus. If you are planning to start a project in C- or D-term, you should find an MQP during A-term.

Some opportunities to get started on finding an MQP:

Advising Appointment Day - Mid to Late February

No classes are scheduled to give you an opportunity to meet with your academic advisor to schedule senior year courses and your preferred time-frame for completing your MQP. This is also a good day to visit faculty to find out about MQPs they have proposed.

Project Presentation Day - Late April

No classes are held on Project Presentation Day. Students who are completing their MQPs present the results of their work to faculty and project sponsors. All students are invited to attend the presentations; it is a good way to see what past projects have involved and to learn about faculty expectations for MQPs.

3. What is an MQP?

For IE students, the MQP represents a capstone *design* experience representative of the type of work you might do in your first job after graduation. Almost all MQPs can be

used to satisfy the 1/3 unit degree requirement for capstone design. You will participate in a real engineering project that you have a hand in defining, which will allow you to experience both the thrill of solving a challenging problem as well as the disappointment of chasing false leads. Your project advisor will need to verify on the project registration form that your project meets the capstone design requirement. If your project will not satisfy the requirement, then you must satisfy it through coursework. Your academic advisor or the IE Program Director can help you choose appropriate courses.

What is design? Engineering design is the process of devising a system, component, or process to meet desired needs. It is a decision-making process (often iterative), in which engineering sciences as well as basic science and mathematics are applied to develop a solution to a problem that meets stated objectives. In IE, the engineering sciences include such areas as optimization, simulation, quality control techniques, financial methods, production planning and control, process analysis and improvement, facility layout, and human factors. Industrial engineering is focused on *integrating* systems, including such components as people, information, materials and equipment, so design also takes these different components into consideration. Among the fundamental elements of the design process are the establishment of objectives and evaluation criteria, synthesis, analysis, construction, testing, and evaluation. It is essential to consider standards and to include constraints, which in reality limit potential solutions due to economic, safety, reliability and other factors.

Because you can do nearly anything that requires IE skills as an MQP, it is difficult to define exactly what your MQP will involve. Indeed, every MQP progresses somewhat differently depending on the problem, the individual student's needs and motivation, the advisor's interests, the sponsoring organization's needs, team dynamics and many other factors. This lack of definition is usually disquieting at some point in the project.

Despite the difficulty in defining exactly what an MQP will involve, nearly all MQPs progress through the stages illustrated in Figure 1. Each of these phases is discussed in more detail below. In a three-term project, the first term is generally focused on phases 1 and 2, the second term on Phase 3, and the third term on Phases 4 and 5. However, the process is not really linear; you will probably return to an earlier stage as the project progresses because you learn more and encounter unexpected obstacles. You will need to complete a project proposal, describing the results of Phase 1 and 2, as well as complete a project report and deliver an oral presentation describing the results of the entire project. These deliverables are described in more detail in Section 5.

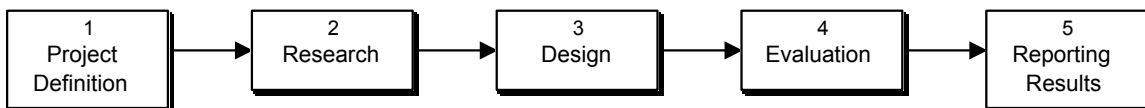


Figure 1: Stages of an MQP

Project Definition

During the project definition phase, you will further develop the description of the project and identify the specific problem(s) you will tackle. To develop this definition you will need to spend time understanding the sponsoring organization's environment, typically through interviews with company liaisons and facility tours. You should work to develop specific project goals, to define the scope of the project, and to identify the techniques that are most likely to help you solve the problem. Based on the project goals, you will need to develop milestones, or intermediate objectives, to help you gauge your progress in reaching the final project goal. The methodology that you use to accomplish your project is essentially a description of how you intend to proceed from milestone to milestone.

As you work through the remaining phases, you will most likely need to reevaluate the project definition as you learn more about the problem and analyze results. The problem definition will only be completely finished when the project is done!

Research

To develop the methodology that you plan to use, you will need to do some research, which may involve interviews with people both within and outside the organization, process observations, and written sources including previous projects, course notes, journals, books, and the internet. You can use the WPI library as a starting point for locating journal articles, many of which are online, but you may need to request some items from interlibrary loan or visit neighboring libraries.

To organize your research efforts, it helps to keep a notebook where you write down all the questions that need answers and possible sources of information. You should also write the answers to questions as you find them and also the sources, including pages numbers, so that you can reference them in your project proposal and project report.

Design

The design phase of a project can take many forms, depending on the nature of your particular MQP. Typically you will need to develop a plan for collecting data, then create a model to analyze the data. Often you will use software tools to support this process. Based on the results of the analysis, you then would design changes to an existing system or develop an entirely new system. For example, you might be working to design raw material provisioning guidelines for a manufacturing division. As a first step, you might collect data about the provisioning methods currently used and analyze them on the basis of cost, ease-of-use, and reliability. You might then suggest guidelines that determine how existing and any new components should be provisioned, using the cost, ease-of-use, and reliability 'models' you've created.

Although each MQP will have different kinds of design components, the design phase is really the time when you apply the theoretical knowledge you've accumulated in courses and in your research to solve a real problem. You'll discover that the theory won't always answer all your questions, so you may need to make assumptions and test their significance.

Evaluation

Proving that you have developed a good design can be difficult, but is essential. Your project should provide an indication of how your design would work when implemented. A first step is to evaluate your design in terms of the criteria you established at the start of the project. What evidence can you provide to demonstrate that your design meets the project objectives? For example, is it more cost effective? reliable? timely?

A second step is to carry out a physical demonstration or test that the design is effective. While it is often difficult to implement an entire design in an organization during the project time frame, you need to develop tests to prove that your design should work well if it is fully implemented. The nature of the test will depend on the project. For example, if you are designing inventory provisioning guidelines for a manufacturing shop, the test might involve implementing the guidelines on a couple of products to demonstrate the difference from current practice and the benefits of the new guidelines.

The evaluation of your design may uncover additional problems or suggest the need for additional work. By the time you successfully complete the evaluation phase it is quite likely that you will have done additional research, updated your design, and re-evaluated your results one or more times.

Reporting Results

After successfully completing the project, you'll need to document the results. Documenting and reporting your results is how you'll ensure that people know about the great work that you've done! Although few beginning engineers realize their importance, making good presentations and writing excellent reports are essential for getting good report cards at work. To complete your MQP, you will need to present the project at least once and write a substantial report.

4. Choosing an Advisor

Because design is a critical objective of your MQP, it is important that your advisor understand and practice engineering design. You must also have at least one advisor who is affiliated with the Industrial Engineering program. You should choose your advisor from the following list of faculty:

Professor Arthur Gerstenfeld

Professor Sharon Johnson
Professor Frances Noonan
Professor Amy Zeng
Professor Joe Zhu

If you are interested in working with a faculty member who is not on this list, you should first talk with the IE Program Director, Professor Sharon Johnson.

In addition to the above issues, consider that the relationship between you and your advisor will be distinctly different from the student/faculty relationship that you have experienced thus far. Most advisors play the role of a supervisor with whom you have made a contract. You will have helped to develop a series of goals and a plan of how to accomplish them and your supervisor will be meeting with you regularly to observe and discuss your progress. What kinds of qualities would you like to see in a supervisor? Who might you work best with? Who might challenge you to do your best work?

5. Deliverables, Expectations & Grading

Deliverables

At a minimum, your project advisor will require that you complete the following as part of your MQP:

Project Proposal: Describes the project objectives and problem to be addressed and delineates the major tasks, supported by background research about the problem and the methodology to be used. The proposal also contains a project schedule that indicates when project milestones are expected to be complete.

The project proposal is typically due no later than the end of the first 1/3 unit of work. The typical elements in a project proposal are described online at <http://www.wpi.edu/Academics/Projects/Proposal>.

Project Report: Documents the entire project. In the report, you will need to describe the project definition, your research, data collection and analysis, the details of your designed solution, and your evaluation of this solution.

The project report is due at the end of the project, although typically you will work on writing it throughout the project. The project proposal usually serves as a first draft of the first chapters in the project report. Most advisors will require that you submit a draft of the entire report 3-4 weeks before the end of the project to leave enough time for comment and revision.

Your project advisor will work with you to develop the format of the report. Some advice about writing project reports is available online at <http://www.wpi.edu/Academics/Projects/Report>.

Oral Presentation: Also documents the results of your entire study, but in a more abbreviated format. The oral presentation should briefly introduce the project, describe the major innovations that made the project succeed, present an evaluation or demonstration of the project, and conclude by assessing the project status and prospects.

Students are required to make at least one oral presentation. Generally it is expected that students will make at least two presentations: one on Project Presentation Day and one to the sponsors of the MQP.

Weekly Meetings, Group Work, and Project Reports

Completing an MQP can be a difficult technical problem, but it is often not the technical problems that slow you down the most! You will need to learn to work together to meet interim project milestones. To facilitate this process, you will have regular meetings with your project advisor (usually weekly for a three-term project) to discuss your progress towards milestones and any problems that you've encountered.

Remember: your faculty advisor and the company liaisons are guides or coaches rather than directors! You are expected to take responsibility for your own project by making decisions and taking INITIATIVE. Come to weekly meetings prepared to talk about what you are going to do next. If you have encountered problems, think about specific questions to ask that might help you get around the problem. Your advisor may then be better able to direct you. Because this is a learning experience, most advisors will let you make mistakes and deal with their consequences. If you get behind schedule, your advisor will be anxious to hear you describe your plans for getting back on schedule.

Based on WPI's expectation, you should be spending approximately 17 hours per week per person per 1/3 unit (e.g, if you are doing 2/3 units of project work in one term this would be 34 hours per week per person) working on your project. As a term progresses, you may find it more difficult to meet and work as a group as members try to finish assignments for classes and participate in extracurricular activities. You need to find effective ways to allocate work among individuals. Each person should be assigned managerial responsibility for a subset of the project tasks, meaning that they are responsible for ensuring that it is completed; they might or might not be responsible for carrying out the task.

Some project advisors will ask you to submit a weekly progress report, often by email, which contains the following:

- progress last week - what you have accomplished the previous week
- weekly plan - what you expect to accomplish in the coming week

problems/obstacles/questions

Even if you don't formally submit a progress report, you can use the above as an agenda for each weekly meeting. Again, you are responsible for the project and you need to make sure that your advisor knows what you have accomplished. You need to play a role in setting the agenda!

Grading Standards

The WPI faculty recently endorsed the following grading guidelines for MQPs:

1. Each term a student is registered for a project, the student receives a grade reflecting judgment of accomplishments for that term.

2. Upon completion of the project, students will receive an overall project grade. It is important to note that this grade reflects not only the final products of the project (e.g., results, reports, etc.), but also the *process* by which they were attained. No amount of last-minute effort should turn a mediocre project effort into an A.

3. The available grades and their interpretations are as follows:

A: a grade denoting a consistently excellent effort and attaining the stated project goals.

B: a grade denoting a consistently good effort and attaining the stated project goals.

C: a grade denoting an acceptable effort and partially attaining the stated project goals.

SP: a grade denoting an effort sufficient for the granting of the credit for which the student is registered. This grade provides students with no feedback, and its use is discouraged except for circumstances in which the faculty member is unable to judge the quality of the work (yet can still determine that the granting of credit is appropriate).

NA: a grade denoting an effort unacceptable for the credit for which the student is registered. Note that this grade is entered into the student's transcript.

NR: a grade denoting an effort insufficient for the credit for which the student is registered. This grade is appropriate when the project has not proceeded due to circumstances beyond the control of the student, or for project extensions which do not represent the full amount of credit for which the student is registered.

4. The results of a project should be such that an outside reviewer would reasonably deem the project as being worthy of the credit and grade given, based on evidence such as the project report.

5. In light of the above grading criteria, it is strongly suggested that a formal project proposal or contract be developed early in the project activity, so that all participants in the activity have a clear understanding of the project goals and advisor and student expectations.

It is important to recognize that projects receiving “B” grades are good projects, in which all project goals are attained. As in your classes, a project grade of an “A” reflects outstanding effort. Your advisor should discuss with you his/her definition of outstanding work, perhaps through examples. You should also ask for feedback as the project progresses.