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.
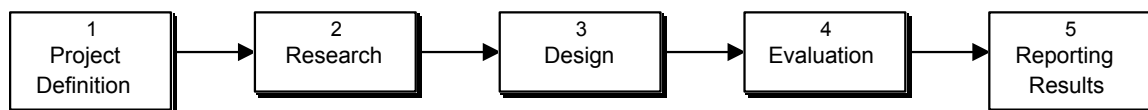

Figure 1: 1 Project Definition → 2 Research → 3 Design → 4 Evaluation → 5 Reporting Results

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.