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ANSWERS/SOLUTIONS FOR EXERCISES IN APPENDIX C

Appendix III collects a series of exercises for the chapters and appendices of the main body. We do not use these exercises as homework, but rather to encourage and stimulate in-class discussion. (We base out-of-class assignments on the faculty-generated project to teach a formal design vocabulary and the reverse engineering project to teach functional analysis.) For instructors who want some additional problems for their own courses, we offer the collection below.

The open-ended nature of many of the exercises limits our ability to give a "unique" answer of the sort students are too often accustomed to. In those cases, we offer some suggestions on what a grader might look for in student work.

EXERCISES AND ANSWERS/SOLUTIONS FOR CHAPTER 1

1.1 Define engineering design in your own words.

There are a number of definitions in the text containing concepts that students might incorporate into their answer:

1) Engineering design is the systematic, intelligent generation and evaluation of specifications for artifacts whose form and function achieve stated objectives and satisfy constraints
   Key Concept(s): Alternatives are intelligently generated and evaluated, based on their ability to realize design goals
2) Engineering design is the organized, thoughtful development and testing of characteristics of new objects that have a particular configuration or perform some desired function(s) that meet our aims without violating any specified limitations.
   Key Concept(s): Design is a thoughtful process leading to realizing functions to meet goals or aims.
3) Design is "a description of an artifice in terms of its organization and functioning - its interface between inner and outer environments".
   Key Concept(s): Designers must describe the shape and arrangement of a device ("its organization"), how that device does what it intended to do (its

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"function"), and how the device (its "inner environment") works ("interfaces") with its operating ("outer") environment; i.e., engineers must design in a systems context.

4) The purpose of design is to derive from a set of specifications a description of an artifact sufficient for its realization. Feasible designs not only satisfy the specifications, but take into account other constraints in the problem arising from the medium in which the design is to be executed, the physical environment in which the design is to be operated and from such factors as the cost and capabilities of the manufacturing technology available.
Key Concept(s): Engineering design can be focused on the object or artifact or object in terms of a broad set of specifications to be met, including cost and manufacturability.

The first three definitions are all concerned with the process of thinking about design and design problems, while the fourth is more focused on the designed object. Simon's definition (#3) is unique in its concern for systems and how the designed object related to the rest of the world.

1.2 *List at least three questions you would ask if you were, respectively, a user (purchaser), a client (manufacturer), or a designer who was about to undertake the design of a portable electric guitar.*

There are, of course, lots of possible questions students can come up with. Some that might come up in class are:

User:

- How much will the new guitars weigh?
- How small will the new guitars be?
- Will they fit in the overhead bin of an airplane?
- Will they let me get rid of my other guitar?
- How good will the guitar sound?
- How much will they cost?

Client:

- How soon can a good design be realized?
- Can the design use lots of common parts from our other guitar products?
- Will portability force us to sacrifice sound quality?
- How much will they cost?

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Designer:

- Who is the intended user of the guitar?
- What use will they make of the guitar (e.g., practice, concerts, etc.)?
- Why are existing guitars not portable?
- How soon is the design needed?
- How much can they cost?
- How portable is portable?
- How many does the client intend to manufacture?
- How durable to they need to be?
- How should the guitar sound relative to other guitars?

1.3 *List at least three questions you would ask if you were, respectively, a user (purchaser), a client (manufacturer), or a designer who was about to undertake the design of a greenhouse for a tropical climate.*

Some questions that might arise include:

User:

- How much will the greenhouse cost?
- What plants can be grown?
- Will the greenhouse stand up to tropical weather such as heavy rains?
- How big will the greenhouse be?
- Can it be used for both seedlings and mature plants?

Client:

- How soon can a good design be realized?
- How long will the greenhouse take to assemble?
- Can the design be easily assembled?
- How much will it cost?

Designer:

- Who are the intended users of the greenhouse?
- What do they intend to grow?
- What environmental factors must the design withstand?
- How soon is the design needed?
- How much can the greenhouse cost?
- How big should the greenhouse be?
- Why is a greenhouse needed in a tropical climate? (This is a key question!)

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1.4 *Suppose you are working for a startup company that is designing a very new and innovative product. Does the client-user-designer model still apply? Who is your client in this case? Since you don't have any customers yet, who are the users and how can we capture their perspectives?*

This is actually an interesting topic that goes beyond the classroom. It is almost certain that a startup company will *want* to have users and customers. On the other hand, startups often have their own vision of what the final system or product will be. Often the client is either one of the founders or the financial backers of the new company. This can create several problems – an "insider's bias" in which the designer thinks that all users will be like her co-workers at the startup, and a tendency to make assumptions about the market that are not realistic. It is extremely important to identify a wide array of target users and involve them in the earliest stages of design in order to ensure that the designed system can be operated successfully by real customers.

1.5 *Much of management may be said to be goal directed. Explain how this description is exemplified by the 3Ss of management defined in Section 1.4.*

One way to think of management in general and projects specifically is in terms of goals of the organization. Usually these goals can be broken out in terms of doing something (scope), with limited resources (spending), and either by a deadline or as fast as possible (schedule).

EXERCISES AND ANSWERS/SOLUTIONS FOR CHAPTER 2

2.1 *When would you be likely to use a descriptive model of the design process?*

A descriptive model can be useful when summarizing design activities (e.g., for a client report or progress report), or when updating the work of a design team to insure that all members agree on the nature of the project and the current status.