Assessment Module:
Introduction to Object Oriented Design Patterns

Module Learning Objectives
This module introduces the idea of design patterns to the students. It helps them to learn what design patterns are and the role they play in software design. Furthermore, it introduces concepts from the Gang of Four book, Design Patterns: Elements of Reusable Object-Oriented Software. Students are exposed to several different design patterns to understand their description and application.

Assessment Objectives
The objective of the assessment will be to gauge a student's familiarity with the concept of design patterns. Students should be able to read and understand several design patterns and understand how they might be applied to a real world design problem. Students should be able to properly evaluate the suitability of certain design patterns for a design problem and demonstrate their ability to apply their design decision.

The type of assessment instrument will be performance based. A knowledge based test seems inappropriate for the subject matter as there is a low correlation between being able to learn facts about the design process and patterns and a student's mastery of the design effort. As such, a performance based assessment instrument will be used to allow the students to demonstrate their abilities to apply knowledge of design patters to a design task. The form of this assessment instrument will be primarily summative. Formative assessment methods might be useful in the assessment. However, the nature of the classroom assessment and the relatively small size of the assigned design task mean that a formative assessment method would generate an enormous amount data for evaluators. The results of this type of assessment would not be very indicative of the differences that exist between students' ability to design and use design patterns.

Assessment Design
The skills of the students are assumed to be per the module specifications, that is, they are comfortable with an object oriented language and basic design principles. As such, they will be expected to exhibit good OO design principles and have a fair amount of implementation skills. Because we can assume this level of skill, the design activity can include more advanced activities. The basic approach of the assessment instrument will be an in-class design activity followed by a "take-home" implementation activity. The instrument may be used repeatedly with variations in the design patterns employed and the design problem itself.

In Class Design Activity
The students will be exposed to a small set of design patterns. These may be introduced via class lectures or by assigning out of class readings. Students are advised to study these and may bring copies of the design patterns with them to the assessment activity. In the activity, the students are given a description of a small piece of software that centers on a task. The student is to evaluate the design problem in the context of the

design patterns studied. The student then chooses the most applicable design pattern and prepares an explanation defending their choice. Students are asked to explain how they would implement and map the necessary software functionality to the structure suggested by the design pattern. At the conclusion of the activity, the students take a copy of the design problem and their solution for use in the subsequent activity. The easiest way to structure this activity would be to have the students come to a lab and type up their solutions. The solution can be written using a word processor and/or computer design tools so it would be easy to make copies for the instructor and student to review. The purpose of this activity is to force a separation between the design and programming effort, that is, prevent the students from hitting the keyboard and designing as they program.

Take Home Implementation Activity
After having committed themselves to their initial design solution, the students now implement a simple prototype of their design. The primary goal is to have them implement the interfaces and functionality suggested by the design pattern. Students use their previous ideas to complete an implementation of the sketched out design. If the students arrive at the conclusion that they chose their design pattern poorly, they are allowed to change it. However, they are to provide a written explanation detailing what was the discovered problem with their design choice and how the new design is believed to better match the problem. Additionally, significant changes from the original design should be noted and explained. Submittals include the code and any supplementing descriptions or writings.

Assessment Instruments
1) *Design Problems* - This task is relatively simple and should be directly applicable to one or more of the design patterns introduced. To increase the level of difficulty of the problem, different wording and descriptions may be used to disguise the similarities. Suggestions for doing this include using domain specific terminology and avoided direct references to concepts or words that would broadcast the intended design pattern or relate directly to the intended design concepts.
2) *Handouts or copies of design patterns* – These are used by the students as reference material for studying and learning about the design patterns.
3) *Rubric for grading designs and implementations* – This will serve as a guideline for the grader to enable them to consistently evaluate the quality of the student's design.

Reliability of Assessment Method
A significant threat to reliability comes from the fact that students may have had prior programming experience using one or more of the design patterns. For example, a particular student may have worked on a project during an internship that gave him direct exposure to a project that was implementing a particular design pattern. Unfortunately, this situation will be difficult to avoid as the most popular design patterns to teach are arguably also the ones most used in industrial practice. To balance this, it is recommended that the instructor make sure that all of the students have had a chance to

expose themselves to the possible design patterns that will be presented in the design activity. This can be done by assigning reading, presenting the patterns in class or otherwise directing the students to focus on a certain subset of the design patterns. While this will not negate an advantage an experienced student will have, it will provide an opportunity for other students to level the playing field by studying the design pattern. Also, giving the design activity on more than one occasion will give less experienced students a trial run and more practice.

Validity of Assessment Method

The first argument for the validity of this assessment module is grounded in criterion validity. In this module, students are taught to do analysis and application of design patterns. The assessment evaluates how well they are able to do this. The nature of the design activity is such that it has been constructed to be similar to the type of small-scale design work that the student is likely to have to perform in an industrial setting. This represents criterion validity because their ability to do this activity correlates with their ability to perform similar tasks in industrial software engineering.

The second argument for the validity of this module is based in construct validity. The first part of the design activity has the student provide an explanation of why they believe their design choice to be appropriate for the problem at hand. This portion of the activity allows the instructor to get a glimpse of the rationale and thinking that the student is employing in order to arrive at a solution to the problem. The sketching out and mapping of the solution allows the instructor to see exactly what the student thought they would be able to accomplish. The second part of the activity forces the student to evaluate their design in the context of an implementation. By having them explain significant deviations from what was planned; the instructor is able to get a glimpse into how the students' thinking has changed about their previous design solution and their view of the problem. From their words the instructor will be able to see how they view the problem and how they believe the design patterns relate to it. Because this aspect of the assessment activity allows an instructor to evaluate and observe the thinking done by the student, this assessment module has construct validity.