

Maharishi International University 1971–1995

MAHARISHI UNIVERSITY OF MANAGEMENT

Engaging the Managing Intelligence of Nature

CS525:
Advanced Software Development
with GoF Design Patterns and
Frameworks
Discovering the Structuring Principles

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January 2018

CS-525: Advanced Software Development

January 2018

Week		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1	AM	Lesson 1 Introduction Lesson 2 Singleton	Lesson 3 Adapter and Proxy	Lesson 4 Template Method and Prototype	Lesson 5 Factory Method and Abstract Factory	Lesson 6 Chain of Responsibility and Command	Lesson 7 Iterator and Composite
	PM	Lab	Lab	Lab	Lab	Lab	
2	AM	Lesson 8 Builder and Flyweight	Lesson 9 Façade and Memento	Lesson 10 State and <i>Strategy</i>	Lesson 11 Bridge and Decorator	Lesson 12 Mediator and Observer	Lesson 13 Visitor and Interpreter
	PM	Lab	Lab	Lab	Lab	Lab	
3	AM	Project	Project	Project	Project	Project	Project
	PM	Project	Project	Project	Project	Project	
4	AM	Project Demo	Review		Exam		
	PM						

CS 525: Advanced Software Development with GoF Design Patterns and Frameworks Discovering the Structuring Principles of Creation

Main Objectives of CS525

- Become well-acquainted with 23 GoF design patterns.
- Become skillful in using GoF design patterns to solve design problems.
- Understand the underlying principles of the 23 design patterns.
- Understand the different mindsets between application and framework designers/developers.
- Develop skills as a software designer/developer in building flexible yet robust object-oriented software applications and frameworks
- Become well-trained in applying concepts of structure, indirection, trade-off, change, etc. in choosing micro-architectures of software design problems.
- Become knowledgeable in getting full support from the Java platform to implement pattern-based software designs (though design patterns are supposed to be language-independent).

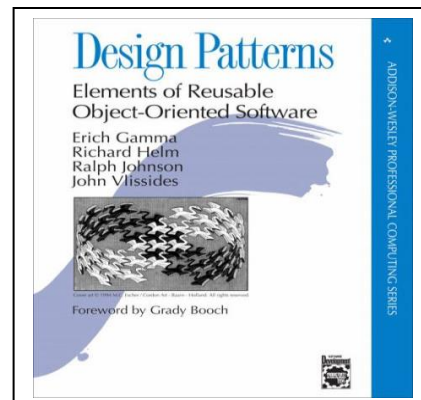
Class Schedule

Class is in session from 10:00 to 12:30 every morning, and from 1:30 to 3:15 every afternoon, except Saturday. Labs may take place in the mornings or in the afternoons. (See the back of the syllabus for a further discussion of class schedule and daily routine.)

Textbook

The textbook for the course is Design Patterns: Elements of Reusable Object-Oriented Software.

Author: Gamma, Erich/ Helm,
Richard/ Johnson,
Ralph/Vliss ISBN13:
978-0-201-63361-0



Readings

The textbook will supplement the material given in the lectures. You will find it helpful to read material from relevant sections in order to complete your understanding of the material and to assist you in doing the labs.

For each of the 23 patterns discussed in the book, the required sections are:

1. Intent
2. Motivation
3. Applicability
4. Structure
5. Participants
6. Consequences
7. Implementation

Supplementary Readings

1. Head First Design Patterns
2. Online tutorials: there is a large number of websites/blogs talking about design patterns. However, keep in mind that some of their examples/ implementations are not the best illustrations of the GoF patterns.

Homework

Some labs will be in the form of pencil and paper exercises; others will require you to write Java programs. Homework will count 5% of your final grade. If you work with someone else, make sure you understand your answers – on the exams, the same concepts will reappear. All labs are due in the morning of the following week by 10am (unless we agree on a different submission time during class discussion).

Attendance

Each late show for a lecture will cost you half of a point. You may volunteer to lead a group meditation in class to cancel each late show but you are not going to earn extra points by being such a volunteer.

Extra credit is available when you lead a group meditation at Dalby Hall on Wednesday morning during the block.

Final Project

During the second half of the block, you will be working on a final project, which will exercise your programming skills and your knowledge in design patterns and frameworks. The project will be due on the last day of class and will count 20% of your final grade.

Exam

There will be one exam only for the course, which counts 70% towards your final grade.

Exam	Date Administered	Exam Content	Value
Final	4 th Thursday	Lessons 1 - 13	70 %

Grading

Your final grade will be a combination of your scores on Final Exam, Homework, Project, and Professional Etiquette. Final Exam counts 70%; combined Homework, Project and your Professional Etiquette scores count 30% towards your total final grade. Each time you are late, you lose half of a point, but each time you volunteer as a mediation lead, you earn half of a point that can be used for cancelling late shows only. Our TAs will be responsible for keeping track of class attendances.

Evaluation Modality	Value
Exam	70%
Homework	5%
Final Project	20%
Professional Etiquette	5%

We will use the following grading scale:

Range	Letter Grade
93-100	A
88 - 92	A-
84 - 87	B+
79 - 83	B
75 - 78	B-
71 - 74	C+
66 - 70	C
64 - 65	C-
0 - 63	NC

Note: It is possible to round up your grade (for example from 91.5 to 92) on the basis of excellent class participation and professional etiquette. **But DO NOT ask for a better grade because you want or you need it.** Your final grade will be given based on the scores for exams, attendance, etiquette, homework and project combined.

How to be successful in the course

- You understand the Intent and Structure of each design pattern and the roles of participants clearly
- You participate well in class
- Read the course material provided and the textbook for better understanding, if necessary
- Do labs individually and make sure you understand it. (Of course you can always discuss with others)
- You can use the knowledge to solve similar design problems. It is important as the programming part counts 40% of the exams.
- **Develop a Framework Developer's mindset.**

Note: You should pay enough attention to details. Use the descriptions given in the textbook as the 'official' source of the knowledge, not some random websites talking about design patterns. Between the structure and implementation, treat the 'structure' as the basis for your 'implementation', not the other way around.

MAIN POINTS – CS525

Lesson 1: Introduction *Unlocking the Blueprint of Creation*

WHOLENESS OF THE LESSON

"Each design pattern describes a problem which occurs over and over again in our environment, and then describes the core of the solution to that problem, in such a way that you can use this solution a million times over, without ever doing it the same way twice". *Science of Consciousness*: The intelligence underlying the functioning of any software object resides in its underlying class, which is the silent basis for the dynamic behavior of objects. Likewise, pure consciousness is the silent level of intelligence that underlies all expressions of intelligence in the form of thoughts and actions in life.

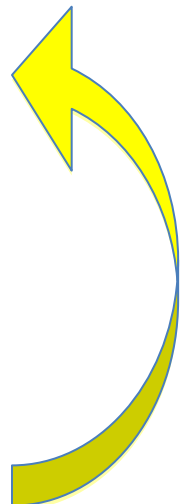
MAIN POINTS

1. Design Patterns are proven solutions to common recurring problems within a given context in software design, which allows developers/designers to fully leverage the power of existing projects and successes.
2. Design Patterns are also considered as common sense or human wisdom applied in the area of software design.

CONNECTING THE PARTS OF KNOWLEDGE WITH THE WHOLENESS OF KNOWLEDGE

From pure intelligence to Design Solutions

1. Using Design Patterns, highly flexible/functional applications can be built more quickly by avoiding to reinvent the wheel.
 2. Design Patterns themselves are extracted from human wisdom from all walks of life.
-
3. **Transcendental Consciousness**: To be successful, action must be based on the field of pure intelligence, which is located at the source of thought.
 4. **Wholeness moving within Itself**: In Unity Consciousness, the pure intelligence located in TC is found pervading all of creation, from gross to subtle.



Lesson 2: Singleton and Adapter Design Patterns

From ideas to expressions

WHOLENESS OF THE LESSON

Singleton ensures that there is only one single instance created, which allows open access from all classes/objects that need its service. Adapter converts the interface of a class into another interface clients expect. Adapter lets classes work together that couldn't otherwise because of incompatible interfaces. *Science of Consciousness: Capture the full value of creative intelligence on the level of unmanifest pure intelligence then capture the home of all knowledge.*

CONNECTING THE PARTS OF KNOWLEDGE WITH THE WHOLENESS OF KNOWLEDGE

1. With Singleton Pattern, we make sure that additional instances of the class cannot be created.
 2. Adapter Pattern simply shows different expressions of the same underlying structure and intelligence.
-
3. **Transcendental Consciousness:** Pure consciousness is the single field of *unbounded awareness* and *infinite silence*.
 4. **Wholeness moving within Itself:** In Unity Consciousness, one observes that this unbounded silent quality of awareness spontaneously supports all levels of action of different forms in the world.



Lesson 3: Proxy And Template Method

Unbounded awareness opens unbounded possibilities

WHOLENESS OF THE LESSON

A Proxy provides a surrogate or placeholder for another object to control access to it. Template Method defines the skeleton of an algorithm in an operation, deferring some steps to subclasses. Template Method lets subclasses redefine certain steps of an algorithm without changing the algorithm's structure. *Science of Consciousness:* *By taking care of the holistic field of life, the pure nature of creative intelligence, we can enrich all aspects of life.*

CONNECTING THE PARTS OF KNOWLEDGE WITH THE WHOLENESS OF KNOWLEDGE

1. A proxy object can act as the intermediary between the client and the target object.
 2. A template method defines abstract "hook" operations, thereby permitting future extensions without affecting itself. The Template Method is a fundamental technique for code reuse.
-
3. **Transcendental Consciousness:** TM acts as a proxy that allows us to tap into the source of thought.
 4. **Wholeness moving within Itself:** To achieve success, everyone can take advantage of a daily routine with regular practice of Transcendental Meditation, comparable to the proven template method with any hook operations to perform as one's profession to gain Nature's support.



Lesson 4: Factory Method and Prototype

Self-referral leads to progressive creation of unbounded intelligence

WHOLENESS OF THE LESSON

Factory Method defines an interface for creating an object, but let subclasses decide which class to instantiate. Factory Method lets a class defer instantiation to subclasses. Prototype allows to specify the kinds of objects to create using a prototypical instance, and create new objects by copying this prototype. *Science of Consciousness: The purpose of most thoughts is to produce successful actions and achievements in the world, and more powerful thoughts will produce more successful actions.*

CONNECTING THE PARTS OF KNOWLEDGE WITH THE WHOLENESS OF KNOWLEDGE

1. Factory Method allows creation of a type without knowing its concrete subtype, which supports “programming to the interface not to the implementation”.
 2. Prototype supports deep clone that can be recursive in the form of a sequence of self-calls
-
3. **Transcendental Consciousness:** TC is the source of creation of all intelligence.
 4. **Wholeness moving within Itself:** In Unity Consciousness, one sees that all activity in the universe springs from the self-referral dynamics of wholeness.



Lesson 5: Façade and Memento

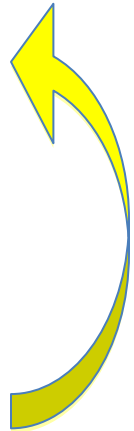
Creational intelligence structures all beings in progressive layers

WHOLENESS OF THE LESSON

Façade provides a unified interface to a set of interfaces in a subsystem. Façade defines a higher-level interface that makes the subsystem easier to use. Without violating encapsulation, Memento captures and externalizes an object's internal state so that the object can be restored to this state later. *Science of Consciousness: Unity in diversity / Pure Knowledge has infinite organizing power.*

CONNECTING THE PARTS OF KNOWLEDGE WITH THE WHOLENESS OF KNOWLEDGE

1. Structuring a system into subsystems helps reduce complexity.
 2. Memento allows externalizing the internal state of an object, which is required when implementing checkpoints and undo mechanisms that let users back out of tentative operations or recover from errors.
-
3. **Transcendental Consciousness:** TC is manifested in the structure of all creations.
 4. **Wholeness moving within Itself:** In Unity Consciousness, all activity is appreciated as the self-referral dynamics of one's own Self.



Lesson 6: Iterator and Composite

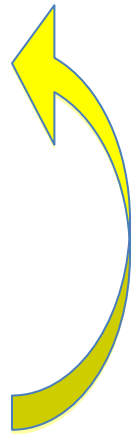
Self-referral is universal in all creations of intelligence

WHOLENESS OF THE LESSON

Provide a uniform way to access the elements of an aggregate object (collection) sequentially without exposing its underlying representation. Composite Pattern composes objects into tree structures to represent part-whole or parent-child hierarchies. *Science of Consciousness: We bring in the light of consciousness, and problems resolve.*

CONNECTING THE PARTS OF KNOWLEDGE WITH THE WHOLENESS OF KNOWLEDGE

1. Iterator provides a uniform interface for traversing different aggregate structures to support polymorphic iteration
 2. Composite lets clients treat individual objects and compositions of objects uniformly.
-
3. **Transcendental Consciousness:** TC is the unbounded context for unbounded layers of self-awareness.
 4. **Wholeness moving within Itself:** When individual awareness is permanently and fully established in its transcendental "context" – pure consciousness – every impulse of creation is seen to be an impulse of one's own awareness.



Lesson 7: Chain of Responsibility

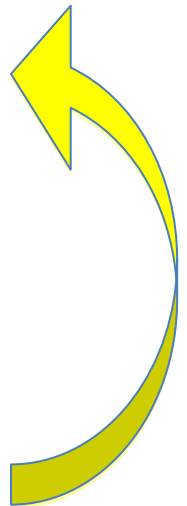
Using a chain to organize externally-invisible roles and responsibilities to support easy change and extension

WHOLENESS OF THE LESSON

Avoid coupling the sender of a request to its receiver by giving more than one object a chance to handle the request. Chain the receiving objects and pass the request along the chain until an object handles it. *Science of Consciousness:* Structure itself is evolved over time to find its most efficient, flexible yet easily extensible way to support its role endowed by nature.

CONNECTING THE PARTS OF KNOWLEDGE WITH THE WHOLENESS OF KNOWLEDGE

1. When more than one object may handle a request and the actual handler is not known in advance.
 2. Chain of Responsibility decouples sender and receiver so that it supports dynamic change of behavior at runtime, which reduces human intervention for systems that accommodate frequent change.
-
3. **Transcendental Consciousness:** The fundamental impulses that structure the behavior of an object have their basis in the silent field of pure consciousness.
 4. **Wholeness moving within Itself:** In Unity Consciousness, the finest structuring mechanics of creation are appreciated as modes of vibration of the Self.



Lesson 8: Abstract Factory

Indirection supports flexibility in creation

WHOLENESS OF THE LESSON

Abstract Factory provides an interface for creating families of related or dependent objects without specifying their concrete classes. *Science of Consciousness*: All actions will be most successful if they arise from a solid basis of thought that is supported by the laws of nature.

CONNECTING THE PARTS OF KNOWLEDGE WITH THE WHOLENESS OF KNOWLEDGE

1. Abstract factory isolates concrete classes even further. Product class names are isolated in the implementation of the concrete factory; they do not appear in client code.
2. Client cannot anticipate which group of related classes is to be selected at runtime. However, the Abstract Factory is prepared to handle a request for any of the predefined groups of classes.

-
3. **Transcendental Consciousness**: TC is the home of all knowledge. All knowledge has its basis in the unbounded field of pure consciousness.
 4. **Wholeness moving within Itself**: In Unity Consciousness, when the home of all knowledge has become fully integrated in all phases of life, it is possible to know anything, any particular thing, instantly.



Lesson 9: Command Pattern

Strengthening individual intelligence makes a better society

WHOLENESS OF THE LESSON

Encapsulate a request as an object, thereby letting you parameterize clients with different requests, queue or log requests, and support undoable operations. *Science of Consciousness: Nature discriminative qualities spring from the pure field of creative intelligence, so we say creative intelligence is holistic; it contains the wholeness of life.*

CONNECTING THE PARTS OF KNOWLEDGE WITH THE WHOLENESS OF KNOWLEDGE

1. Command decouples the object that invokes the operation from the one that knows how to perform it.
 2. Command Pattern allows dynamic change and/or expansion of software without having to change a single line of code.
-
3. **Transcendental Consciousness:** Transcendental Consciousness is the unbounded value of awareness that nourishes individual growth
 4. **Wholeness moving within Itself:** In Unity Consciousness, creation is seen as the interaction of unboundedness and point value: the unbounded collapses to its point value; point value expands to infinity; all within the wholeness of awareness.



Lesson 10: State and Strategy

Fundamental patterns of consciousness in the realm of Nature-supported structures

WHOLENESS OF THE LESSON

State allows an object to alter its behavior when its internal state changes. The object will appear to change its class. Strategy defines a family of algorithms, encapsulates each one, and makes them interchangeable. Strategy lets the algorithm vary independently from clients that use it. *Science of Consciousness: Before the unmanifest sap starts to green or red, it must begin to function within itself, the activity must start in unmanifest value, and then the next stage of that activity will be turning to be green.*

CONNECTING THE PARTS OF KNOWLEDGE WITH THE WHOLENESS OF KNOWLEDGE

1. State pattern localizes state-specific behavior in each concrete state.
 2. Strategies can provide different implementations of the same behavior. The client can choose among strategies with different time and space trade-offs.
-
5. **Transcendental Consciousness:** TC spontaneously structures creation intelligence into where it belongs.
 6. **Wholeness moving within Itself:** Unity Consciousness supports the emergence of all states of consciousness of individuals.



Lesson 11: Bridge

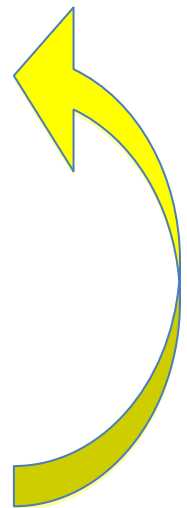
Decoupling is a fundamental mechanism of supporting flexibility

WHOLENESS OF THE LESSON

Bridge decouples an abstraction from its implementation so that the two can vary independently. *Science of Consciousness*: Living unbounded awareness within boundaries.

CONNECTING THE PARTS OF KNOWLEDGE WITH THE WHOLENESS OF KNOWLEDGE

1. Bridge lets us avoid permanent binding between abstraction and implementation by favoring composition over inheritance.
 2. You want to share an implementation among multiple objects, and this fact should be hidden from the client.
-
3. **Transcendental Consciousness:** TM is a bridge between superficial values of life and the field of pure consciousness.
 4. **Wholeness moving within Itself:** In Unity Consciousness, one sees that the "bridge" to accessing complete knowledge of any object is the infinite value of that object, pure consciousness. Knowing that level of the object, it then becomes possible to know any more relative level of the object as well.



Lesson 12: Mediator and Observer

Once the right direction is set, inherent intelligence simultaneously ensures the right result

WHOLENESS OF THE LESSON

Define an object that encapsulates how a set of objects interact. Mediator promotes loose coupling by keeping objects from referring to each other explicitly, and it lets you vary their interaction independently. Define a one-to-many dependency between objects so that when one object changes state, all its dependents are notified and updated automatically. *Science of Consciousness: Like the principle of diving, we want to take the right angle and let go.*

CONNECTING THE PARTS OF KNOWLEDGE WITH THE WHOLENESS OF KNOWLEDGE

1. A mediator localizes behavior that otherwise would be distributed among several objects. Changing this behavior requires subclassing Mediator only; Colleague classes can be reused as is.
 2. When an abstraction has two aspects, one dependent on the other. Encapsulating these aspects in separate objects lets you vary and reuse them independently.
-
3. **Transcendental Consciousness:** TC is the home of all the laws of nature, the home of "right action".
 4. **Wholeness moving within Itself:** Action in the state of Unity Consciousness is spontaneously right and uplifting to the creation as a whole.



Lesson 13: Visitor Pattern

Expansion of consciousness leads to a broader spectrum of possibilities

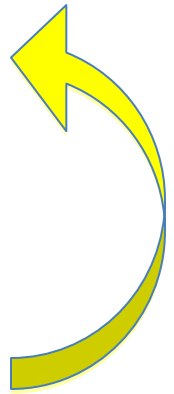
WHOLENESS OF THE LESSON

Represent an operation to be performed on the elements of an object structure. Visitor lets you define a new operation without changing the classes of the elements on which it operates. *Science of Consciousness*: Seek the highest first, by starting with a good foundation and building upon that.

CONNECTING THE PARTS OF KNOWLEDGE WITH THE WHOLENESS OF KNOWLEDGE

1. Visitor also allows us to externalize operations of an object structure into a separate class yet still supports polymorphism by “Double Dispatch”.
2. Visitor pattern minimizes the need to make frequent changes to code even for frequently changed business rules. Instead, we achieve the same by adding new visitors to the hierarchy so that client code remains unchanged.

-
3. **Transcendental Consciousness**: TC is the field of truth, the field of *Sat*. "Know that by which all else is known." -- *Upanishads*
 4. **Wholeness moving within Itself**: In Unity Consciousness, the final truth about life is realized in a single stroke of knowledge.



Supplement: Professional Etiquette

And Daily Routine

DAILY SCHEDULE

The daily schedule of all courses is designed to give students mastery of specific fields of knowledge and to cultivate higher states of consciousness for success and fulfillment in life. Do your best to get to bed by 9:30 p.m. so you are rested and fresh in the morning. Don't stay up late to do homework.

MORNING

before 9:30	Group practice of the Transcendental Meditation and TM-Sidhi programs
10:00 – 12:15	Class lecture, discussion, activities, labs
12:15 – 12:30	Group meditation
12:30 – 1:30	Lunch

AFTERNOON

1:30 – 2:45	Continuation of morning class and/or labs
2:45 – 3:05	Group practice of the Transcendental Meditation

EVENING

6:30 – 7:30	Dinner
7:30 – 9:30	Homework
10:00	Rest

CLASS ATTENDANCE

Attendance at all classes is required, because all elements of class — lectures, questions and answers, discussions, group work, student presentations — contribute to the learning process. Absences are usually excused only if you are sick in bed or have family emergency.

If you must miss a class, please let me know ahead of time. Give me a call, send me an email, or send a note with a friend. Simply not showing up where one is expected is unprofessional and discourteous and will be considered an unexcused absence. If I don't hear from you, I'll ask the TAs to get in touch with you.

There is no such thing as a "personal day." If you have personal business to take care of, please schedule it for after class or during the days between blocks. At the same time, I recognize that it may be occasionally be necessary for a student to miss a class (or part of a class) for some reason other than illness or family emergency. I'm open to considering your needs with you. Please speak with me beforehand.

The first lesson of each course is the most important. Students are expected to be present from the first lesson onward. Any student not present on the first morning (except for such compelling reasons as illness or family emergency) may be asked to withdraw from the course.

PUNCTUALITY

Punctuality is expected and required in the professional world. People commonly lose their jobs for being late — especially new college graduates unfamiliar with professional expectations. Colleges and universities have come under criticism for not properly preparing students in these values.

Therefore we place a similarly high value on arriving on time for every class session. If students are late, they disrupt the learning environment and may miss the wholeness of the lesson. Coming late is unprofessional and shows lack of courtesy to the instructor and to fellow students.

Thus the faculty request that students arrive a couple minutes early, so everyone is seated and settled when the class begins. *Well begun is half done.*

Punctuality also extends to returning from the class break in a timely fashion (as announced by the professor at the beginning of the break). The instructor should not need to go out and round up students.

If you need to be late to class for some reason beyond your control (a dentist appointment, for example), please arrange that with me ahead of time.

DRESS

PREFERRED — Classic professional

For men, suits, jackets, dress shirts, ties, dress pants, dress shoes with socks. For ladies, suits, career dresses or blouses and skirts (knee length or longer) with jackets and cardigans, pant suits, dress shoes.

ACCEPTABLE — Less professional but acceptable for class

For men, shirts with collars and sleeves, trousers. For ladies, sweaters and skirts (knee length or longer), career slacks, dresses (knee length or longer), coordinated outfits.

INAPPROPRIATE — Students will be asked to change for class or dining at lunchtime.

For everyone, blue jeans, T-shirts, shorts, asana clothes, flip-flops; torn, dirty, or sloppy clothes. For men, sleeveless shirts or improperly fitting clothes. For ladies, camisole or spaghetti strap tops, skirts or dresses above the knee or with high slits. very tight or low-cut apparel, uncovered midriffs.

For details on the above, please see the Student Handbook.

PROFESSIONAL ETIQUETTE

Proper etiquette is essential to our personal and professional success, and the college years are an ideal time to cultivate these values. To give attention and importance to this, several fundamental values of etiquette are built into the grading system in every course:

BOOST YOUR GRADE — If you observe the following values of professional etiquette throughout the course, it will be possible to raise your final score by half a grade — for example, from a B+ to an A– :

- Attend every class
- Be on time for every class
- Dress at least half or more of the time at the *Preferred* level and the rest at the *Acceptable* level.

This grade boost is reserved for those students who meet these professional etiquette standards without exception throughout the course.

REDUCE YOUR GRADE — Your final score may be lowered by half a grade if the following happens:

- **Attendance** — If you skip a class without your instructor's approval, your instructor will reduce your grade. If you must miss more than three days even for illness or family emergency, you won't have completed enough of the coursework to be eligible for course credit. Typically, in this case, you will be asked to withdraw from the course.
- **Punctuality** — Your final score may be reduced one half grade for every 60 accumulated late minutes (e.g., from B+ to B).
- **Dress** — Your grade will be reduced one half grade if you need to be spoken with more than once about dress, whether by the instructor or the Deans of Students.

Your Professional Etiquette Score will be monitored using the following record-keeping tables: