ESI6912 DIVERGENT THINKING
Fall 2014

Course Description. The highest levels of creativity require both divergent and convergent thinking. Divergent thinking encourages the generation of numerous solutions whereas convergent thinking promotes the use of information and a set of rules to arrive at a single 'correct' solution to a problem. While the former can be highly unstructured and unguided in nature, the latter is typically structured and directed. According to the well-known *Geneplore Model*, creativity involves a cyclical process of *generating* ideas and then systematically *exploring* the most promising ideas for implementation. While the generation stage is believed to involve divergent thinking whereas the exploration stage believed to engage convergent thinking. The traditional engineering curriculum and pedagogy rely and place an emphasis on the development of convergent thinking skills of students for the delivery of discipline-specific domain knowledge.

Engineering has directed and fueled the advance of civilization from Stone Age to Renaissance to Industrial Revolution to Digital Revolution. The century ahead poses challenges as difficult as any humanity has encountered to date. A careful examination of the National Academy of Engineering's Grand Challenges for Engineering demonstrates that the problems that require engineering solutions are large and complex necessitating a need for the innovative use of discipline-specific knowledge in inter-, multi-, trans-, and cross-disciplinary contexts. This, in turn, challenges the traditional engineering curriculum and pedagogy.

This course will focus on a set of in-class activities and homework assignments challenging students to (1) cultivate multiple forms of intelligence, (2) develop their skills that help support divergent thinking, and (3) challenge them to adopt a divergent thinking approach to address some of the Grand Challenges for Engineering.

Students who want to think broadly, desire to cast a wider net, wish to exercise both sides of their brains, and have an interest in developing their potential for creativity are encouraged to register.

Course Objective. This course develops student's divergent thinking abilities to develop creative solutions to Grand Challenges for Engineering. By the end of this course, the students are expected to: (1) have an appreciation of different forms of intelligence; (2) be aware of their own thinking and learning processes; (3) acquire a set of skills that allows them to use both sides of their brains to discuss topics, generate ideas, and devise solutions; (4) develop a thorough understanding of the Grand Challenges for Engineering; and (5) exercise divergent thinking skills with intent and work in interdisciplinary teams to develop a solution to an Engineering Grand Challenge of their choice.

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Classroom Meetings. M 9 and W 9 NEB 102

Class Policies. Let the following principles guide you throughout the course:

1. Be adventurous and playful.
2. Give yourself permission to push your own boundaries.
3. Bring your "whole" self to everything you do for this class.
4. Say "Yes, and…" instead of "Yes, but…"

Attendance: This class is highly experiential and requires each student to come prepared to participate actively. Given the nature of the course, it is virtually impossible to make up for the challenges completed during the missed sessions, and **you can't miss more than two classes**.

Grading. Your final grade for the class will be calculated based on your attendance, in-class participation, and homework assignments as follows: Attendance 10%, Journal 30%, In-class Challenges 20%, Assignments 20%, and Final Project 20%. Final grade averages will be rounded off to the nearest one-tenth point, and assigned on the standard scale as follows: 90.0 and above A; 88.0 to 89.9 B+; 80.0 to 87.9 B; 78.0 to 79.9 C+; 70.0 to 77.9 C; 68.0 to 69.9 D+; 60.0 to 67.9 D; and Below 60.0 E.

Course Outline. This is a tentative outline and the instructor reserves the right to make changes as she sees necessary.

Week	Date	Topic	Activity	Assignment
1	8/25	Introduction: Goals and expectations	Circles Walnuts	
	8/27	Introduction: Getting to know each other	Divergent thinking Grand challenges	
2	9/1	**Labor Day**	No Class Meeting: Holiday	
	9/3	Curiosity: Asking questions	10+ questions	
3	9/8	Curiosity: Observing	Design exercise	Assignment 1: Coffee shop
	9/10	Curiosity: Challenging assumptions	20 assumptions	
4	9/15	Curiosity: Contemplating	Stream of consciousness	Assignment 2: A 100 questions
	9/17	Learning: Own beliefs	3+ ideas on 3 areas	Project Proposal
5	9/22	Learning: Own sources	Media, people, experience	Assignment 3: State of the art
	9/24	Learning: Points of view. Six thinking hats.	Review your view from a distance	
6	9/29	Learning:	What if no fear?	Assignment 4:

		Anti-models	Mistakes to avoid	Mistakes
	10/1	Sensing Seeing and hearing	See vs. Look Hear vs. Listen	
7	10/6	Sensing: Touching	Blindfold touch Touch nature	Assignment 5: Sunrise or Sunset
	10/8	Sensing: Tasting and smelling	Honey tasting Coffee tasting	
8	10/13	Sensing: Synesthesia	No Class Meeting: Workshop	Assignment 6: Synesthesia
	10/15	Ambiguity and Uncertainty: Drawing uncertainty	No Class Meeting: Workshop	
9	10/20	Ambiguity and Uncertainty: Feeling ambiguity	3 ambiguous situations	Assignment 7: Ambiguity & anxiety
	10/22	Ambiguity and Uncertainty: Processing paradoxes	A paradox	
10	10/27	Ambiguity and Uncertainty: Working with uncertainty	Puzzle	Assignment 8: Uncertainty
	10/29	Logic and Imagination: Right- or Left-brained?	Art and science	
11	11/3	Logic and Imagination: Details vs. Big Picture	Fast drawing exercise	Assignment 9: Imagine
	11/5	Logic and Imagination: Mind-mapping 1	Mind mapping exercise	
12	11/10	Logic and Imagination: Mind-mapping 2	No Class Meeting: INFORMS	Assignment 10: Memory Mind Map
	11/12	Movement: Your body	Let's move	
13	11/17	Movement: Bioenergetics and breathing	Let's breath	
	11/19	Movement Ambidextery: Drawing	Interlocking	Assignment 11: Draw
14	11/24	Movement Ambidextery: Writing	The other Mirror	
	11/26	**Thanksgiving Holiday**	No class meeting:	
15	12/1	Interconnections: Connections	3-4 connections	Assignment 12: Connect
	12/3	Interconnections: Empathy	Be something Be someone	
16	12/8	Interconnections: Origins	A book, your clothes, a bread	
	12/10	Interconnections: Metaphors and Analogies	Your family Nature's inventions	Project Report
17	12/16	Final Project Presentations		Project Presentation

Assignment 1: A Hundred Questions

This is an assignment that needs to be completed in one sitting. Write quickly; don't worry about spelling, grammar, or repeating the same question with different words. In your notebook, make a list of a hundred questions that are important to you. Your list can include any kind of question as along as it's something you deem significant: anything from "How can I save more money?" or "How can I have more fun?" to What is the meaning and purpose of my existence?" and "How can I best serve the society?" When you have finished, read through your list. Consider the emerging themes without judging them and highlight them. Choose your top 10 questions that seem most significant. Rank them in importance from one to ten. Do not make any attempt to answer them.

The purpose of this exercise is to let your explore your thoughts and perspective in a free-flowing, incomplete, and non-judgemental manner.

Assignment 2: Coffee shop

Go to a coffee shop and sit at a table where you can observe people. Plan on spending about 10 minutes observing and writing down details about 6 different people in your notebook. In particular, observe their movements, their posture, their gestures, what they are wearing, their hair, etc. Write down your observations on the spot. If someone asks what you are doing, tell them that it's an assignment to develop your observation skills in a course about divergent thinking. Please do not take pictures but rely on your observation skills.

The purpose of this exercise is to get you started in observing and note taking, and to give you the experience of being a "passive" (non-participant) observer.

Assignment 3: State of the art

Interview 2-5 different friends/family members/professors to find out what they know/think about the grand challenge assigned to you. Conduct a search on the internet to familiarize yourself with the discourse in the popular media on the grand challenge assigned to you. Find a *Science* or *Nature* article that is related to the grand challenge assigned to you. Write down your findings in your notebook.

The purpose of this exercise is to get you use different sources to learn about a topic.

Assignment 4: Mistakes

Explore your attitude towards mistakes by contemplating on the following questions and recording your reflections in your notebook:

- What did you learn at school about making mistakes?
- What did your parents teach you about making mistakes?
- What is the biggest mistake you ever made?
- What did you learn from it?
- What role does the fear of making mistakes place in your daily life, at work and at home?
- Are you more likely to make mistakes of commission or omission?

The purpose of this exercise is for you to explore your attitude towards making mistakes.

Assignment 5: Sunrise or Sunset

Look in the newspaper or on the internet to learn the exact time of the sunrise or sunset. Find a quiet place to sit where you get a good view. Arrange to arrive at least 10 minutes before the official time. Do the palming exercise for three minutes, then focus near and far, accessing soft eyes as you take in the horizon. Describe the details of the experience in your notebook.

The purpose of this exercise is to practice eye-palming, focus near and far, and soft eyes approaches.

Assignment 6: Synesthesia

Do the following exercises:

- Listen to your favorite piece of music. As you listen, experiment with expressing your impressions by drawing shapes and colors.
- Look at a reproduction of your favorite painting. As you look, experiment with tasting the colors, shapes, and textures.
- Revisit your favorite piece of music. As you listen, imagine how it would feel and taste like if you could bite into it.
- Revisit your favorite painting. As you look, imagine how it would feel like if you could touch the colors, shapes, and textures.

The purpose of this exercise is to practice merging of the senses and prescribing one sense in terms of others.

Assignment 7: Ambiguity & Anxiety

Count the number of times per day that you use an absolute such as "totally," "always," "certainly," "must," "never," and "absolutely."

The purpose of this exercise is to monitor your tolerance for ambiguity.

Make a note of each time you feel anxious throughout the day. Make a note of it your notebook describing the conditions. Where in your body do you feel it? If anxiety had a shape, a color, a sound, a taste, a smell, what would they best?

The purpose of this exercise is to recognize when you feel anxious and what you think about anxiety.

Assignment 8: Uncertainty

Make a list of 100 questions for the grand challenge that is assigned to you. Recognize the themes and determine the 10 most important questions. Which ones cause the greatest sense of uncertainty and ambivalence? Are there any paradoxes at the heart of these questions? Working in your notebook, try your hand at some abstract art. Sketch the feeling of uncertainty generated by a particular question from your list.

The purpose of this exercise is to recognize the uncertainties in a problem and how to cultivate an understanding of the uncertainties and how to internalize them.

Assignment 9: Imagine

Familiarize yourself with the terms *microcosm* and *macrocosm*. Consider the grand challenge assigned to you. "Be" the grand challenge. Make a list of all the systems that are affected by the grand challenge. For one of these systems imagine the elements that make up the system and imagine how these elements are affected by the grand challenge. Write down that what comes to your mind quickly in your notebook. Next, think of what the system you have chosen is a subsystem of. Think of the networks that this system is a part of. Think broadly to include physical, information, and geopolitical networks. Then visualize the role of the system in the bioregion, planet, solar system and the galaxy. Write down what comes your mind quickly in your notebook.

The purpose of this exercise is to help you explore and contemplate the relationship between microcosm and macrocosm as it relates to a grand challenge.

Assignment 10: Memory Mind Map

Think of the grand challenge you are working on. Make a comprehensive mind map of your subject, emphasizing vivid images of your most important points. You may need to work on multiple drafts to organize, integrate, and clearly express the subject.

The purpose of this exercise is to use mind-mapping to organize your thoughts and knowledge to learn something.

Assignment 11: Draw

Pick an object that you are interested in. Pick two colored pens or pencils. Make blind contour drawings with your non-dominant and dominant hand using different colors on the same sheet. Make two zentangle drawings, one with non-dominant hand and the other with your dominant hand. Reflect on your experience in your notebook.

The purpose of this exercise is to help you cultivate ambidexterity in drawing.

Assignment 12: Connect

Consider the list of seemingly unrelated things that is assigned to you. Find ways to link them. Write down your connections in your notebook. Next, find ways to link them to propose a solution to the grand challenge that is assigned to you.

The purpose of this exercise is to help you see relationships and patterns, and make unfamiliar combinations and connections.

Course Project: An Engineering Grand Challenge

Students will be asked to form teams of three or four and develop a solution to address an Engineering Grande Challenge. Teams will be required to submit a Project Proposal (5 points) in Week 4, a Final Project Report (10 points) in Week 16 and a Project Presentation (5 points) to present their work in Final Exam Week with the rest of the class.