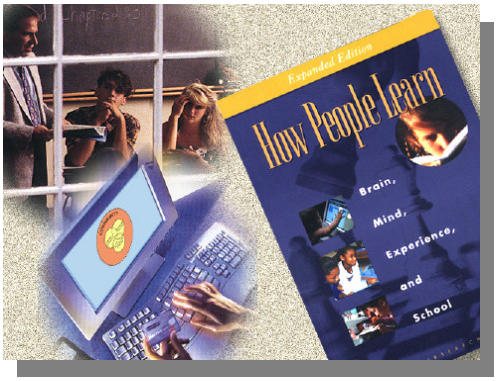
VaNTH ERC FOR BIOENGINEERING EDUCATIONAL TECHNOLOGIES

Vanderbilt - Northwestern - Texas-Harvard/MIT Engineering Research Center

"How People Learn" Engineering

A Workshop on Designing Effective Instruction

FULL-DAY SESSION with PRE-WORKSHOP ACTIVITIES



Building on an HPL framework to enhance learning environments that develop innovative engineers

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MATERIALS AND ACTIVITES
FOR WORKSHOP PARTICIPANTS
TO READ AND DO
BEFORE ATTENDING THE WORKSHOP

TASK ONE - DEFINING COURSE OBJECTIVES (pp. 5 and 6) adapted from the work of Sean Brophy, Ph.D., Department of Engineering Education of Purdue University

Getting Started – Two Weeks Before Attending the Workshop

Working through the following activities will prepare you to accomplish the most from your one-day VaNTH workshop.

The following few pages of pre-workshop information and activities are designed to enable you to get the most from the one-day VaNTH workshop experience and to assist you in designing content modules that you can take with you from the workshop and immediately use in teaching your course.

In these pages you will find the following:

1. A diagram of the five-task "backwards design" process VaNTH uses, based on the Wiggins and McTighe's *Understanding by Design* (1999).
2. Information on defining course objectives – the **first design task**
    a. An activity identifying your own course objectives
    b. An activity identifying course sub-objectives
    c. An activity identifying potential instructional difficulties in accomplishing the objectives
    d. An activity identifying real-world applications of course objectives
3. Information on creating models of knowledge - the **second design task**
    a. Instruction on developing a concept map to identify concepts and skills involved in the course and how these relate to one another.
    b. An activity developing a concept map
    c. An activity prioritizing course concepts and skills

You will use the ideas and materials you bring with you from these first two design tasks to complete the remaining three during the workshop…

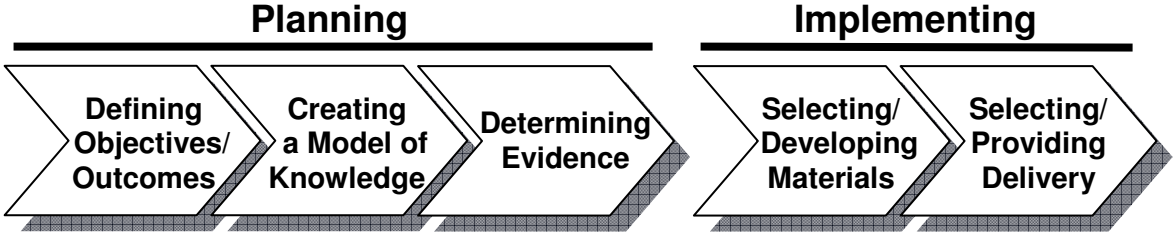
> …determining what assessment evidence you will accept as proof that students have mastered the objectives - the **third design task**.
>
> …selecting and/or developing learning materials to help students master the objectives – the **fourth design task**.
>
> …determining how the selected materials should be delivered to students - the **fifth design task**.

When you attend the workshop, you will have the opportunity to share and receive feedback on the ideas you bring with you from these next few pages and to gain additional lesson design knowledge and skills, based on current learning theory as set forth in the National Research Council's publication, ***How People Learn: Mind, Brain, Experience, and School*** (Bransford, et al., 1999).

GETTING STARTED

The five-task design process VaNTH uses is one of "backwards design," based on the Wiggins and McTighe's *Understanding by Design* (1999).

In the following activities you will work step-by-step through the first two tasks in the *planning* section of this design process outlined below to produce materials to bring to the one-day workshop. The materials you generate in the next few pages and bring with you to the workshop will be the initial building blocks you will use in the workshop to develop content modules for your course.



Graphic adapted from Sean Brophy, Ph.D.

Two-thirds of the initial *planning* section you will do on your own and bring with you to the workshop. Then in the day-long workshop you will have the opportunity to share what you have done and receive feedback on your initial planning, to gain knowledge in learning theory, and to gain knowledge and skills in researched and proven methods of applying this theory in designing modules for the teaching of your selected course.

In TASK ONE – the first design task – you will consider and select specific objectives for your course. What are the things you want your students to be able to do? (This will help define the "target" you want your students to hit – and it's easier to hit a target if you can see it.) Your task here is to generate a list of specific course objectives. Also, you will be asked to think about course sub-objectives, about possible difficulties your students may have in mastering the objectives, and about relating your course objectives to the real world.

TASK TWO -- the second design task – has two parts.

> Part One: First, you will consider what are the concepts and skills involved in the course and how these relate to one another. What are the specific facts, concepts, generalizations, skills, and values that make up the content of the selected course and how do they articulate? Your task here is to develop a cognitive map that represents the content of the course.
>
> Part Two: Next, you will use the concept map you develop in Part One to prioritize the facts, concepts, generalizations, skills, and values as they relate to students' achieving the learning outcomes for the class you are designing/revising. Which things are crucial concepts that require enduring understanding, which things are important to know and do, and which things are worth being familiar with? Your task here is to rank/prioritize the component parts of the content of your course.

Identify the targeted course for design/revision: _____

Year level of students: 1 2 3 4 5 Grad

PRE-WORKSHOP ACTIVITY 1

TASK ONE – DEFINING COURSE OBJECTIVES

The **first design task** involves clearly defining the course and unit level objectives/outcomes. Objectives are defined in explicit terms and target global outcomes that require cumulative knowledge of the course (and prior courses). Below are several examples of high level goals – primary objectives -- for a course:

- Students will be able to *analyze* forces applied to a muscular skeletal system in both static and dynamic conditions. (biomechanics, mechanics, physics)
- Students will be able to *analyze* basic circuits and *explain* how they function in terms of fundamental principles (intro circuits)
- Students will be able to *explain* the various transitions of an ECG trace relative to the anatomy and physiology of the heart (systems physiology))
- Students will be able to *identify* characteristics of an abnormal ECG trace
- Students will be able to *design* signal conditioning circuits to amplify low voltage and current signals with minimal reduction in signal response (signal processing)
- Students will be able to *quantify* effects of light on tissue using mathematical models, basic and physical concepts (biooptics, imaging)
- Students will be able to *design* a manufacturing process for a high volume bioreactor (biotechnology)
- Students will be able to *troubleshoot* amplifier circuits that measure low voltage low frequency signals.

Such course objectives typically use action verbs like *analyze*, *explain*, *quantify*, *compute*, *troubleshoot*, and *design* to identify what students should be able to demonstrate. Note that this makes them natural descriptors of what kind of assessment methods can provide evidence that students meet these objectives.

An integral part of this task is also defining the secondary or sub-objectives – the knowledge, skills, and values that, while not primary to the course, are necessary for students to have to enable them to accomplish the course objectives.

- Students should bring with them some of these sub-objectives from prior coursework.
- Others may be a part of the curriculum of the course you are addressing.
- Do not assume that all students come to class possessing all of the needed sub-objectives.

Remember, too, that connecting these objectives to real-world experiences will help make them relevant to your students. Identifying these will supply starting points as you develop lesson challenges to frame instruction.

Completing the boxes on the next page will help you complete this first design task – and prepare you to complete the coming second task.

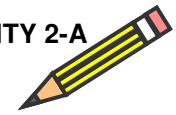
TASK ONE. Complete the statements in each box below as either one extended sentence or several bulleted items.

TASK 1A: MAJOR COURSE OBJECTIVES.
By the end of the course students should be able to …

TASK 1B: COURSE SUB-OBJECTIVES.
Accomplishing these objectives will require that students to be able to…

TASK 1C: POTENTIAL DIFFICULTIES.
Possible, typical instructional difficulties that I predict may occur…

TASK 1D: REAL-WORLD CONTEXTS.
Real-world situation in which students would use the learning objectives include…



TASK TWO – CREATING A MODEL OF KNOWLEDGE

The **second design task** involves two parts: (A) creating a concept map and (B) prioritizing course content.

2-A. Concept Map. First, sketch a concept map that shows the major concepts and the relationships among these concepts that students need to master to achieve your course objectives above. (See sample concept maps on pages 9 and 10.) Directions are below.

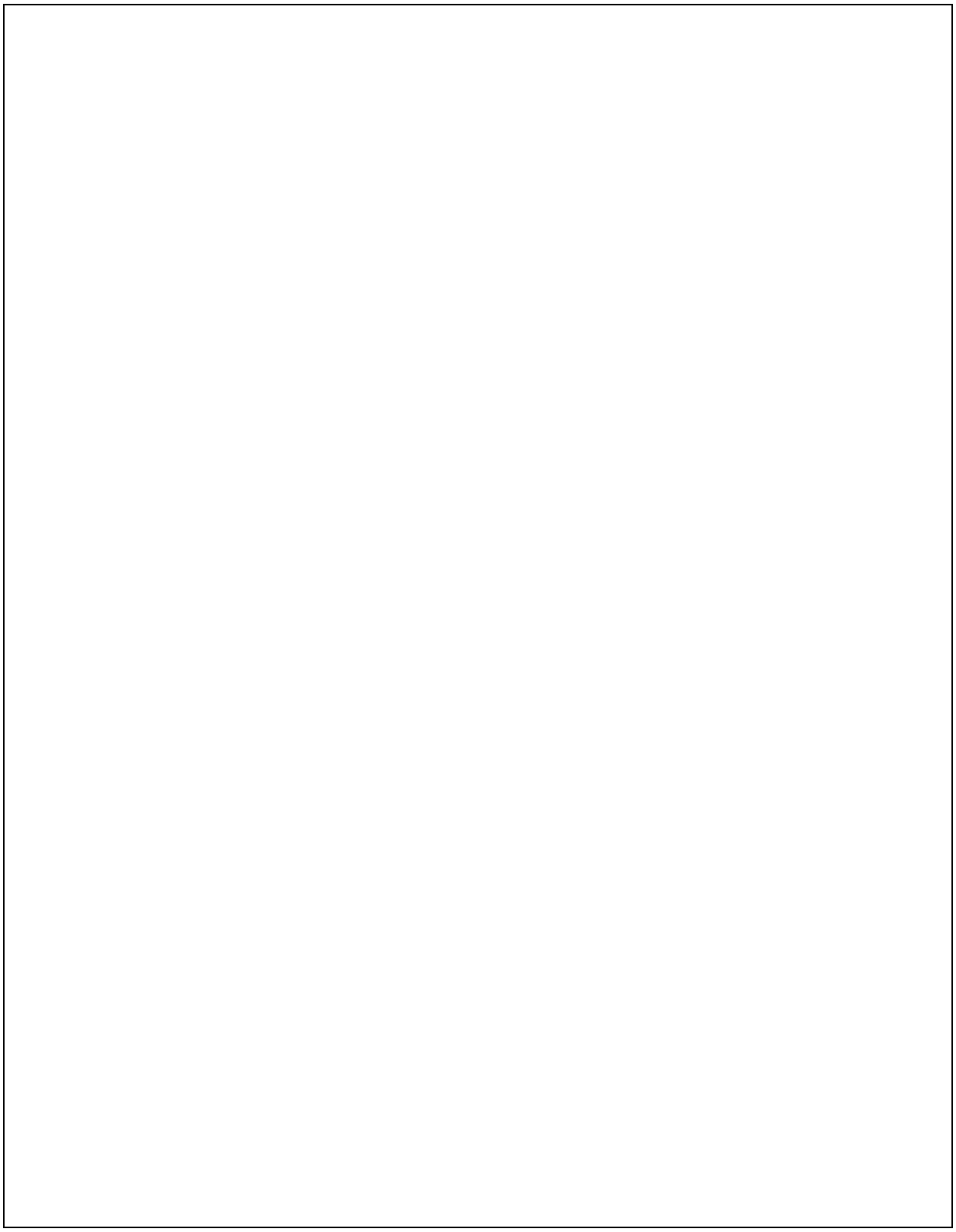
1. Think about the course you wish to design/revise and identify 10 to 20 of the most pertinent concepts (single nouns or noun phrases). List these concepts on a piece of paper, and then write each one on a separate small post-it note. Write the course title on a post-it note.
2. There are two options for arranging your post-it notes.
   - Your map can be structured hierarchically by placing course title at the top and arranging the most inclusive, most general concept(s) to the top and less important concepts towards the bottom.
   - Your map may also be constructed as a non-hierarchical network. In this case, there is no superordinate concept; the map is structured like a web, with the course title in the center.
3. Now begin arranging your post-it notes in a way that reflects which concepts are related.
   - If your map is hierarchical, place less important concepts under the more general concepts. In other words, if someone else read the map they would move "top down" from the most to the least important ideas.
   - If your map is non-hierarchical, array the concepts according to their degree of relatedness. The map would be read in a non-linear fashion.

     Note: Sometimes people change their minds about the map's overall structure as they begin arranging the concepts. Whatever structure you prefer is fine. There are no right or wrong constructions.
4. Now, draw your post-it notes arrangement on the following page and link related concepts with lines.
5. Next, label the lines with a verb or verb phrase that defines the relationship between the two concepts (e.g., "involves" or "leads to").
6. Each pair of linked concepts should read like a sentence. For example, in a concept map for a lab, the concepts "clear lab rules" and "safe lab exercises" could be linked by the words "leads to." This creates the statement "clear lab rules lead to safe lab exercises."
7. Finally, add arrowheads to the lines between the concepts to indicate the direction of the relationship. Depending on the nature of the concepts' relationship, lines can have single or double arrowheads. For example, the proposition "clear classroom rules lead to good student behavior" would have a single-headed connecting arrow the two:

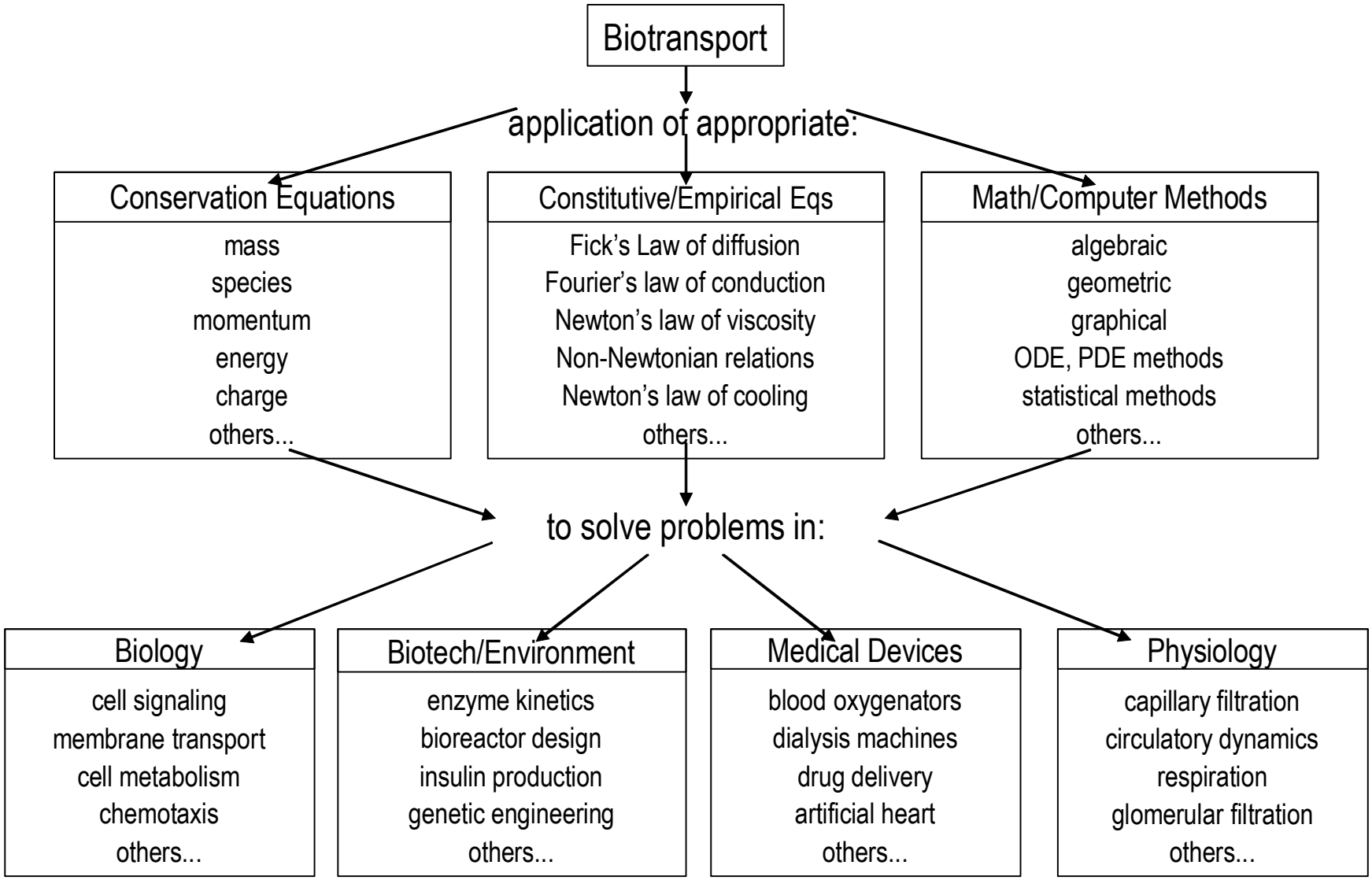
   "clear lab rules ⟶ safe lab exercises"

   Other concepts may be mutually influential (bi-directional). Use double-headed arrows to depict this relationship (⟷).

TASK TWO: Draw the concept map for your course, showing (1) the major concepts students in your course must master in order to achieve the major objectives you have for your course and (2) the relationships that exist between and among these concepts in the box below.

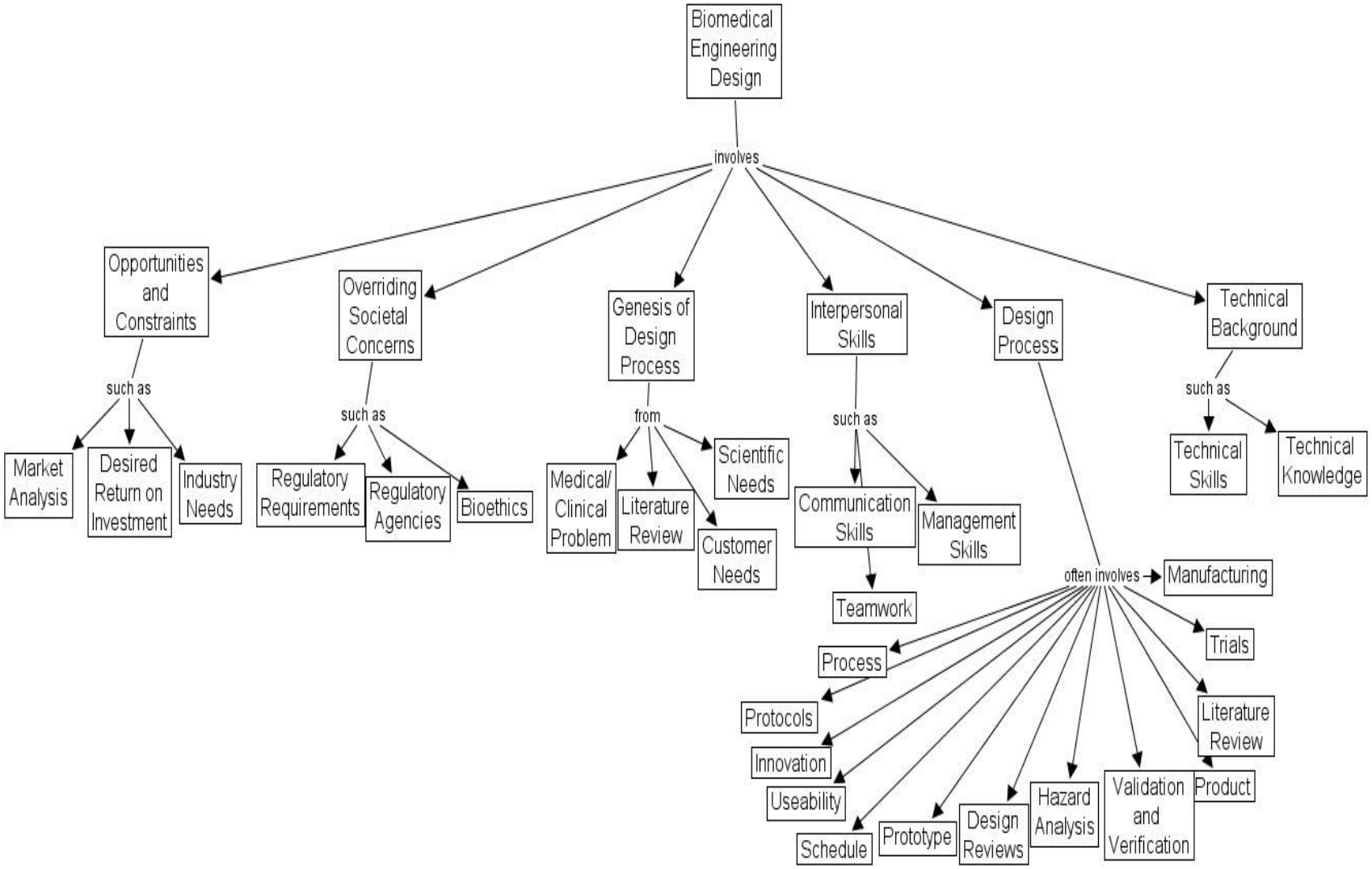


Biotransport Concept Map*



*used with permission of Robert J. Roselli, Ph.D., Department of Biomedical Engineering, Vanderbilt University

Biomedical Engineering Design Concept Map*



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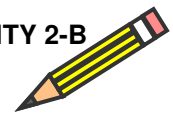

2-B. Content Priorities. Now, refer to the concept map you created as you prioritize the concepts and skills of the course into the three categories below:

Enduring Understanding - concepts fundamental to achieving the course objectives and fundamental to the domain in general:

Important To Know and Do - ideas and skills necessary for achieving the objectives, but not necessarily requiring mastery by the end of the course:

Worth Being Familiar with - things not critical to performing a desired outcome of the course, but students should be aware of their association with the course objectives:

TABLE 1 - Establishing Curricular Priorities for My Course (Wiggins and McTighe format)