

**Course Syllabus**  
**JEI 1901H F**  
**Technology, Society and the Environment I**  
**Fall 2009**

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Lectures: Monday 1-4pm, Room GB217

Textbook: Vanderburg, W.H., The Labyrinth of Technology, University of Toronto Press, 2000 or 2002.

Vanderburg, W.H., Living in the Labyrinth of Technology, University of Toronto Press, 2005.

**Purpose and Scope:**

All of us directly and indirectly involved in technological and economic growth face a common problem. Most of the consequences of our design or decision-making fall beyond our areas of competence. How do we know that what we intended to accomplish will not be partly or wholly undermined by undesired and unintended consequences that fall beyond the horizon of our specialty? How can we be sure that our overall contribution to society and the environment is a positive one? There is a collective dimension to these questions as well. How can we effectively work together with other specialists when the “intellectual worlds” of some of our disciplines or professions are full of technology and little else, while the “intellectual worlds” of others are full of human beings, societies and ecosystems but little technology? Using science and technology to build a socially viable and environmentally sustainable way of life requires that we all have a general knowledge of how science and technology influence human life, society and the biosphere. In addition, we must have the ability to use this knowledge to adjust our design and decision-making to ensure that the desired results are obtained as efficiently and economically as possible while simultaneously preventing or greatly minimizing any undesired harmful effects.

The course will introduce you to state-of-the-art methods for overcoming the above difficulties and effectively dealing with the negative social and environmental implications of your decisions. Together these methods can be built into a technological and economic strategy that will permit economies to deliver goods and services more competitively while at the same time substantially reducing burdens imposed on human life, society and the biosphere. Such a feat is impossible with conventional approaches because they are based on an intellectual and professional division of labour embedded in institutions in which specialists of all kinds make decisions whose consequences mostly fall beyond their domains of competence, to be dealt with in an end-of-pipe or after-the-fact manner by others within whose specialties undesired effects fall. Hence, problems are first created and then dealt with by adding to the “system”. For example, devices designed to remove pollutants from waste streams may be installed in factories and power plants, or social and health services may be created to assist employees. First creating

problems and then attempting to deal with them has proven to be very costly and not very effective. We have begun to recognize that pollution control removes pollutants from waste streams only to transfer them to landfills. Socio-epidemiology has shown that modern workplaces are a major source of physical and mental illness. Creating health and social services for employees is useful but since it does not go to the root of the problem, their costs can only grow. Preventive approaches go to the root of the problem by anticipating possible harmful effects so as to adjust design and decision-making to avoid or greatly reduce them. As such, they are much more effective and, in most cases, less costly than their conventional counterparts. Initiatives such as the Responsible Care Program of the chemical industry and ISO 14000 will not be effective unless they are platforms for preventive approaches. The current shift away from “command and control” environmental strategies to ones that place a greater emphasis on self-regulation within a regulatory framework will have little success unless self-regulation is based on preventive approaches. These alone can reconcile profitability with higher environmental standards.

By addressing the above kinds of questions, a consensus is gradually building that a “Factor 10” policy is feasible. Several nations and a group of corporations once committed themselves to this policy (at least on paper), whose long-term goal is to sustain contemporary ways of life with one-tenth of the consumption of materials and energy. This strategy is technologically and economically possible, socially and politically desirable, and environmentally a question of survival. Just consider the following fact. Some economists have estimated that for nearly four decades net wealth production in the industrially-advanced world has actually been declining because the costs incurred in the production of wealth have been growing more rapidly than gross wealth production. It is estimated that 93% of the resources we extract from the biosphere do not end up in salable products, with the result that pollutants are our primary “products,” except that these, instead of being sold, translate into growing costs. Spiraling disease-care costs can effectively be reduced only by preventing disease through the design of healthier workplaces, cities and food systems. In sum, the present system is not only environmentally but also economically and socially unsustainable; and preventive approaches are a necessary part of turning the present situation around.

### **Course Structure:**

Competence in preventive approaches involves two interdependent components. First, we need to understand how technology fits into the economy and how the economy in turn fits into society and the biosphere. This will be referred to as the ecology of technology. Second, this understanding must be applied in design and decision-making in order to identify undesired consequences for the purpose of eliminating or at least greatly reducing them. This will be referred to as the practice of preventive approaches. The course will introduce these two components as follows:

**Part One:** The Process of Industrialization and the Emergence of the Ecology of Contemporary Technology

- § Design and decision-making as ways of connecting ourselves to one another, society and the biosphere. Industrialization as the making, breaking and transforming of connections.
- § People changing technology: The application of conservation principles to the

understanding of how industrialization changes the consumption of materials and energy and how this in turn requires major social, economic, political and legal adjustments in society. All such adjustments are integral to a larger pattern of change which, on the one hand, expresses our dependence on the biosphere for all flows of matter and energy and, on the other hand, reflects the fact that individually, and collectively, human beings live lives and that societies have histories.

- § Technology changing people: The above adjustments add up to fundamental changes in the social and natural environments in which people live their lives, and these environments in turn influence them in a significant way. This influence will be examined via the concept of culture as the basis on which people individually and collectively make sense of and live in the world by means of a unique way of life. It will then become evident that industrialization involves profound additional changes, including those of a moral, religious and artistic kind.
- § Industrialization as a complete transformation of technology and society: The above two aspects will be integrated into a single generic model of the first phase of industrialization, including its dependence on preceding conditions and on a complete restructuring of the relationship between technology and society.
- § Knowledge separating from experience and culture: A second phase in the process of industrialization is characterized by a fundamental change in the “software” of technology, namely, the way technological knowledge is applied, developed and transmitted from one generation to the next.
- § A second phase in the emergence of the ecology of contemporary technology: The changes in the “software” of technology are superimposed on the previously-described ongoing changes in the “hardware” of technology. In order to make use of this new kind of technological knowledge, societies make changes to their corporations, economies, social structures and political workings. Again, these changes are integral to a larger pattern of ongoing industrialization that continues to reflect our dependence on the biosphere for all flows of materials and energy, and on culture to make sense of, and live in, the world.

#### **Part Two: The Practice of Preventive Approaches**

- § What are preventive approaches?
- § Individual and collective prerequisites for preventive approaches
- § Tools and values
- § Design and decision matrices
- § Application One: Rethinking materials and production
- § Application Two: Rethinking energy
- § Application Three: Rethinking work and its organization
- § Application Four: Rethinking healthy/sustainable cities

### **Schedule and Topics of Lectures and Readings:**

#### **Part One: The Ecology of Contemporary Technology**

Week 1: Lectures 1-3: Organizational Lecture and Course Structure. Readings: “Can the University Escape From the Labyrinth of Technology? Part 1: Rethinking the Intellectual

and Professional Division of Labor and its Knowledge Infrastructure” (download from <http://bst.sagepub.com/>). Preface and Chapter 1, Section 1.1, Chapter 3, Sections 3.3, 3.4, 3.5 in textbook The Labyrinth of Technology.

- Week 2: Lectures 4-6: The Biology-based, the Technology-based, and the Culture-based Connectedness of Human Life and Society. Readings: Chapter 6, Sections 6.2 and 6.3 from Labyrinth.
- Week 3: Lectures 7-9: Industrialization as People Changing Technology. Readings: Introduction and Chapter 1 from Living in the Labyrinth of Technology.
- Week 4: Lectures 10-12: Industrialization as Technology Changing People I. Readings: Chapter 2, Sections 2.1-2.3, from Living in Labyrinth.
- Week 5: Lectures 13-15: Industrialization as Technology Changing People II. Readings: Chapter 2, Sections 2.4-2.8 from Living in Labyrinth.
- Week 6: Lectures 16-18: Industrialization and the Change in the Relationship between Technology and Society. Readings: Chapter 3 from Living in Labyrinth.
- Week 7: Lectures 19-21: The Transformation of Technological Knowledge. Readings: Chapters 4 and 5, Sections 5.2 and 5.3 from Living in Labyrinth.
- Week 8: Lectures 22-24: The Transformation of the First Generation of Industrial Societies as a Consequence of Knowledge Separating from Experience. Readings: Chapter 6 from Living in Labyrinth.

## **Part Two: Preventive Approaches**

- Week 9: Lectures 25-27: What are Preventive Approaches? Readings: Chapter 1 of Labyrinth.
- Week 10: Lectures 28-30: “Tools” and Values for Preventive Approaches. Readings: Chapters 4 and 5 from Labyrinth.
- Week 11: Lectures 31-33: Application Area One: Rethinking Materials and Production. Readings: Chapter 8, Sections 8.2, 8.3, 8.4, 8.6 and 8.7 from Labyrinth. Application Area Two: Rethinking Energy. Readings: Chapter 9 from Labyrinth.
- Week 12: Lectures 34-36: Application Area Three: Rethinking the Organization of Work. Readings: Chapter 10, Sections 10.1-10.3, 10.7-10.9 from Labyrinth.
- Week 13: Lectures 37-39: Application Area Four: Rethinking Healthy/Sustainable Cities. Readings: Chapter 11, Sections 11.1-11.3 from Labyrinth.

## **Course Grade:**

This is a preliminary proposal for class discussion and possible modification:

- § A review of a key book in your chosen area of application, not to exceed seven double-spaced pages, excluding references. Value: 30% of final grade.
- § Final paper comprising a possible strategy for implementing preventive approaches in your chosen area of application. Length: not to exceed 15 double-spaced pages. Value: 70% of final grade.

## **Course Papers**

The book review and final paper are designed to deepen your understanding of the theoretical and practical framework of the course in an area related to your present field of study, your interest beyond your field of study, or your intellectual curiosity. There are four areas of application, from which you must choose one. The first addresses the consumer society, including its dependence on the biosphere for materials and energy. It begins with a review of the book by T. Jackson, Material Concerns: Pollution, Profit and Quality of Life, New York: Routledge, 1996. The second deals with human work and its organization in a contemporary society and begins with a review of the book by Robert Karasek and Töres Theorell, Healthy Work: Stress, Productivity and the Reconstruction of Working Life, NY: Basic Books, 1990. The third area deals with healthy/sustainable cities and begins with a review of the classic work by Jane Jacobs, The Death and Life of Great American Cities, NY: Random House, 1961. A fourth option involves your making a proposal to the instructor, which may be accepted if it can be dealt with by means of the methods and approaches of the course, if you have adequate background preparation, and if it is deemed feasible within the short time frame available.

The book review must include a comprehensive summary of its thesis, a critical evaluation of this thesis and a brief discussion of the relationship between this thesis and what you are learning in the course. The first assignment introduces you to what has gone wrong in a particular area of application and what can be done about it. Since you are not expected to be an expert in the field, it is not necessary to undertake a literature survey to identify similar or contrasting views in order to situate it in the relevant literature. Your level of understanding will be assessed primarily in terms of your ability to give the “big picture” and to situate details within it, as opposed to discussing one detail after another without being clear about what they have in common and how they contribute to a broader understanding of what is happening in your chosen area and beyond. It is recommended that you choose an area and begin reading the prescribed book as soon as possible. However, the evaluation of the thesis of the book and relating it to the material you are learning in the course should not be done until we have dealt with most of Chapter 6 in Living in the Labyrinth of Technology, which takes us to the last week of October.

In preparation for your final paper, you must relate what you have learned about your chosen area of application to the broader patterns of industrialization described in the first half of the course. How did these patterns help shape production, work or cities? How can these external influences be related to the internal factors shaping the evolution of these areas of society? In this way, you are asked to bring together what you are learning in the course with what you are learning about your specific area of application. This should preoccupy you from the time you hand in your first assignment and the time when, in class, we begin to discuss preventive approaches. You may also wish to read ahead and have a preliminary look at Chapters 8, 9, 10 or 11 from The Labyrinth of Technology – whichever corresponds to your current area of application. You are now ready to begin planning your final paper.

For your final paper, you are asked to imagine and work out a feasible chain-reaction-like process that would result in full implementation of preventive approaches in your chosen area of

application. To get this chain-reaction-like process rolling, you must “invent” those initiatives that are likely to encounter the least resistance and which have a chance of being “sold” to a likely party such as a university, corporation, government, non-governmental organization, political party, etc. Please remember that we have carefully examined the process of industrialization as having put into place a particular kind of society with particular institutions and relations with the biosphere. These are not the result of preventive approaches; hence a great deal of resistance can be expected. It is your task to launch a strategy involving particular parties. It should attempt to take advantage of the potential of preventive approaches, and to do this in a manner in which the early steps help prepare for the subsequent ones, and these for still later ones, in a way that is likely to gradually create a more favourable environment for preventive approaches.

In preparing your final paper, be mindful of the fact that the consequences of any initiative are a function of the characteristics of that initiative itself and of the context into which it is launched. The cultural context is particularly important — it is the outcome of the reciprocal interaction of people changing technology and technology changing people. For example, production has been profoundly shaped by the fact that the cultural unity of mass societies leads to many non-material needs being met by the consumption of material goods. It has also transformed the values and beliefs related to work, as well as the role the urban habitat plays in human life. Hence, you must carefully examine the obstacles that may be put in the way of any initiative or strategy by the cultural setting created by over 200 years of industrialization. *Make very sure that your paper does not merely list the components of a preventive strategy (which would make it little more than a kind of wish-list of what we desire to happen), but goes beyond them to include the specifics of how we could improve the chances of its happening.*

In describing this chain-reaction-like process of transformation, also answer the following 3 questions. What effects would the fullest possible use of preventive approaches have on your chosen area of application? Would this transformation create new problems for any of the other areas of application or for society as a whole? What would the implications be for the biosphere? You must (briefly) answer these questions to ensure that your strategy is genuinely preventive and does not transfer problems from one area to another. You should therefore also have a reasonable familiarity with the other areas of application. Your final paper must provide the instructor with some feedback on how well you have learned the subject matter of the course. As with the book review, it is easy to get lost in endless details. To avoid this, your paper must give the “big picture” and select details to illustrate the strengths and weaknesses of the approaches you have learned within this “big picture”. Once you have made a plan for your paper, you are encouraged to discuss it with your instructor to obtain some early feedback.

Please include the following signed and dated statement with each of your assignments:  
*This report was written entirely by the author, is properly referenced where information came from other sources, and has not received previous academic credit at this or any other institution.*

## Relation of Course to other Disciplines

The subject of how contemporary technology transforms our lives and the world in which we live is relevant to many different disciplines including environmental studies, engineering, urban studies, business administration, sociology, political science, international relations, education and religious studies. Our common focus is to study the inner workings of contemporary technology and its effects on human life, society and the biosphere in order to ensure a humane future that can be sustained by the biosphere.

## Deadlines

- § Book review: Monday, November 2, 2009 (in class)
- § Final paper: TBA

**Note: This course is not recommended for students whose proficiency in the English language is weak.**

## Format of Submissions

The deadlines for the two papers will be set with the assumption that nearly everyone will record them on large cassettes or music CDs, as well as submit a hard copy for each. Any student who cannot meet this requirement should contact the instructor to arrange to hand in their paper one week prior to the deadline to permit it to be recorded by someone else.

The following instructions are designed to help you record your paper. In order to make a clear recording, seat yourself comfortably with your paper flat in front of you, with your tape recorder's or computer's microphone facing you from directly behind the hard copy. At the beginning of the recording, give your family name followed by your first name, your topic, and the telephone number where you can be reached in case there is a problem with the recording. Please repeat this information at the very end of the recording. Also, print this information on the container.

Remember that reading aloud does not convey formatting information such as new paragraphs, subtitles, references and so on. Please enter such details into the recording by stating: new paragraph, new subtitle, reference 9, and so on. The speed at which you read should be one that is convenient for you. The instructor will play back the recording at a much higher speed on special equipment.

The preferred format for references is to number them consecutively, to read only the numbers into the text by stating "... reference 9 ...", and to read the references themselves at the end of the paper so as not to interrupt the flow of the text.

Again: Kindly identify your cassette or CD by labeling it with your name, topic and telephone number.

## **Hints for a Final Paper**

### **What is a Strategy?**

A strategy is very different from a wish list. If you say things such as: “The government should . . .,” you are describing things you would like to see happen. However, they clearly are not happening now. To turn a wish list into a strategy, you need to explain what might be done to have governments or corporations begin to undertake the kinds of initiatives wished for. What kind of group or stakeholder might undertake the persuading? What resources will they require? Where will these resources come from? How can stakeholders with deep pockets who are opposed to the initiative be frustrated in their attempts to lobby governments or use integration propaganda to mobilize public opinion against it? To sum up: a final paper that simply consists of a list of desirable initiatives that we all wish for but which does not convert this into a strategy may fall short of the requirements of the final paper and could result in a failing grade.

### **What is the Cultural Context?**

The kinds of things we might like to see happen will most likely go against the patterns of evolution that accompany industrialization (as described in the first part of the course). These patterns have created contemporary ways of life in which everything is connected to everything else in specific ways that frequently create an enormous resistance to any change that does not reinforce or complement these patterns. For example, integration propaganda cannot be used to induce behaviour contrary to these patterns because it builds on the cultural unities of contemporary societies. Hence, it can only be used to integrate people into these patterns and not for mutating these patterns, quite apart from the question as to whether integration propaganda is compatible with democracy. If, after thinking about a possible strategy for your final paper, you do not reach the conclusion that the task is next to impossible, you have missed something fundamental about the first part of the course. As you persist, you will begin to discover areas where some free play may be created in the system, and how this can then be leveraged into larger changes in a chain-reaction-like fashion that may gradually accomplish what initially was unthinkable. This brings us back to the difference between a wish list and a strategy. When we say things such as: “The government or a corporation should . . .” we are indulging in a kind of modern magic. We act as if just saying this could transform the structures of experience and cultures of the people involved so that they will begin to do things that normally would not come into their heads.

### **Where to Start**

The final paper should start where your first paper left off. In other words, do not summarize or describe any preventive approaches in your area of application. Do not reiterate the theme or findings of the book you reviewed for your first paper. For example, Tim Jackson and I both describe strategies for making contemporary ways of life more sustainable. There is no point in summarizing them once again. You should begin your paper by directly introducing your strategy. The description of a strategy will provide me with a good window on how well

you have understood the first part of the course. As a rule of thumb, I would caution you that if everything in your strategy looks easy, you have almost certainly missed something in the course. Remember that no one on this planet desired an environmental crisis and, despite this, the current patterns of evolution continue to intensify this crisis. In mass societies, there is an almost complete disconnect between how people participate in contemporary ways of life and the kinds of political, religious and moral convictions they hold. Just think of how different engineers are with respect to the latter, and how similar they are with respect to the former.

**Please . . .**

Please do not assume that you can get away with importing into your final paper things you may have learned in your technical courses.

For example, do not convert what you may have learned in a course on environmental management into a strategy. There is no question that environmental management sometimes moves things in the right direction but, as I have shown with the master equation, far more will be required if we are to achieve any significant mutation in the current patterns of evolution of contemporary societies. Similarly, describing the work redesign practices of your company may well constitute a tiny step in the right direction, but much more will be required in constituting a strategy for the kind of change proportional to the magnitude of the problems generated by contemporary workplaces. I recognize that for part-time students with busy working lives, importing things from your other courses or work experience is always a temptation as a shortcut to meeting the requirements for your final paper. However, this could get you into trouble.

**Table 1. Research Instruments**

<b>Scoring System</b>	<b>Technical Courses</b>
0	no reference to context issues.
1	minor reference(s) to context issues which remain peripheral to the thrust of the paper or course. Usually, this amounts to little more than outlining the context in which the problem arose, but once the problem is cast in engineering terms, little or no reference to context is made.
2	some reference to context issues with some consequences for the thrust of the paper or course.
3	major reference to context issues with substantial consequences for the thrust of the paper or course.
4	substantial consideration of context (as in 3) plus evaluation of consequences to adjust or reassess methods or theories (i.e., 4 includes some negative feedback; 3 does not).
<b>Context Issues Include</b>	
a)	implications of technology for human life, society, or nature.
b)	ethical considerations and relationships to values.
c)	nontechnical aspects of engineering education and the professional paradigm (following T. S. Kuhn).
d)	implications of engineering theories and practices, including the consequences of quantification and mathematisation, particularly of a qualitative sociocultural human reality.
e)	implications of engineering decision making, including the implicit and explicit values, beliefs, assumptions, and models which guide it.
<b>Scoring System</b>	<b>Complementary Studies Courses</b>
0	no reference to technological issues.
1	minor reference(s) to technological issues, which remain peripheral to the thrust of the paper or course. Usually, this amounts to little more than outlining the problem, but once the problem is cast in social scientific terms, little or no reference to technology is made.
2	some reference to technological issues, which have some influence on the thrust of the paper or course.
3	major reference to technological issues, with substantial consequences for the thrust of the paper or course.
4	substantial consideration of technology (as in 3), plus evaluation of consequences to adjust or reassess methods and theories used in engineering and technological practice or in the social sciences and humanities.

**Table 2: Faculty Scores**

	Year	CHE	CIV	ELE	ESC	IND	MEC	MMS	Mean
Core courses	1	0.5	0.5	0.4	0.1	0.8	0.3	0.5	0.4
	2	0.3	0.7	0.3	0.6	0.5	0.2	0.3	0.4
	3	0.7	1.2	0.7		1.6	0.7	0.9	1.0
	4	1.8	1.4				1.3		1.5
	<i>N</i>	30	38	29	18	25	32	26	
Core and technical electives	1	0.5	0.4	0.4	0.3	0.8	0.3	0.6	0.5
	2	0.4	0.6	0.4	0.6	0.5	0.3	0.4	0.5
	3	0.7	1.1	0.6	0.7	1.5	0.8	0.9	0.9
	4	1.5	1.5	0.8	1.1	1.3	0.9	0.5	1.1
	<i>N</i>	57	51	67	94	43	67	47	
Publications	Score	0.2	0.6	0.1	0.2	0.6	0.2	0.3	0.3
	<i>N</i>	367	237	306	204	121	290	169	

Key to abbreviations: CHE – Chemical Engineering; CIV – Civil Engineering; ELE – Electrical Engineering; ESC – Engineering Science; IND – Industrial Engineering; MEC – Mechanical Engineering; MMS – Metallurgy and Materials Science; *N* – Number of courses scored.

Figure 1: Complementary Studies

Figure 2: Faculty Publications

Figure 4: MSc Civil Engineering Theses

Figure 3: Fourth-Year Industrial Engineering Theses