

Yale University  
School of Forestry and Environmental Studies  
Fall Term 2008

**F&ES 83026a**

**Technology, Society, and the Environment (Seminar)**

Room: Marsh

Time: Tuesday 2.30 - 5.20 pm.

Instructor: Arnulf Grubler (arnulf.grubler@yale.edu)

Teaching Assistant: Daniel Steinberg (daniel.steinberg@yale.edu)

Office hours: Mondays and Tuesdays 9.30-11.30 am

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**Synopsis**

This 3 credit advanced seminar addresses technology's dual role as both source and remedy of global environmental change. The seminar discusses first conceptual and theoretical aspects of technological change from an interdisciplinary perspective including social science, history, economics, engineering, as well as management theory. Examples of technological change and its environmental impacts in agriculture, industries, and the service economy are addressed through case studies. Questions discussed include: Why are some technological innovations successful (e.g. cell-phones) while others (e.g. fast breeder reactors) are not? What determines rates of change in the adoption of new technologies and how can these be accelerated? How many people can the earth feed? Is dematerialization actually occurring, and why? What are the implications of the Internet's digital North-South divide and what are strategies to overcome it? Active student participation is an essential ingredient of the seminar: students participate in seminar debates, perform case studies in home assignments, and write also a (short) final term paper on a mutually agreed topic.

**Seminar Objectives**

- Provide a concise "big picture" overview of technology, the drivers of technological change and the social and environmental in- and externalities of technology.
- Introduce key concepts for technology policy, including uncertainty, increasing returns, and technological inertia
- Provide a platform to discuss technology policy opportunities that further social, economic, or environmental objectives.

## Organization, Assignments and Evaluation

The seminar consists of a series of lectures by the instructor and/or prepared student presentations on particular topics followed by a general discussion. The first half of the seminar provides basic information on technology and is more in traditional class/lecture mode and includes a mid-term. The second part of the seminar is discursive. It is proposed that during the Fall 2008 semester, discussions revolve around the **common theme of “Urban Sustainability”** where the technological, institutional, and social dimensions of energy, transport, housing, and climate change protection in a rapidly urbanizing world are discussed.

Active student participation in the seminar is essential. Participants will perform short assignments (reporting on literature reading, preparing short presentations, perform didactical analytical case studies, represent alternative concepts/theories and engage in seminar debates, etc.). The number of sessions for which individual students will prepare discussion materials will depend on numbers of students in class (but will include at least one presentation per student).

All class material is available at the Yale v2 Classes Server.

**General reading** (an annotated reading list posted on the class server):

W.B. Arthur, 2005, **The Logic of Invention**, Working Paper 2005-12-045, Santa Fe Institute,

W.B. Arthur, 1990, **Positive Feedbacks in the Economy**, *Scientific American* 262(2):92-99.

J.H. Ausubel, 1989, **Regularities in Technological Development: An Environmental View**, In: J.H. Ausubel and H. Sladovich (eds), *Technology and Environment*, National Academy Press, pp. 70-91.

H. Brooks, 1973, **Technology and Values: New Ethical Issues Raised by Technological Progress**, *Zygon* (March):17-35.

H. Brooks, 1994, **The Relationship between Science and Technology**, *Research Policy* 23:477-486.

R. Burlingame, 1961, **Technology: Neglected Clue to Historical Change**, *Technology and Culture* 2(3):219-229. (To be read in conjunction with the papers by Gilfillan and Mumford).

P. David and G. Wright, 1996, **The Origins of American Resource Abundance**, WP-96-15, International institute for Applied Systems Analysis, Laxenburg, Austria.

D. Edgerton, 2007, Excerpts from: **The Shock of the Old: Technology and Global History since 1900**, Oxford University Press.

F. Engels, 1845, Excerpts (chapters The Industrial Proletariat, and The Great Towns) from **The Conditions of the Working Class in England**. Available at: <http://www.marxists.org/archive/marx/works/1845/condition-working-class/index.htm> (Not posted on class server).

C. Freeman, 1996, **The Greening of Technology and Models of Innovation**, *Technological Forecasting & Social Change* 53(1):27-39.

S.C. Gilfillan, 1962, **The Inventive Lag in Classical Mediterranean Society**, *Technology and Culture* 3(1):85-87. (To be read in conjunction with the papers by Burlingame and Mumford).

B. Gilles, 1978, Excerpts from: **Histoire des Techniques**, Engl. Translation: Gordon and Breach, 1986.

P. Gray, 1989, **The Paradox of Technological Development**, in: J. Ausubel and H. Sladovich (eds.) *Technology and Environment*, National Academy Press, Washington D.C., pp. 192-204.

A. Grubler, 1996, **Time for a Change: On the Patterns of Diffusion of Innovations**, *Daedalus* 125(3):19-42.

A. Grubler, 1998, **Technology: Concepts and Definitions**, Chapter 2, *Technology and Global Change*, Cambridge University Press, pp.19-115.

R.L. Heilbroner, 1967, **Do Machines Make History?**, *Technology and Culture* 8(3):335-345.

Intergovernmental Panel on Climate Change (IPCC), 2007, **Technology**, IPCC WGIII, Chapter 2, pp. 147-160.

R. Kates, 1996, **Population, Technology, and the Human Environment: A Thread Through Time**, *Daedalus* 125(3):43-71.

R. Kline and T. Pinch, 1996, **Users as Agents of Technological Change: The Social Construction of the Automobile in the Rural United States**, *Technology and Culture* 4(October):763-795.

J. Mokyr, 1990, Excerpts from: **The Lever of Riches: Technological Creativity and Economic Progress**, Oxford University Press.

L. Mumford, 1961, **History: Neglected Clue to Technological Change**, *Technology and Culture* 2(3):230-236. (To be read in conjunction with the papers by Burlingame and Gilfillan).

W.D. Nordhaus, 1998, **Do real-Output and Real-Wage Measures Capture Reality? The History of Lighting Suggests Not.** Cowles Foundation Paper 957, New Haven.

V. Ruttan, 2001, **The Process of Invention and Innovation**, Chapter 3, Technology, Growth, and Development, Oxford University Press, pp. 63-99.

T.C. Schelling, 1996, **Research by Accident**, *Technological Forecasting and Social Change* 53:15-20.

F. Scherer, 1999, **Investing in Technological Innovation**, Chapter 5, *New Perspectives on Economic Growth and Technological Innovation*, Brookings Institution, Washington D.C., pp. 53-87.

P. Waggoner, 1996, **How Much Land Can 10 Billion People Spare for Nature?** *Daedalus* 125(3):73-93.

L. White, 1967, **The Historical Roots of our Ecological Crisis**, *Science*, Vol. 155, No.3767 (March 10):1203-1207.

Additional reading material will be distributed in class.

## **Grading**

will be based on the following criteria:

- 40% (active) class participation
- 20% mid-term (Q/A session in class)
- 40% final term paper (max 10 pages)

## FES 83026a (802a)

### Technology, Society, and the Environment

#### Seminar Sessions

**September 9: Overview** (course overview by instructor -- self introduction of students -- sign-up for class presentations of reading list -- presentation of proposed common "urbanization" theme and topics/case studies to be discussed in second half of seminar -- student suggestions)

**September 16:**

[Student report on reading list](#)

**What is technology?** (definitions of technology - sources of technological change - systems hierarchy of changes - a simple model: technology life cycles - innovation uncertainty - the social construction of technologies)

**September 23:**

[Student report on reading list](#)

**Concepts/models of technological change: Diffusion theory** (diffusion in time and space - determinants of diffusion - technological substitution - examples - diffusion time constants).

[Discussion of diffusion case studies using LSM model \(individual homework\).](#)

**September 30:**

[Student report on reading list](#)

**Explaining change 1 - Growth factors:** (R&D - innovation agents - cost reductions [learning phenomena] - joint expectations [Moore's law] - network externalities; **Explaining change 2 - Stagnation/rejection factors:** (lack of improvements - erratic R&D - "sailing ship" effects - infrastructure and standardization needs - institutional congruence - social resistance)

**October 7:**

[Student report on reading list](#)

**Impacts of technological change 1 - Economy:** (output growth - economies of scale and economies of scope - price declines - productivity and efficiency - choice and complexity - division of labor [functionally and spatially] - interdependence);

**October 14:**

[Student report on reading list](#)

**Impacts of technological change 2 - Society:** (trends in population size, health and life expectancy - income and working time - structural changes [work-pleasure, primary-tertiary, rural-urban])

[Progress report and Q/A on individual diffusion case study home assignments.](#)

**October 21:**

[Student report on reading list](#)

**Impacts of technological change 3 - Environment:** (positive impacts: resource augmentation - resource substitution - conservation -environmental "fixes"; negative impacts: novel impacts - growth in human numbers and activities - non-linear dose-response relationships - illustrations of global change - some orders of magnitude, incl. a critical look at the IPAT identity).

**October 28:**

**Wrap-up session of technology impacts (previous classes);**

[10-min each student presentations on LSM case study.](#)

**Diffusion case study report due (2-page write-up plus LSM model files)**

**November 4:**

**Mid-term (oral Q/A session in class);**

**Lead-in into discussion common theme topic "urbanization"**

Presentation by instructor – proposed case studies/topics for discussions – student sign-up for topics

[\(mid-term social event after class\)](#)

**November 11:**

**Urbanization past and future**

Lecture by instructor – two student commentators – general discussion  
proposed comments: a) technological and b) social dimensions of urbanization

**November 18:**

**Urban metabolism: theory and practice**

Lecture by Helga Weisz – summary of background reading - general discussion

**Title and abstract for final seminar paper due.**

**November 25: Fall Recess (no class)**

**December 2:**

**Technology strategies to address urban sustainability**

4 student presentations on Housing - Water – Energy – Climate Change – general discussion

**December 16: Final term paper due.**

Grading will be announced after the Holiday Season.