

Module Outline

BSN3701/TR3008 Technological Innovation

Academic Year 2021/22, Semester 1

Lecturer

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Overview and objectives

Technological innovations are the most important contributing factor to economic growth. This module is roughly divided into three parts. In the first part, we employ historical case studies to elucidate major technological revolutions and techno-economic paradigms since 1780. Different types of innovation (product, process, business model, social etc.) will be examined and illustrated. In the second part, we look at innovation decisions by firms and policymakers. In the third part, we zoom in on a contemporary example of a radical technological innovation: digital platforms. Along the way, we will encounter concepts such as R&D, diffusion, datafication and artificial intelligence.

At the end of this course, students will have acquired a thorough understanding of technological innovations, both at the level of the individual firm and for the economy as a whole. They will be familiar with key concepts of innovation research, strategy, implementation and public policy. Having worked through historical systems of radical and incremental technological innovations will allow them to independently analyse the current frontier of innovation clusters and technological change – and in particular the platform business model, which rapidly grew out of the information and communication revolution.

Course materials

The course requires a fair amount of reading and reflection in between classes. We will be reading and discussing book chapters, journal papers and mainstream media accounts. You can find the reading materials assigned to each lesson in the schedule below.

The material is interdisciplinary by nature. It draws from political economy, history, management, sociology and other areas of social science. You might find some of it challenging and/or abstract. Part of the goal of the course is to make you more comfortable reading various sources, synthesizing them into insights and applying them to a practical business context.

I expect you to read the assigned pages and chapters *before* each class. During class time, we will focus on discussions, interpretation, analysis, applications and exercises. If you have any questions about the readings, you can bring them up in class.

All required readings can be downloaded for free from NUS Libraries, LumiNUS or the internet. You do not need to buy any books.

Assessment

Class participation (20%)

To be prepared for class, you must read and reflect the assignments before class. Your participation will be evaluated based on attendance and the ability to contribute comments that are insightful, relevant and progressive (i.e., comments that move the discussion forward, rather than restate what has already been said). I will be looking for quality in your participation. You will not need significant “airtime” to earn a high participation grade.

Group project (45%)

In a group with four members (minimum), you will write a 2,000-word paper on a twentieth-century technological innovation. (I will provide a list of innovations to choose from.) The paper should analyse and expound the innovation, its origins, inventors, the businesses that commercialized it and its impact on the corporate bottom-line, society and the economy at large. In addition, you can investigate the role of technology transfer, diffusion, adoption, patents, licensing revenues and the R&D department (however, not all of these aspects might be relevant to your innovation).

The target audience of the paper are business managers and executives. Make sure that you explain the technology, its history and impact in a way that is relevant for (and understandable by) a corporate decision maker. Your paper should be more than just a historical essay. Try to make a connection to the present (via analogies, conclusions or other means).

All groups will present their interim findings in a 12-minute PowerPoint presentation, followed by approx. 10 minutes of Q&A, to the class in week 6. You will receive verbal and written feedback on the interim presentation, which should help you structure and sharpen your paper. The papers are due in week 12.

The total score will take into account both the interim presentation (10%) and the final paper (35%).

Final test (35%)

The final test will be closed-book, multiple-choice. It will be held during class time in week 13.

Academic integrity

Plagiarism is generally defined as “the practice of taking someone else’s work or ideas and passing them off as one’s own” (The New Oxford Dictionary of English). The University does not condone plagiarism.

A [Revised NUS Plagiarism Policy](#) was approved by the University Senate on 17 February 2016. As NUS expects all students to maintain the highest standard of academic integrity, the policy aims to send a clearer and stronger signal on the University’s stern view on plagiarism.

You have the obligation to make clear to the assessor which is your own work, and which is the work of others. Otherwise, your assessor is entitled to assume that everything being presented for assessment is being presented as entirely your own work. This is a minimum standard.

For more information, please consult [this](#) guide by NUS Libraries on plagiarism, academic dishonesty and how to avoid them.

Schedule (subject to change)

Lesson 1	Key concepts and definitions
Reading	OECD/Eurostat, <i>Oslo Manual 2018: Guidelines for Collecting, Reporting and Using Data on Innovation, 4th Edition</i> (OECD Publishing, 2018), https://doi.org/10.1787/9789264304604-en , pp. 67-83 (you can skip paragraphs 3.43-3.48 and 3.84-3.90)
Topics covered	<ul style="list-style-type: none"> • Product innovations and business process innovations • Business model innovations • Radical vs. disruptive innovations • Changes that are not innovations • Innovative and innovation-active firms • Technological and non-technological innovations
Lesson 2	Technological revolutions and techno-economic paradigms
Reading	Chris Freeman and Luc Soete, <i>The Economics of Industrial Innovation</i> (Routledge, 1997), eBook available at NUS Libraries , pp. 1-22 Carlota Perez, "Technological Revolutions and Techno-Economic Paradigms," <i>Cambridge Journal of Economics</i> 34, no. 1 (2010): 185-202, http://www.jstor.org.libproxy1.nus.edu.sg/stable/24232030
Topics covered	<ul style="list-style-type: none"> • Importance of technological innovation for economic progress • The rise of knowledge industries • The conceptual distinction between invention and innovation • Trends in gross domestic expenditures on R&D (GERD) • Schumpeter's theory of successive industrial revolutions (long waves) • Innovation trajectories • Radical vs. incremental innovations • Five technological revolutions and their structure • Diffusion, resistance and assimilation of successive techno-economic paradigms
Lesson 3	From the industrial revolution to electricity and steel
Reading	Freeman and Soete, <i>The Economics of Industrial Innovation</i> , pp. 31-84
Topics covered	<ul style="list-style-type: none"> • Interdependence of technical, marketing and organizational innovations • Labour productivity improvements • Capital markets and other sources of financing • Transport and communication infrastructure • Substitution of capital for labour • Complementarities between innovations • Implications of electric power for factory layout • Giant firms and cartelization • The rise of a professional manager class
Case studies	<ul style="list-style-type: none"> • Josiah Wedgwood (pottery) • Richard Arkwright (cotton) • Samuel Crompton (cotton) • Andrew Carnegie (steel)

Lesson 4	Petrochemicals, the automobile and mass production
Reading	Freeman and Soete, <i>Economics of Industrial Innovation</i> , pp. 106-157 (you can skip Sections 5.10 and 5.11)
Topics covered	<ul style="list-style-type: none"> • The professionalization of research and development (R&D) and the role of the industrial R&D laboratory • Patents as a measure of inventive output • Patents and innovations • Mass production and mass consumption • Dynamics of product and process innovation • Innovation in Japan • Lean production
Case studies	<ul style="list-style-type: none"> • IG Farben (Bayer, BASF and Hoechst) • PVC • Polyethylene • Corfam (synthetic leather) • Internal combustion, steam and electric engine • Henry Ford and the Model T • Alfred P. Sloan at General Motors • The Toyota-Ohno system
Lesson 5	Electronics and computer networks
Reading	Freeman and Soete, <i>Economics of Industrial Innovation</i> , pp. 158-187 (you can skip Section 7.4 on radar) James W. Cortada, "Building the System/360 Mainframe Nearly Destroyed IBM," <i>IEEE Spectrum</i> , April 5, 2019, https://spectrum.ieee.org/tech-history/silicon-revolution/building-the-system360-mainframe-nearly-destroyed-ibm
Topics covered	<ul style="list-style-type: none"> • The convergence of computer and telecommunication technology • Interplay of component innovations, materials innovations, software innovations and new capital goods and consumer products • Transition from the inventor-entrepreneur to the corporate R&D department • Growth of public broadcasting • Early military and scientific applications of computers • Economies of scale in the semiconductor industry
Case studies	<ul style="list-style-type: none"> • Marconi Company, Telefunken and Radio Corporation of America (RCA) • Colour television • Video cassette recorders and "lock-in" by standards • IBM
Lesson 6	Group project presentations
Lesson 7	Innovation and the firm
Reading	Freeman and Soete, <i>Economics of Industrial Innovation</i> , pp. 193-204, pp. 242-250 and pp. 265-284
Topics covered	<ul style="list-style-type: none"> • Market demand for innovations

	<ul style="list-style-type: none"> • Capacity to link together technical and market possibilities (innovation as a coupling process) • Characteristics of successful innovating firms • Risk and uncertainty • Cash flow planning of innovations • The difficulty of future market estimates • Offensive and defensive innovators • Imitative, dependent, traditional and opportunist strategies
Lesson 8	Diffusion of innovations
Reading	Everett M. Rogers, <i>Diffusion of Innovations</i> (Free Press, 2003), pp. 12-31 and pp. 272-285 (scanned PDF can be downloaded from LumiNUS)
Topics covered	<ul style="list-style-type: none"> • Definitions: diffusion, communication, uncertainty, information • Four main elements of diffusion: innovation, communication channels, time, social system • Hardware and software components of technology • Technology clusters • Re-invention of innovations • Mass media and interpersonal communication channels • Homophily and heterophily • The innovation-decision process • Opinion leaders and change agents • The S-shaped curve of adoption • Organizational innovativeness • Adopter categories
Case studies	<ul style="list-style-type: none"> • QWERTY and Dvorak keyboards
Lesson 9	Technology transfer and innovation policy
Reading	<p>Everett M. Rogers, "The Nature of Technology Transfer," <i>Science Communication</i> 23, no. 3 (2002): 323-41, https://journals-sagepub-com.libproxy1.nus.edu.sg/doi/abs/10.1177/107554700202300307</p> <p>Mariana Mazzucato, "Mission-Oriented Innovation Policies: Challenges and Opportunities," <i>Industrial and Corporate Change</i> 27, no. 5 (2018): 803-15, https://doi.org/10.1093/icc/dty034</p>
Topics covered	<ul style="list-style-type: none"> • Definition of technology transfer • Differences between diffusion of innovations and technology transfer • How to measure the degree of success of technology transfer activities • Individual roles in the technology transfer process: champions, gatekeepers and boundary spanners • Strategies for technology transfer • From grand challenges to mission-oriented innovation policies • Principles for mission-oriented policymaking • Choosing and implementing mission-oriented policies
Case studies	<ul style="list-style-type: none"> • Xerox Palo Alto Research Park (PARC) • Hotmail • UN Sustainable Development Goals

Lesson 10	Digital platforms as radical innovations
Reading	Robin Mansell and W. E. Steinmueller, <i>Advanced Introduction to Platform Economics</i> (Edward Elgar Publishing, 2020), eBook available at NUS Libraries , Chapters 1 and 2
Topics covered	<ul style="list-style-type: none"> • Two clusters of innovations – internet connectivity and common standards for the Web • Virtualisation of publication and commerce <ul style="list-style-type: none"> – Offline to online translation process – E-commerce and online sales – Online search and indexing • Working definition of a digital platform • Business models for platforms • Collection, retention and use of data about users • The role of norms, rules and standards
Case studies	<ul style="list-style-type: none"> • Amazon • Google • Facebook
Lesson 11	Economic analysis of platforms
Reading	Mansell and Steinmueller, <i>Advanced Introduction to Platform Economics</i> , Chapter 3
Topics covered	<ul style="list-style-type: none"> • Neoclassical economic analysis • Institutional economic analysis • Critical political economy analysis
Lesson 12	Datafication and artificial intelligence (AI)
Reading	Mansell and Steinmueller, <i>Advanced Introduction to Platform Economics</i> , Chapter 4
Topics covered	<ul style="list-style-type: none"> • Big data • Innovations in data-driven AI techniques • AI as a radical innovation in its own right • Can AI predictions be trusted? • Concerns about technological unemployment • Creating, acquiring and utilising content
Lesson 13	Wrap-up and final test