

Models of Technological Change

GEO3-2264 (level 3)

Bachelor 3, period 4

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1. Course content

The course on models of technological change teaches students how to translate theories into models and use these models to analyze specific innovations and technological trajectories. In this course we use models because models help students to think more clearly, to make sense of data and to formulate policy and managerial recommendations. In short, models help to develop the analytical skills of students. In the course we study a number of well-known modeling papers from the innovation studies literature. The lecturer provides simulation models for several papers and the students have to work with these models in order to understand the underlying theories and their policy and managerial implications. In the final weeks of the course the students have to demonstrate their understanding of the course topics in a serious game setting.

After completion of the course, the student:

- (1) Has knowledge and comprehension of models of technological change.
- (2) Can translate theories of innovation and technological change into explanatory models.
- (3) Can use these models to analyze actual examples of technical change.
- (4) Can give a coherent description of the theoretical framework, explanatory model, research outcomes and their interpretation.

As this is a level three course, it contributes to several of the learning goals of the NW&I Bachelor programme (more specifically goals 1, 2, 3, and 5 - see appendix B). It builds on theories and methods that most of you have studied in previous years (Introduction to technology and innovation, Micro-economics of innovation, Economics of Technology and Innovation). You will have to study scientific articles that build on these theories and that propose models of technological change. In order to ensure that you truly understand these models and their contribution you are asked to work with these models and apply your knowledge to an actual innovation management problem in a serious game setting.

2. Course overview

The main course elements are lectures, computer labs and self-study. You are expected to read the relevant literature before the lecture. During the computer labs you can work on your assignments. Floortje Alkemade, Allard van Mossel or other teaching staff will be present during the computer labs to help you with your assignments.

Week 17

Tuesday (April 23) Lecture 1: *Introduction*
Thursday (April 25) Computer Lab

Week 18

Thursday (May 2) Computer lab

Week 19

Tuesday (May 7) Computer lab
Tuesday (May 7) Lecture 2: *Innovation diffusion*
Wednesday (May 8) **Deadline Concept Assignment 1**

Week 20

Tuesday (May 14) Computer lab
Tuesday (May 14) Lecture 3: *Learning curves*
Thursday (May 16) Computer lab
Thursday (May 16) **Deadline Assignment 1**

Week 21

Tuesday (May 21) Computer lab
Tuesday (May 21) Lecture 4: *Competing technologies*
Thursday (May 23) Computer lab

Week 22

Tuesday (May 28) Computer lab
Tuesday (May 28) Lecture 5: *Technological Trajectories*
Thursday (May 30) Computer lab
Thursday (May 30) **Deadline Concept Assignment 2**

Week 23

Tuesday (June 4) Computer lab
Tuesday (June 4) Lecture 6: *Game introduction*
Thursday (June 6) Computer lab
Thursday (June 6) **Deadline Assignment 2**

Week 24

Tuesday (June 11) Computer lab/Game
Thursday (June 13) Computer lab/Game

Week 25

Tuesday (June 18) Computer lab
Thursday (June 20) Computer lab
Friday (June 21) **Deadline Concept Assignment 3**

Week 26

Tuesday (June 25) Computer lab
Thursday (June 27) **Deadline Assignment 3**

Week 27

Thursday (July 4) Feedback Assignment 3

Week 28

Thursday (July 11) Deadline Supplementary assignments

3. Literature

The literature for this course is available through Blackboard during the first week of the course. Additional literature will be made available during the course. Furthermore, you will need the reader on academic skills (academische vaardigheden) in order to complete the assignments. During the course we will study the following articles and book chapters:

Please make sure you read the relevant literature before the lecture.

Lecture 1 and 2:

[1] Lave, C.A. and J.G. March. *An introduction to models in the social sciences*. University Press of America, 1993. Chapter 1: What are we up to?

[2] Lave, C.A. and J.G. March. *An introduction to models in the social sciences*. University Press of America, 1993. Chapter 2: An introduction to speculation.

[3] Bass, F.M. A New Product Growth for Model Consumer Durables. *Management Science*, 50(12):1825-1832, 2004 (first version 1969)

[4] Fisher, J.C. and R.H. Pry, A simple substitution model of technological change, *Technological Forecasting and Social Change*, 3:75-88, 1971–1972

Lecture 3:

[5] J. McNeerney, J.D. Farmer, S. Redner, and J.E. Trancik. Role of design complexity in technology improvement. *PNAS* 108(22):9008-9013

[6] OECD/IEA (2000). Experience curves for energy technology policy.

Lecture 4:

[7] Dosi, G. Technological paradigms and technological trajectories: A suggested interpretation of the determinants and directions of technical change. *Research policy* 11:147-162, 1982.

[8] G. Silverberg and B. Verspagen. A percolation model of innovation in complex technology spaces. *Journal of economic dynamics and control* 29:225-244, 2005

[9] Adner, R., Levinthal, D. Demand heterogeneity and technology evolution: Implications for product and process innovation. (2001) *Management Science*, 47 (5), pp. 611-628

Lecture 5:

[10] Arthur, W.B. Competing Technologies, Increasing Returns, and Lock-In by Historical Events. *The Economic Journal*, 99(394): 116-131, 1989.

[11] Saviotti, P.P. A. Pyka. Economic development by the creation of new sectors. *Journal of Evolutionary Economics* 14:1–35, 2004.

4. Software

NetLogo freely available online, see also Floortje.alkemade.nl for link to NetLogo and to course-specific models.

5. Requirements, assignments and grading

The knowledge and skills of the students will be tested through assignments and in a serious game setting (pilot). You will receive formative feedback on all assignments. Assignments must be uploaded to through Blackboard and also handed in as hardcopy to the lecturer, including the mandatory assignment cover sheet (see Appendix A).

Course element	% of final grade
Concept 1	
Assignment 1	30%
Concept 2	
Assignment 2	30%
Concept 3	
Assignment 3	40%

Table 1: Grading

All assignments are mandatory and have to be submitted in order to pass the course. The concept versions of the assignments will not be graded but you will receive feedback on your concept version in order to improve the quality of your assignment. Submitting a concept version is not mandatory.

Final marks below 6.0 (unsatisfactory marks) are expressed in whole numbers only. If you have fulfilled all the obligations as stipulated in this course manual, have submitted assignments **as well as complete concept versions** for each assignment, and nevertheless are not awarded a final pass grade, but are awarded a final grade of at least 5.00 before rounding off, you will be given a **once only opportunity** to do a supplementary assessment. The lecturer determines the content of the supplementary assessment. If the student obtains a passing grade (5.5 or higher) for the supplementary assessment, a passing grade of 6.0 will be awarded as final grade for the course.

If you cannot come to class because you are ill you have to report your absence in advance to the department's secretary Mw. Bakker-Maas. Unfortunately, I cannot offer a possibility to submit assignments after the deadline to students who have been ill. The reason for this policy is that I plan to give fast feedback on the assignments in order to best facilitate student learning. If you have been ill you have the opportunity to do a replacement assignment for at most 1 assignment. Over the entire course period a student is entitled to at most 1 replacement assignment and 1 supplementary assignment.

6. Academic honesty

Reference any written source you use in your assignments, including web sites. All assignments will be checked for plagiarism. Plagiarism of text and/or ideas is not permitted and will be punished with a zero grade for the specific assignment where the plagiarism is found. All plagiarism will be reported to the Board of Examiners.

7. Course load

The course Models of technological change requires a high level of independent work. The majority of the course load consists of self-study: reading and processing the literature and

making assignments. Please make a careful planning of the course taking this into consideration.

Week	17	18	19	20	21	22	23	24	25	26	27	Total
Lectures	2		2	2	2	2	2					12
Computer Labs	4	4	2	6	6	6	6	8	8	4		54
Consultation hours											10	10
Self-study	14	16	16	14	14	14	14	12	12	16		134
Total	20	20	20	20	20	20	20	20	20	20	10	210

Table 2: Contact hours and required self-study

9. Blackboard

During this course Blackboard and my website floortjealkemade.nl will be used to provide access to the assignments, the NetLogo models, the course literature, and to hand in assignments.

10. Course evaluation and quality management

This course has been carefully developed and prepared by the lecturer. In order to further improve the quality of the course your feedback is needed. As part of our quality management program we have implemented several opportunities to give us your feedback on the course:

- *Course-feedback groups* will monitor the course and will regularly discuss possible improvements with the lecturer.
- The *course evaluation* at the end of the course will also be used to improve the course. It is thus very important that you all fill out the course evaluation as it helps me improve the course.

A course-feedback group (CFG) consists of 4-5 students per course. The task of the CFG is to monitor the quality of the course through discussions with the student group and to discuss the results of these discussions with the lecturer. The focus thereby is on issues that can be solved during the course period. During the first lecture the CFG will be appointed. Of course you can also directly contact me if you experience any problems during the course.

Although last year's evaluations were very positive, feedback from the students has led to minor changes in the course setup. I have reduced the number of hours to be spent on the game and I have allotted some more time to become acquainted with NetLogo.

Appendix A: Assignment cover sheet.

This assignment cover sheet is a mandatory part of the assignment. Assignments that do not conform to the standards described below will be considered as not-submitted. In addition all assignments will be checked for plagiarism. A Word version of this document can be downloaded from Blackboard or floortjealkemade.nl

I declare that my assignment conforms to the following standards:

- I have read and studied the course guide.
- I have read and studied the course literature for this assignment.
- The assignment contains no spelling errors (used Microsoft Word spelling check).
- The assignment contains no grammatical errors (used Microsoft Word grammar check).
- All tables and figures have captions.
- All tables and figures are properly referred to in the assignment text.
- The document does not exceed the page/word limits stated in the assignment.
- All pages, tables and figures are numbered.
- The assignment references any written source used in the assignment, including web sites.
- I will not use the data provided in this assignment for any other purposes.

Here you can write any remarks regarding the assignment. Your feedback is highly appreciated!

Student name:

Date:

Signature

Appendix B: Onderwijsdoelen NW&I

De bacheloropleiding NW&I heeft de volgende onderwijsdoelen:

- 1. De afgestudeerde heeft kennis van en inzicht in het vakgebied van de natuur- en innovatiewetenschappen.**
- 2. De afgestudeerde heeft kennis van en inzicht in de theoretische en methodologische grondslagen van de natuur- en innovatiewetenschappen.**
- 3. De afgestudeerde beschikt over algemene academische vaardigheden, in het bijzonder met betrekking tot de natuur- en innovatiewetenschappen.**
4. De afgestudeerde is in staat om kennis en inzicht op dusdanige wijze toe te passen, dat dit een professionele benadering van zijn werk of beroep laat zien.
- 5. De afgestudeerde kan:**
 - een praktijkvraag of probleem op het vakgebied herformuleren tot een duidelijke en onderzoekbare probleemstelling;
 - de daarin vervatte begrippen op adequate wijze operationaliseren;
 - een onderwerp zowel theoretisch als empirisch bestuderen, in onderlinge samenhang;
 - het resultaat weergeven in een coherent betoog dat wordt afgesloten met een heldere, synthetiserende conclusie;
 - de resultaten gebruiken voor het beantwoorden van de praktijkvraag of het bijdragen aan verheldering en zo mogelijk oplossing van het probleem;
 - een oordeel vormen dat mede gebaseerd is op het afwegen van relevante sociaalmaatschappelijke, wetenschappelijke of ethische aspecten.
6. De afgestudeerde is in staat om informatie, ideeën en oplossingen over te brengen op een publiek bestaande uit specialisten of niet-specialisten.
7. De afgestudeerde bezit de leervaardigheden die noodzakelijk zijn om een masteropleiding aan te gaan