



Government of Russian Federation

**Federal State Autonomous Educational Institution of High Professional
Education**

«National Research University Higher School of Economics»

National Research University
High School of Economics
Faculty of Computer Science

**Syllabus for the course
«Ergonomics of Human–Machine Interaction»**

for Bachelor degree specialization
09.03.04 «Software Engineering»

Author:

Alexey A. Klimov, Lecturer, Ph.D aklimov@hse.ru

Recommended by:

Department of Organizational Psychology, School of Psychology Faculty of Social Sciences

Department head — Stroh W.A. _____
« ___ » _____ 2016.

Approved by:

Academic Council of Bachelor's programme 09.03.04 «Software Engineering»

Programme Academic Supervisor — Shilov V.V. _____
« ___ » _____ 2016.

Moscow, 2016



1. Teachers

Instructor and author: Alexey A. Klimov, National Research University Higher School of Economics, Faculty of Social Science, Department of Psychology.

2. Scope of Use

The present program establishes minimum demands of students' knowledge and skills, and determines content of the course.

The present syllabus is aimed at department teaching the course, their teaching assistants, and students of the course.

This syllabus meets the standards required by:

- Educational standards of National Research University Higher School of Economics;
- Educational program of Federal Bachelor's Degree Program for 2015;
- University curriculum of the Bachelor's program in 09.03.04 «Software Engineering» for 2016.

Summary

The course trains the computer science students what is a human factor, and how to make user-centered design and sustain proper fit in human-machine interaction. Introduction to the course is various design implementations besides graphical interfaces challenged in historical perspective. The first part of the course is limitless of humans. The second part of the course is science perspective to usability engineering or simply, design. Design rules are discussed including Standards, Guidelines, Rules-of-Thumb. Design process rationale, models and theoretical aspects are followed by couple of tools including prototyping and task analysis implementation. Finally, interface quality and its evaluation methods through cognitive modeling, expert analysis, user participation is covered. Slightly covered accessibility topic.

3. Learning Objectives

The learning objective of the course «Ergonomics of Human–Machine Interaction» is to provide students with essential knowledge of Ergonomics applicable to design a real world object, with more narrow but today's most popular case of human-machine interaction called graphical interface.

4. Learning outcomes

After completing the study of the discipline «Ergonomics of Human–Machine Interaction» the student should:

- Know basic notation and terminology used in Ergonomics science and human factor
- Understand basic principles behind design rules (including Standards, Guidelines, Rules-of-Thumb)
- Be able to visualize, summarize and compare pros- and cons- of several design variants
- Be capable to evaluate interface quality through cognitive modeling, expert analysis and user participation



5. Prerequisites

The material that is both discussed in the course and recommended for self-studying presupposes the basic knowledge of visual design; experimental and basic psychology; statistics and computer science. A basic knowledge about R programming language will be an advantage.

Besides, students should be able to read and understand recommended papers (book chapters), accompanying materials and various online sources in English (mainly) as well as to prepare presentations on the work (research) done during mastering the course. Besides, brief presentations (*short oral report* on selected topics during the course) will have positive impact on the final grade.

The following knowledge and competence are needed to study the discipline:

- A good knowledge of the English language, both orally and written.
- A basic knowledge of mathematics or general statistics
- A basic programming experience

After completing the study of the discipline «Ergonomics of Human–Machine Interaction» the student should have the following competences:

Competence	Code (HSE UC)	Descriptors (indicators of achievement of the result)	Educative forms and methods aimed at generation and development of the competence
The ability to think critically and interpret experiences (own and others') reflex social and professional activity.	CK-Б10	The student is able to reflect visual design	Lectures and tutorials.
The ability to create program interface	ПК-14, ИК-14	The student is able to visualize and summarize user-data, develop mockup.	Examples covered during the lectures and tutorials. Assignments.
The ability to describe problems and situations of professional activity in terms of humanitarian, economic and social sciences to solve problems which occur across sciences, in allied professional fields.	IC-M5.3_5_4_5.6_2.4.1	The student is able to describe design in terms of Ergonomics and Human Factor science.	Lectures and tutorials.



6. Schedule

Two pairs consist of 2 academic hours for lecture followed by 2 academic hours for computer exercises/labs after lecture. Additional office hours for lectures' content are provided.

№	Topic	Total hours	Contact hours		Self-study
			Lectures	Seminars	
1.	Introduction to Ergonomics	10	2	2	6
2.	Defining the machine	10	2	2	6
3.	Human information processing	11	2	2	7
4.	Human memory	11	2	2	7
5.	Usability engineering or design	11	2	2	7
6.	Design rules	13	2	4	7
7.	Design process rationale	11	2	2	7
8.	Human-Computer Interface	13	2	4	7
9.	Overview of methods of design evaluation tools	11	2	2	7
10.	Basic Experiment Designs	11	2	2	7
11.	Analysis Experimental Design	14	2	4	8
12.	Analysis Experimental Data	16	2	6	8
13.	Gather user needs	11	2	2	7
14.	Study of User Preferences by asking right questions	11	2	2	7
15.	Review and final project (homework) description	16	2	4	10
Total:		180	30	42	108

Requirements and Grading

Type of grading	Type of work		
	Homework	1	Solving homework task and examples.
Exam	1	Written exam. Preparation time – 120 min.	
Final			

9. Assessment

The assessment consists of one homework, handed out to the students during the semester. The homework required problems are based on each lecture topics.

Final assessment is the final exam. Students have to demonstrate knowledge of probability and statistics theory.

The grade formula:

The exam will consist of 15 questions, giving ten marks each, worth 40% of the final mark.



Final course mark is obtained from the following formula: $\text{Final} = 0,2 * (\text{Lecture \& seminar attendance}) + 0,4 * (\text{Homework}) + 0,4 * (\text{Exam})$.

The grades are rounded in favour of examiner/lecturer with respect to regularity of class and home works. All grades, having a fractional part greater than 0.5, are rounded up.

Table of Grade Accordance

Ten-point Grading Scale	Five-point Grading Scale	
1 - very bad 2 – bad 3 – no pass	Unsatisfactory - 2	FAIL
4 – pass 5 – highly pass	Satisfactory – 3	PASS
6 – good 7 – very good	Good – 4	
8 – almost excellent 9 – excellent 10 – perfect	Excellent – 5	

1. Course Description

The following list describes the topics that will be covered in the course in correspondence with lecture order.

Topic 1. Introduction to Ergonomics

Objectives of the course. History and intellectual roots of human oriented paradigm. Interaction as communication.

Base readings:

1. Rantanen E.M. Educational and Skill Needs of New Human Factors/Ergonomics Professionals / E.M. Rantanen, W.F. Moroney // Proceedings of the Human Factors and Ergonomics Society Annual Meeting. – 2011. – Vol. 55. – № 1. – P. 530–534.
2. Norman D.A. The design of everyday things: Revised and expanded edition / D.A. Norman. – Basic books, 2013. Chapter 1 (pp. 1-31).

Supplementary readings:

1. Van Cott H.P. Human Factors Specialists' Education and Utilization: Results of a Survey / H.P. Van Cott, B.M. Huey. – 1992.

Supplementary materials:

Video: Human Factors Success Stories 1987

Topic 2. Defining the machine

Difference between machine and computer. Relation to Ergonomics and Human Factors to Human-Computer Interaction. Problems and challenges.



Base readings:

1. Dix, A. (2004). *Human-computer Interaction* (Third Edition.). Pearson/Prentice-Hall. Foreward and Chapter 2.

Supplementary readings:

2. Licht, D. M., Polzella, D. J., & Boff, K. (1989). *Human Factors, Ergonomics, and Human Factors Engineering: An Analysis of Definitions*. CSERIAC-89-01. Wright Patterson AFB, Dayton, OH: CSERIAC

Topic 3. Human information processing

Human cognitive and sensory limitations. Models of cognitive architecture. Human problem solving.

Base readings:

1. Dix, A. (2004). *Human-computer Interaction* (Third Edition.). Pearson/Prentice-Hall. Foreward and Chapter 2.

Topic 4. Human memory.

Declarative and implicit memory. Recall vs. recognition. Addressing problems of automation & situation awareness.

Base readings:

1. Dix, A. (2004). *Human-computer Interaction* (Third Edition.). Pearson/Prentice-Hall. Chapter 1.3 & 1.4
2. Sternberg, R. J., & Sternberg, K. (2011). *Cognitive Psychology*. Wadsworth Publishing Company. Chapter 5 (memory research methods)

Topic 5. Usability engineering or design.

Usability engineering tools (techniques for prototyping): Storyboards, Paper Prototypes, and Mockups. Pitfalls of iterative design.

Video: Five Days at IDEO. Redesign of the shopping cart.

Base readings:

1. Dix, A. (2004). *Human-computer Interaction* (Third Edition.). Pearson/Prentice-Hall. Chapter 6.4

Supplementary readings:

2. Sommerich, C. M., et al. (2001). Effects of computer monitoring viewing angle and related factors on strain, performance, and preference outcomes. HF, 43, 39-55.
3. Cham, & Redfern, M. (2001). Effect of flooring on standing comfort and fatigue. HF, 43, 381-391.
4. Simeonov, P. I., Hsiao, H., Dotson, B. W., & Ammons, D. E. (2003). Control and perception of balance at elevated and sloped surfaces. HF, 45, 136-147.

Topic 6. Design rules

Basic design rules types: Standards; Guidelines; Golden rules, heuristics, or Rules-of-Thumb

Base readings:



1. Dix, A. (2004). *Human-computer Interaction* (Third Edition.). Pearson/Prentice-Hall. Chapter 7
2. Norman, D. A. (2013). *The design of everyday things: Revised and expanded edition*. Basic books. (Seven principles of good design)
3. Stewart, T. (2000). Ergonomics user interface standards: are they more trouble than they are worth? *Ergonomics*, 43(7), 1030–1044. doi:10.1080/001401300409206

Supplementary readings:

4. Panero, J., & Zelnik, M. (2014). Human dimension and interior space: a source book of design reference standards.
5. Alan, von, R. H., March, S. T., Park, J., & Ram, S. (2004). Design science in information systems research. *MIS quarterly*.

Topic 7. Design process rationale

Prototyping and task analysis implementation

Base readings:

1. Dix, A. (2004). *Human-computer Interaction* (Third Edition.). Pearson/Prentice-Hall. Chapter 6

Supplementary readings:

2. Lee, J., & Lai, K. Y. (1991). What's in design rationale? *Human–Computer Interaction*. doi:10.1080/07370024.1991.9667169

Topic 8. Human-Computer Interface

HCI in the software process, iterative design practices, dialog as main interaction form

Base readings:

1. Dix, A. (2004). *Human-computer Interaction* (Third Edition.). Pearson/Prentice-Hall. Chapter 16 (dialog notation)
2. Dix, A. (2004). *Human-computer Interaction* (Third Edition.). Pearson/Prentice-Hall. Chapter 6.1 (role HCI in the software process) & Chapter 6.1 (iterative design practices).

Topic 9. Overview of methods of design evaluation tools

Conceptual Models of Interaction evaluation: philosophy, task analysis, link analysis, critical incident technique.

Base readings:

1. Dix, A. (2004). *Human-computer Interaction* (Third Edition.). Pearson/Prentice-Hall. Chapter 9 (mostly 9.1)

Supplementary readings:

2. Vicente, K. J. (2002). Ecological interface design: Progress and challenges. *HF*, 44, 62-78. (philosophy)
3. Rogers, W. A., et al. (2001). Analysis of a simple medical device. *Ergonomics in Design*, p. 6-14. (task analysis)
4. Smith, H., et al. (1992). The ergonomic analysis of a trauma resuscitation room. *Health Bulletin*, 50, 252-258. (link analysis)
5. Cooper, J. B., et al. (1978). Preventable anesthesia mishaps: A study of human factors. *Anesthesiology*, 49, 399-406. (critical incident technique)



Topic 10. Basic Experiment Designs

Difference between observational methods, query techniques, physiological and direct recording, and experimental methods.

Base readings:

1. Dix, A. (2004). *Human-computer Interaction* (Third Edition.). Pearson/Prentice-Hall. Chapter 9.4

Topic 11. Analysis Experimental Design

Types of experimental designs. Detect sample size, issues in conduct and running Web Experiments.

Base readings:

1. Dix, A. (2004). *Human-computer Interaction* (Third Edition.). Pearson/Prentice-Hall. Chapter 9.4
2. R Core Team (2016). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL <https://www.R-project.org/> (anova, t.test, lm functions).

Supplementary readings:

3. Dix, A. (2004). *Human-computer Interaction* (Third Edition.). Pearson/Prentice-Hall. Chapter 9.4
4. Stephane Champely (2015). pwr: Basic Functions for Power Analysis. R package version 1.1-3. <https://CRAN.R-project.org/package=pwr>

Advanced readings:

5. Ferreira, E. B., Cavalcanti, P. P., & Nogueira, D. A. (2014). ExpDes: An R Package for ANOVA and Experimental Designs. *Applied Mathematics*, 05(19), 2952–2958. doi:10.4236/am.2014.519280

Topic 12. Analysis Experimental Data

Between- and within - subject design in R: parametric versus nonparametric tests.

Base readings:

1. Dix, A. (2004). *Human-computer Interaction* (Third Edition.). Pearson/Prentice-Hall. Chapter 9.4
2. R Core Team (2016). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL <https://www.R-project.org/> (aov).

Supplementary readings:

3. Douglas Bates, Martin Maechler, Ben Bolker, Steve Walker (2015). Fitting Linear Mixed-Effects Models Using lme4. *Journal of Statistical Software*, 67(1), 1-48. doi:10.18637/jss.v067.i01.

Topic 13. Gather user needs

Techniques to gather user needs: Interviews, focus groups, observation, participatory design

Base readings:



1. Dix, A. (2004). *Human-computer Interaction* (Third Edition.). Pearson/Prentice-Hall. Chapter 9.4.3

Supplementary readings:

2. Shaughnessy, J. J., & Zechmeister, E. B. (2012). *Research methods in psychology* (9 ed.). NY: McGraw-Hill. Chapter 2

Topic 14. Study of User Preferences by asking right questions

Validity in Survey Design and Analysis.

Base readings:

1. Shaughnessy, J. J., & Zechmeister, E. B. (2012). *Research methods in psychology* (9 ed.). NY: McGraw-Hill. Chapter 5
2. Dix, A. (2004). *Human-computer Interaction* (Third Edition.). Pearson/Prentice-Hall. Chapter 9.4.3

Topic 15. Review and final project (homework) description

See assessment section.

1. Term Educational Technology

The following educational technologies are used in the study process:

- discussion and analysis of the results during the computer exercises;
- regular assignments to test the progress of the student;
- consultation time on Monday mornings with lecturer and after lecture;
- teleconference lectures
- office hours and classes with tutor and teaching assistants
- tutorship

2. Recommendations for course lecturer

Course lecturer is advised to use interactive learning methods, which allow participation of the majority of students, such as slide presentations, combined with writing materials on board, and usage of interdisciplinary papers to present connections between probability theory and statistics. The course is intended to be adaptive, but it is normal to differentiate tasks in a group if necessary, and direct fast learners to solve more complicated tasks.

3. Recommendations for students

The course is interactive. Lectures are combined with exercises. Students are invited to ask questions and actively participate in group discussions.

The lecturer is ready to answer your questions online by official e-mails that you can find in the “contacts” section. Additional references found in section 15.2 are suggested to help students in their understanding of the material. This course is taught in English, and students can ask teaching assistants to help them with the language.

In addition to introductory classes on R language you may find useful course from Coursera: <https://www.coursera.org/course/rprog>



4. Final exam questions

The final exam will consist in fifteen questions equally weighted. No material is allowed for the exam. Each question will focus on a particular topic presented during the lectures.

5. Reading and Materials

We do not follow a particular textbook in this subject, but the student may find the following references useful:

5.1. Recommended Reading

1. Human-Computer Interaction (3rd Ed): by Alan Dix, Janet E. Finlay, Gregory D. Abowd, and Russell Beale
2. Norman, Donald A. "People are from earth, machines are from outer space." *ACM Interactions* 16.1 (2009): 39-41
3. Norman D.A. *The design of everyday things: Revised and expanded edition* / D.A. Norman. – Basic books, 2013.
4. Zaharias, P. "Developing a usability evaluation method for e-learning applications: beyond functional usability." *International Journal of Human-Computer Studies* 25.1 (2009):75-98

5.2. Supplementary Reading

5. David Easley and John Kleinberg. "Networks, Crowds, and Markets: Reasoning About a Highly Connected World." Cambridge University Press 2010.
6. Shackel, B. Ergonomics for a computer. *Design* 120 (1959), 36–39.
7. Shackel, B. Human-computer interaction - Whence and whither? *Interacting with Computers (IWC)* 21, 5–6 (2009), 353–366.
8. Hewett, T. et al. *ACM Curricula for Human-Computer Interaction*. 1992;
<http://old.sigchi.org/cdg/index.html>
9. Myers, B.A. A brief history of human-computer interaction technology. *interactions* 5, 2 (1998), 44–54.
10. Grudin, J. Brian Shackel's contribution to the written history of human-computer interaction. *Interacting with Computers* 5–6 (2009), 370–374.
11. Carroll, J.M. Human computer interaction (HCI). In *Encyclopedia of Human-Computer Interaction*. M. Soegaard and R.F. Dam, eds. The Interaction Design Foundation, Aarhus, Denmark, 2009;
http://www.interactiondesign.org/encyclopedia/human_computer_interaction_hci.html
12. Nickerson, R. Man-computer interaction: A challenge for human factors research. *Ergonomics* 12, 4 (1969), 501–517.

5.3. R programming

1. W. N. Venables, D. M. Smith and the R Core Team. *An Introduction to R*, 2016
<https://cran.r-project.org/doc/manuals/R-intro.pdf>
2. Robert Knell. "Introductory R: A Beginner's Guide to Data Visualisation, Statistical Analysis and Programming in R", 2013



5.4. Popular Reading

1. Norman, D. A. (2013). The design of everyday things: Revised and expanded edition. Basic books.
2. Vicente, K. (2010). The human factor: revolutionizing the way we live with technology. Vintage Canada.
3. Weinschenk, S. (2011). 100 things every designer needs to know about people. Pearson Education.

5.5. Course webpage

Students are provided with links to the lecture notes, problem sheets and their solutions, assignments and their solutions, and additional readings.

6. Equipment

The course requires a laptop and projector.
R statistical modeling environment, RStudio IDE
R: <http://www.r-project.org>
RStudio: <http://www.rstudio.com>

Lecture materials, course structure and the syllabus are prepared by Alexey Klimov.