

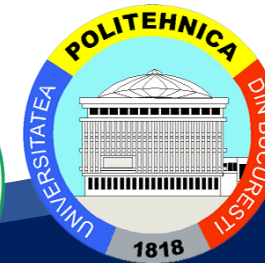


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Course 14: Human Centric Design

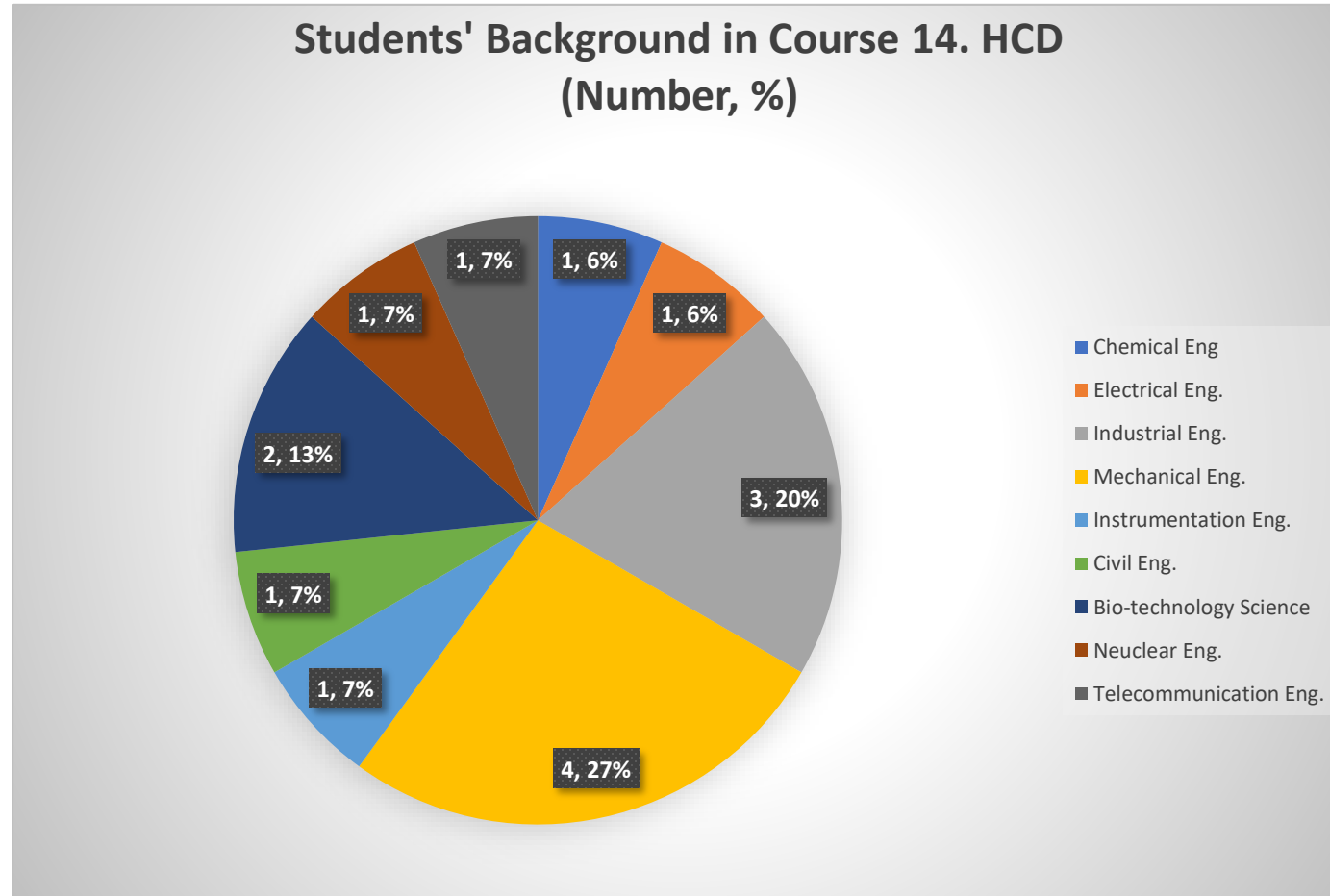
Problem-Based Learning Course



Curriculum Development
of Master's Degree Program in
Industrial Engineering for Thailand Sustainable Smart Industry

Students' Background

16 Students registered in Course 14 HCD



Course Learning Outcome



Apply human abilities, limitations, needs and other important human characteristics for designing tasks, jobs, equipment, products, environments, processes and other element in working systems.



Evaluate occupational health and safety (OHS) risks to accidents, injuries, and ill health in a working system.



Create solutions and opportunities for reducing OHS risks, enhancing operators' performance and preference.



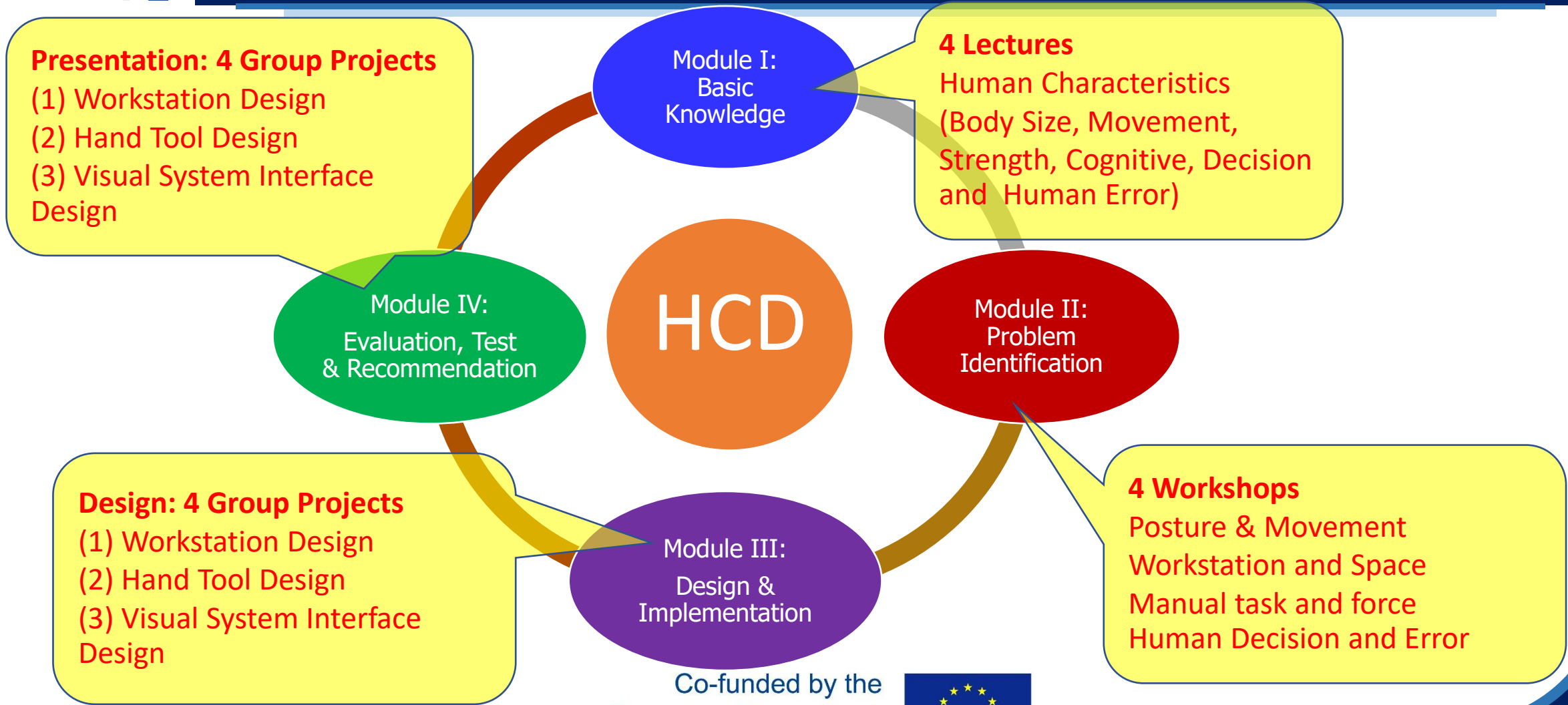
Design tasks, equipment, workstation, workspace, environment, and other elements in working systems compatible with needs, abilities and limitations of operators for better well-being and performance.



Analyze work organization affecting on human behavior and performance, e.g. policy, work schedule, motivation, satisfaction, communication and participatory.



Structure of Course 14.



Workshops



Problem Discussion



Workshops and Presentations



Examples: Student's Project

Workshop I
Human Movement and Posture

Group #2



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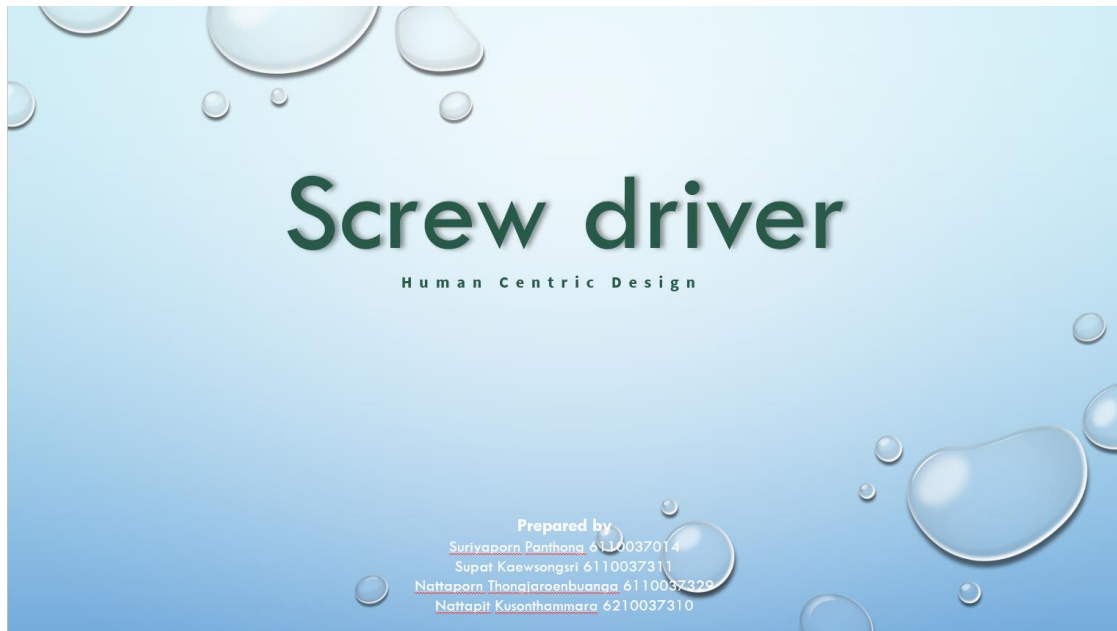
Human Movement and Posture
EMM784 Human Centric Design

Slide 1

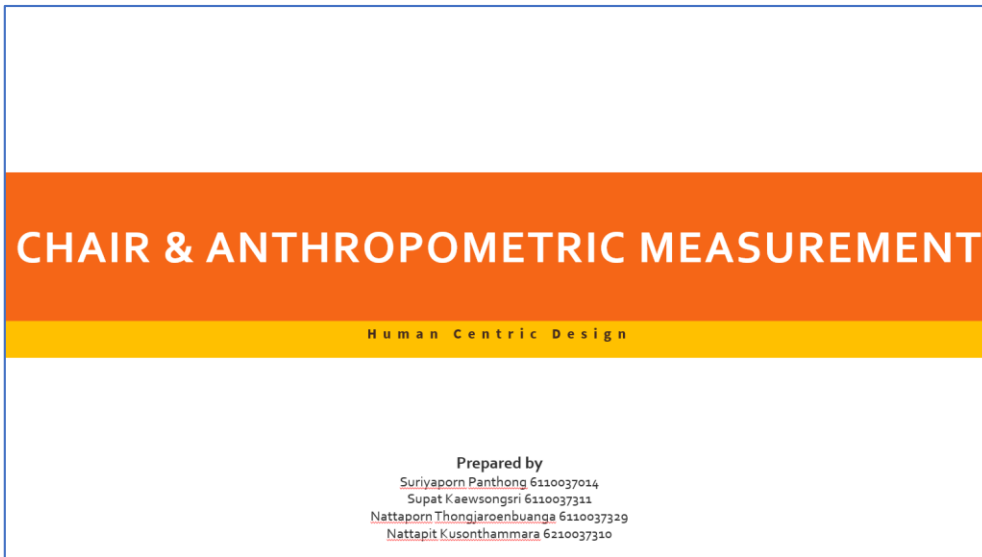
Thammasat School of Engineering



Examples: Student's Project



Examples: Student's Project



Examples: Student's Project

HUMAN CENTRIC DESIGN - HANDTOOL DESIGN

SCREWDRIVER

Hand tool design project focusing on ergonomics and user-friendliness. The project includes a detailed analysis of a standard screwdriver and a proposed 'NEW SCREWDRIVER' design.

NEW SCREWDRIVER
ERGONOMICS | MULTI-PURPOSE | COMFORT | DURABILITY | USER FRIENDLY

ความยาวด้ามจับ (Palm Breadth): 11 ซม. (2) ความยาวด้ามจับ 150 มม. ถึง 170 มม. (3) ความยาวด้ามจับ 150-170 มม. ความยาวด้ามจับ 150-170 มม. ความยาวด้ามจับ 150-170 มม.

ขนาดด้ามจับ (Grip Diameter): 22 มม. (1) ความยาวด้ามจับ 150-170 มม. ความยาวด้ามจับ 150-170 มม. ความยาวด้ามจับ 150-170 มม.

รูปทรงด้ามจับ (Grip Shape): 1) ความยาวด้ามจับ 150-170 มม. ความยาวด้ามจับ 150-170 มม. ความยาวด้ามจับ 150-170 มม.

วัสดุด้ามจับและสี (Grip Material and Color): 1) ความยาวด้ามจับ 150-170 มม. ความยาวด้ามจับ 150-170 มม. ความยาวด้ามจับ 150-170 มม.

ความยาวก้าน (Shaft Length): 1) ความยาวด้ามจับ 150-170 มม. ความยาวด้ามจับ 150-170 มม. ความยาวด้ามจับ 150-170 มม.

ปลายก้าน (Shaft Tip): 1) ความยาวด้ามจับ 150-170 มม. ความยาวด้ามจับ 150-170 มม. ความยาวด้ามจับ 150-170 มม.

References:
1) Sunyaporn P. 6110037014, Nattaporn T. 6110037329, Supat K. 6110037311, Nattakit K. 6210037310
2) [Proposed by] 6110037301
3) [Proposed by] 6110037302
4) [Proposed by] 6110037303
5) [Proposed by] 6110037304

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HANTOOL'S ANALYSIS AND EVALUATION

EMM784 Human Center Design

Chayanon (6110037090) | Pattama (6110037220) | Thanaphon (6110037337) | Surasak (6210037120)

Introduction
What is product? Who are users? What is the problem? What is the solution?

Define problem
Degree of Freedom

Cultural design
Dimension design

Risk assessment before improvement
LUBA (Upper Limb Bio-mechanical Assessment)

Risk assessment after improvement
LUBA (Upper Limb Bio-mechanical Assessment)

References:
1) [Proposed by] 6110037301
2) [Proposed by] 6110037302
3) [Proposed by] 6110037303
4) [Proposed by] 6110037304

Hand Tool Design #02

Hand tool design project focusing on ergonomics and user-friendliness. The project includes a detailed analysis of a standard hand tool and a proposed 'Good designed hand tools' design.

Hand Tool

References:
1) [Proposed by] 6110037301
2) [Proposed by] 6110037302
3) [Proposed by] 6110037303
4) [Proposed by] 6110037304



Examples: Student's Project

Hand Tool A Scrubber Brush with Handle.

Product detail:

- Nylon and Plastic Tile Cleaning Multi Purpose Scrubber Brush with Handle.
- Single-Handle Tools
- Washing/Cleaning Tools

Condition for used:

- Types of grip: Power grip.
- Use the hand and arm by repeatedly moving (Speed: Fast/Slow; Force: Light/heavy) and moderate movement.

Product description: An ideal tool for bathrooms and floor. It has Nylon fiber material with plastic handle and powerful sponge. The Scrubber makes cleaning difficult corners pretty easy. It cleans better than ordinary scrubs and lasts much longer. It is easy to hold and use and can effectively scrub out tough stains. It is ideal for cleaning Sink, Bathroom, Pool, Floor Tile, Boat Decks, Utensils etc. It cleans the floor without any scratches.

Checklist for the Ergonomic Evaluation of Hand Tools.

Checklist for the Ergonomic Evaluation of Hand Tools.

Considering the job the tool is designed for and the work environment, respond to each item by checking "Yes", "No", "N/A" (Not applicable). Please do not check "No" unless you are certain the "Yes" answer will be correct in all cases in all the work areas of use. (International Ergo, 2005, pp. 913-917, and 10 or not applicable for all items.)

Item	Ergonomic Feature	Yes		No		N/A		Score
		NA	Y	N	Y	N	Y	
1	Does the tool have a power grip?							61.75
2	Does the tool have a power grip?							61.75
3	Does the tool have a power grip?							61.75
4	Does the tool have a power grip?							61.75
5	Does the tool have a power grip?							61.75
6	Does the tool have a power grip?							61.75
7	Does the tool have a power grip?							61.75
8	Does the tool have a power grip?							61.75
9	Does the tool have a power grip?							61.75
10	Does the tool have a power grip?							61.75
11	Does the tool have a power grip?							61.75
12	Does the tool have a power grip?							61.75
13	Does the tool have a power grip?							61.75
14	Does the tool have a power grip?							61.75
15	Does the tool have a power grip?							61.75
16	Does the tool have a power grip?							61.75
17	Does the tool have a power grip?							61.75
18	Does the tool have a power grip?							61.75
19	Does the tool have a power grip?							61.75
20	Does the tool have a power grip?							61.75
21	Does the tool have a power grip?							61.75
22	Does the tool have a power grip?							61.75
23	Does the tool have a power grip?							61.75
24	Does the tool have a power grip?							61.75
25	Does the tool have a power grip?							61.75
26	Does the tool have a power grip?							61.75
27	Does the tool have a power grip?							61.75
28	Does the tool have a power grip?							61.75
29	Does the tool have a power grip?							61.75
30	Does the tool have a power grip?							61.75
31	Does the tool have a power grip?							61.75
32	Does the tool have a power grip?							61.75
33	Does the tool have a power grip?							61.75
34	Does the tool have a power grip?							61.75
35	Does the tool have a power grip?							61.75
36	Does the tool have a power grip?							61.75
37	Does the tool have a power grip?							61.75
38	Does the tool have a power grip?							61.75
39	Does the tool have a power grip?							61.75
40	Does the tool have a power grip?							61.75
41	Does the tool have a power grip?							61.75
42	Does the tool have a power grip?							61.75
43	Does the tool have a power grip?							61.75
44	Does the tool have a power grip?							61.75
45	Does the tool have a power grip?							61.75
46	Does the tool have a power grip?							61.75
47	Does the tool have a power grip?							61.75
48	Does the tool have a power grip?							61.75
49	Does the tool have a power grip?							61.75
50	Does the tool have a power grip?							61.75
51	Does the tool have a power grip?							61.75
52	Does the tool have a power grip?							61.75
53	Does the tool have a power grip?							61.75
54	Does the tool have a power grip?							61.75
55	Does the tool have a power grip?							61.75
56	Does the tool have a power grip?							61.75
57	Does the tool have a power grip?							61.75
58	Does the tool have a power grip?							61.75
59	Does the tool have a power grip?							61.75
60	Does the tool have a power grip?							61.75

Result: Score is 61.75 points from 100 points. Interpretation is "Poor"

TABLE VI. Proposed Interpretation of Checklist Scores

Score	Interpretation	Justification
>90	Good	Tool is well designed with highly important ergonomic design features.
80-90	Fair	Tool is well designed with some important ergonomic design features.
70-80	Poor	Tool is not well designed with some important ergonomic design features.
<70	Poor	Tool is not well designed with some important ergonomic design features.

Problems and guidelines for solving design problems.

Several Guidelines for Hand tools design (For power grip)

- Grip with entire hand.
- Grip length minimum 125 mm.
- Grip shape non-cylindrical.
- Tool weight maximum 2.3, 1.2 kg. is preferable.
- Trigger activated by thumb with locking mechanism.

Improvement:

- Back pain, neck pain and bent too much because of scrubbing.
- Posture: Improve the handle for longer.
- Hand length (The most significant factor for hand grip strength.)
- Hand diameter (The most significant factor for hand grip strength.)
- Hand length
- Hand diameter
- Hand inter distance/grip span
- Hand flange
- Trigger type and size

Hand length

- Hand length
- Hand diameter
- Hand inter distance/grip span
- Hand flange
- Trigger type and size

Hand diameter

- Hand length
- Hand diameter
- Hand inter distance/grip span
- Hand flange
- Trigger type and size

Hand inter distance/grip span

- Hand length
- Hand diameter
- Hand inter distance/grip span
- Hand flange
- Trigger type and size

Hand flange

- Hand length
- Hand diameter
- Hand inter distance/grip span
- Hand flange
- Trigger type and size

Trigger type and size

- Hand length
- Hand diameter
- Hand inter distance/grip span
- Hand flange
- Trigger type and size

Potential injury to the body in the case of prolonged use.

- Injured from being cut or cut.
- Injury from blistering.
- Injury from bruises.
- Cumulative injury from the wrist.
- Injuries from sprains.
- Injury at Tennis elbow.
- Other at below

Related research

Hand orientation was range of 70° to 80°.

The horizontal handle orientation was better than the vertical orientation.

"Hand orientation is the angular position measured from the horizontal plane to the handle axis. Good angulation of the handle is required in hand plane design to maintain the wrist in neutral posture. In general, handle orientation in the range of 70° to 80° is recommended. Compare with horizontal and vertical handle orientation, hand torque output and flexor muscle activity in the horizontal was higher than the vertical as same as grip strength was greatest in horizontal orientation."

Hand material was made by rubber or mixture between rubber and polyurethane foam.

Hand texture should be the rough surface.

"The materials of handle are suggested to be covered by adhesive tapes and vinyl rubber to reduce manual exertion. An ergonomically design of hand tool handle is fabricated from non-conductive and non-slippery materials. One of the most commonly used materials is rubber. It offers a superior performance in terms of a firm grip, averts the handle from slipping out of the hand and minimizes contact stress in skin and soft tissue of the palm whilst grasping the handle. The other one, combination of rubber and polyurethane foam has been proven to be effective material for tool handle to reduce contact pressure. The texture or roughness of the handle surface can reduce the friction between the hand and the handle. Hence a non-slip texture is suggested for the handle surface to ensure a secure grip and to avoid slippage."

The surface contact area.

"They have come up with equations for simplified the task determining the right dimension for power grip tool. Thus, the dimension derived through these equations not only ensured greater subjective perceived comfort but also made sure that maximum grip strength can be obtained for particular set. Prior to this subjective analysis, data collection for anthropometric data of 67 subjects was carried out. The overall comfort rating of various cross-section shapes is accompanied by the surface contact area of the subjects. The profile of the model was reverse engineered from an existing handle using a new approach through the application of a CAD software. The geometry of the profile with finger grooves."

Grip size design

For grip size design are design based on measurements result from hand length (HL), Hand breadth (HB), Finger length (FL) and Hand breadth at metacarpal (HBM), and reference equation from research paper of Hammer design that study suitable hand grip design for reduces the musculoskeletal disorders mainly wrist pain.

Reference: M. Tashir Hogue (2018), "Ergonomic design of hammer handle to reduce musculoskeletal disorders of carpenters M.T. Hogue", International Journal of Engineering and Technology 4(2):78-83. May 2018.

Direction of wrist/hand movement using: (a) conventional tool; (b) redesigned tool.

"A commercially available long straight handle cleaning tool for floor mopping was used as a conventional cleaning tool. The length of the tool could be adjusted between 105 and 190 cm. The redesigned cleaning tool was bent at three points, upper, middle and lower part of the tool in such a way that it produced an arc shape in Right picture. The redesigned cleaning tool allowed neutral wrist posture while mopping the floor as compared to the conventional cleaning tool where there was extension of the wrist was needed while mopping the floor. The arrow in the figure shows the movement of the wrist/hand using each tool."

Reference: Rajesh K. Mumbhani, C. Shreevan, K. Kamesh "Physiological, subjective and postural study to determine the impact of using a conventional and redesigned cleaning tool" International Journal of Industrial Ergonomics, 2005, pp. 913-917.

New design

New design is refer 3D as below.

The surface contact area

Extend the handle for longer.

Easy for assembly.

Posture Expected during use for Real

Checklist for the Ergonomic Evaluation of Hand Tools.

Re-checklist for the Ergonomic Evaluation of Hand Tools.

Result: Score is >90 points from 100 points. Interpretation is "Good"

TABLE VI. Proposed Interpretation of Checklist Scores

Score	Interpretation	Justification
>90	Good	Tool is well designed with highly important ergonomic design features.
80-90	Fair	Tool is well designed with some important ergonomic design features.
70-80	Poor	Tool is not well designed with some important ergonomic design features.
<70	Poor	Tool is not well designed with some important ergonomic design features.

Member Team

- Chanapa Phinjal 8110037582
- Vipavorn Sangpitt 8110037246
- Mayika Wongmudaporn 8110037048
- Vasin Sampantharatt 8110037113

Course Structure Revise

The course structure will be revised after the course finish at the end of May 2020.

Adapting Problem Based Learning for Human-Centric Design Course

Naris Charoenporn^{1*}, Jirawan Kloypayan² and Apiwat Mutamara³

Department of Industrial Engineering, Thammasat School of Engineering, Thammasat University, THAILAND

Email: ¹cnaris@engr.tu.ac.th, ²kjirawan@engr.tu.ac.th, ³mapiwat@engr.tu.ac.th

* Corresponding author

Abstract

Human-centric design is a unique approach to solve problems of products, process, environments, and other human operations challenging with incompatibilities of human needs, abilities and limitations. The objective of this course is to understand, analyse, and apply the interactions among humans and other elements of a system, evaluate and design tasks, equipment, products, processes, jobs, environments and other elements in working systems including work organization in order to design and optimize human well-being and overall system performance. The course was designed by adapting problem-based learning for more practical, and divided into 4 modules (1) Basic, (2) Problem Identification, (3) Design and Intervention, and (4) Evaluation. Students will be educated all the basic knowledge of human factors related to work elements and human interaction system designs via lectures and case study discussions at the first module. During the second module, they will learn how to identify the problems related to human in several work systems by practical workshops and case studies. Individual assignments will be assigned to the students to gain their understanding. The third module will provide more skill of human-centric design in practice via workshop, laboratories and self-learning based on a project of interest. To complete the project, the students will be able to discuss and get recommendations from instructors and share their learning with other students in the class during the workshops in the third module. At the last module, the students will learn and practice more and more in evaluation tools of human-centric design techniques to increase their skill for optimizing human well-being and system performance in their project.

Keywords: Problem Based Learning; Human-Centric Design, Human Factors and Ergonomics, Engineering Education



Module I: Basic Knowledge

Table 2 Course Contents (Module I: Basic of Human Factors Knowledge for Human-Centric Design)

	Time (hrs)	Contents	Activities			Related CLO				
						1	2	3	4	5
Module I: Basic of Human Factors Knowledge for Human-Centric Design	1 (2-2-0)	Introduction to Human-Centric Design (HCD) - Meaning, scope and applications of human-centric design - Basic concepts of HCD for engineering - Professional in HCD	Lecture in class Case study discussions			✓				
			Lecture	Workshop	Lab					
			2	2	0					
	2 (2-2-0)	Human characteristics: Physical / Physiological / Psychological and Cognitive / Behavioral Characteristics Stress and strain in human Human fatigue and human errors and their effect to health, accident and efficiency	Lecture in class Case study discussions			✓	✓			
			Lecture	Workshop	Lab					
			2	2	0					
	3 (2-2-0)	Human System Interaction: Manual working system, Semi-automation working system, Automation HCD for product design HCD for process and physical environmental design HCD for work organization design	Lecture in class Case study discussions			✓	✓			✓
			Lecture	Workshop	Lab					
			2	2	0					
	4 (2-2-0)	Human System Interaction: Situation Awareness and Usability Testing HCD for product design HCD for process and physical environmental design HCD for work organization design	Lecture in class Case study discussions			✓	✓			✓
			Lecture	Workshop	Lab					
			2	2	0					

Module 2: Problem Identification

Table 3 Course Contents (Module II: Problem Identification)

	Time (hrs)	Contents	Activities			Related CLO				
						1	2	3	4	5
Module 2: Problem Identification	5 (0-6-0)	Human factors evaluation tools for identifying risk factors effecting on health, incident, accident and efficiency such as Posture Evaluation, Task Analysis, Usability Scale, Human Error Risk Assessment et.al.	Lecture and practice in class			✓	✓			
			Lecture	Workshop	Lab					
			0	6	0					
	6 (0-6-0)	Each student selects a problem of interest related to HCD Identify human factors elements related to the selected problem Analysis the problem Presentation and discussion in the class	Self-study and presentation Problem based discussion Group project for 2-3 students depending on total students in the class.			✓	✓			
			Lecture	Workshop	Lab					
			0	6	0					
	7 (0-6-0)	Final report of the problem identification Formative Assessment	Poster/Oral presentation				✓	✓		
			Lecture	Workshop	Lab					
			0	6	0					

Module 3: Implementation & Design

Table 4 Course Contents (Module III: Intervention and Design)

	Time (hrs)	Contents	Activities			Related CLO				
						1	2	3	4	5
Module 3: Intervention & Design	8 (0-6-0)	Workstation and Workspace Design - Measurement of human dimensions and motion. - Application of human anthropometry for workstation and workspace designs - International standards related to HCD such as ISO7250, ISO14738 et.al.	Practice in class & Case study discussion					✓	✓	
			Lecture	Workshop	Lab					
			0	6	0					
	9 (0-6-0)	Design for Human Control/System Interaction (HCI/HSI) Visual/Display Control Design HCD for control centers Accessible design for special people Physical environment design for HCI/HSI	Practice in class & Case study discussion					✓	✓	
			Lecture	Workshop	Lab					
			0	6	0					
	10 (0-6-0)	Man-machine system and interaction and cognitive designs - Human perception, information and sensory receptors - Human fallibility: human information processing / memory - Visual display of static and dynamic information / designs - Human decision	Practice in class & Case study discussion					✓	✓	
			Lecture	Workshop	Lab					
			0	6	0					
	11 (0-0-9)	Design of physical environment Light, Temperature, Pressure, Noise/Auditory, and Vibration	Practice in class & Learning from laboratories			✓	✓	✓	✓	
			Lecture	Workshop	Lab					
			0	0	9					

Module 2: Problem Identification

Table 5 Course Contents (Module IV: Evaluation, Test, and Recommendation)

	Time (hrs)	Contents	Activities			Related CLO					
						1	2	3	4	5	
Module 4: Evaluation & Test & Recommendations	12 (0-6-0)	Evaluation of manual work Size and dimension evaluation Posture and strength evaluation Space and movement evaluation	Problem based discussion				✓	✓	✓		
			Lecture	Workshop	Lab						
			0	6	0						
	13 (0-6-0)	Evaluation of physical environment in design Light, Temperature, Pressure, Noise/Auditory, and Vibration	Problem based discussion				✓	✓	✓		
			Lecture	Workshop	Lab						
			0	6	0						
	14 (0-6-0)	Evaluation of HCI/HIS and Cognitive - Usability testing of human compatibility/ capacity and limitation - Usability testing of human performance - Usability testing of human error in controlling system	Problem based discussion				✓	✓	✓		
			Lecture	Workshop	Lab						
			0	6	0						
	15 (0-6-0)	Final report of evaluation and test Summative Assessment	Poster/Oral presentation					✓	✓		
			Lecture	Workshop	Lab						
			0	6	0						



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Thank You

Together We Will Make Our Education Stronger



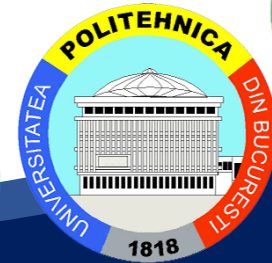
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