

Designing Automated Guidance Systems for Learning Analysis

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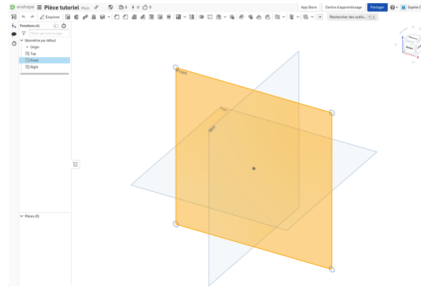


Isae
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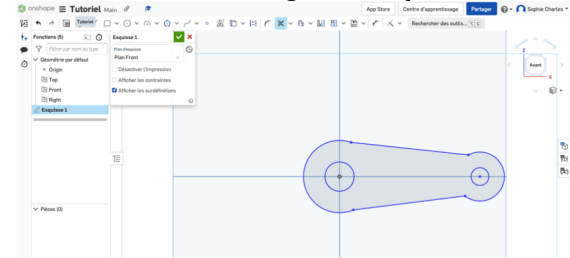


3-D modelling

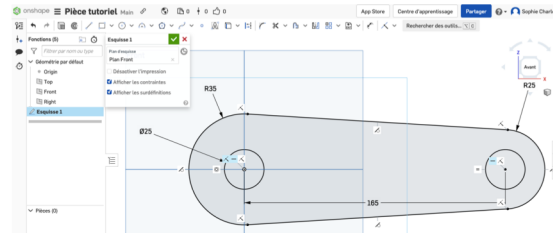
1) Choice of sketch plane



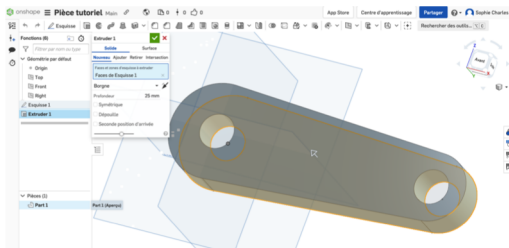
2) Sketching of 2-D profile



3) Dimensioning and constraining



4) Application of feature



Research context

Research question

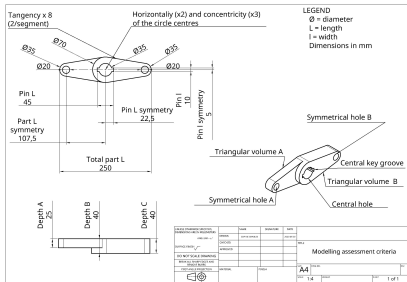
Methodology

Results

Conclusion



Assessing modelling performance



Accuracy of model

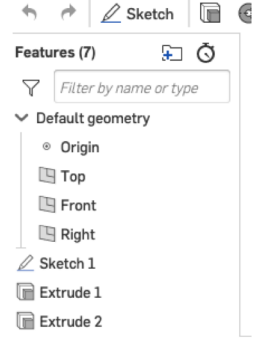
- Geometry
- Dimensions
- Completion
- Number of errors
- Robustness of model

Lang *et al.* (1991), Branoff & Dobelis (2012), Steinhauer (2012).

Modelling strategy



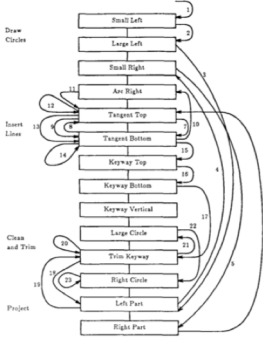
- Number of commands
- Variety of commands
- Number of expert strategies
- Completion time
- Structure of model

Lang *et al.* (1991), Chester (2007), Steinhauer (2012), Hamade *et al.* (2007).





Characterising modelling activity

Observing		Encoding	
			<p>Identification of expert strategies used (Chester, 2007).</p> <p>Transcript analysis for mentions of geometry + functions used, sketch plane selection, copy of elements (Hartman, 2005).</p>
Lang et al. (1991), Chester (2007).	Hartman (2005)	Lang et al. (1991)	



Research objectives

- To characterise engineering freshmen's modelling strategies before and after taking a 3-D modelling course.
- To present the development of a semi-automated method designed to detect and characterise sequences of operations and actions that constitute engineering freshmen's modelling activity.

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Data collection



Sept 2019

135 students
149 students

First-term courses including
a 3-D modelling course using CATIA



Dec 2019

92 students
102 students

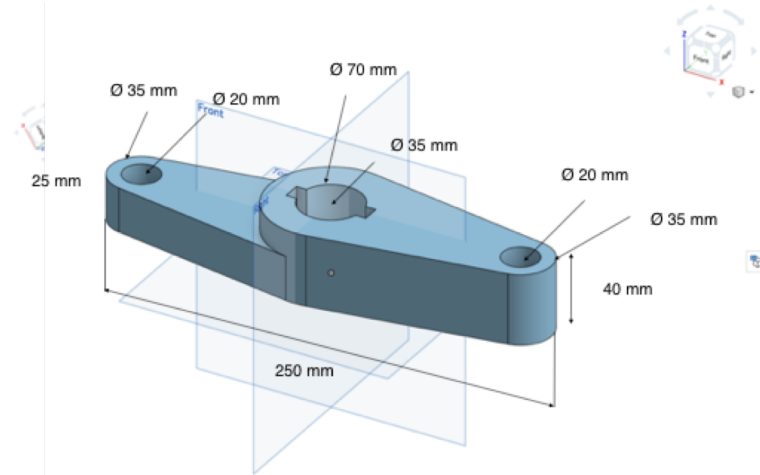
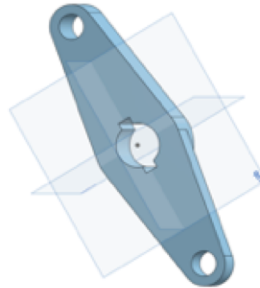
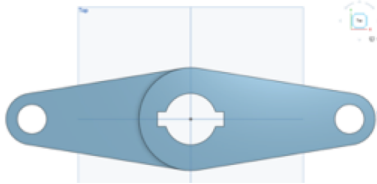
Legend:



Modelling task using Onshape



Battery of 5 spatial tests



Research context

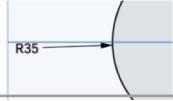
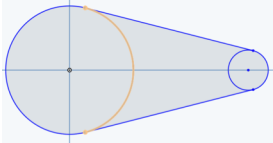

Research question

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Encoding grid

Object	Code	Indicator	Description	Example
Keyboard	DIM	Dimension	Dimension typed	
Mouse : movement	DT	Erratic mouse movement	Subject moves curser without a precise direction.	Erratic or slow mouse movement on screen.
Mouse : click	CPD	Production of a sketch element	Subject clicks on an element they want to constrain.	
Modeller	ME	Error message	Modeler indicates subject's action does not comply with modelling rules.	Sktech could not be solved.
Eye focus	INSTR	Visual focus on the instructions	Subject looks at the instructions.	

Research context

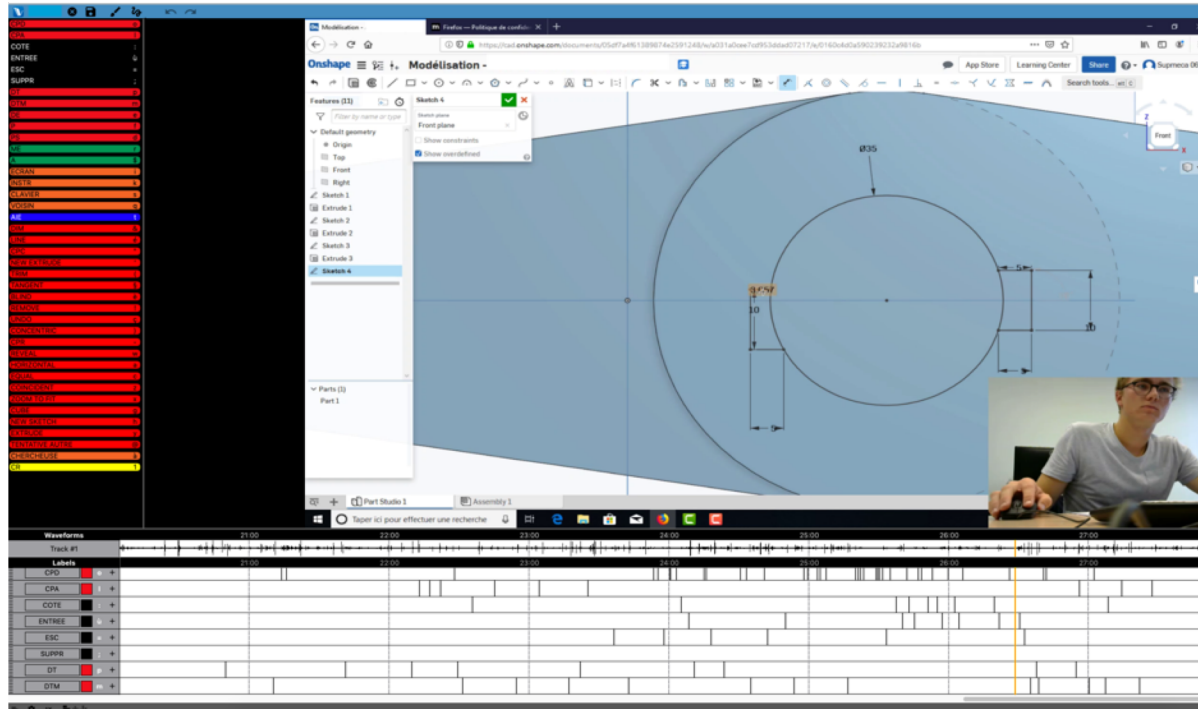
Research question

Methodology

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Manual encoding



Research context

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Automated encoding

Timestamp	Coded operation (manual)	Coded action (automated)
00:02:13	CPC	CIRCLE*2
00:02:14	INSTR	
00:02:18	CPD	
00:02:18	SCREEN	
00:02:19	INSTR	
00:02:20	SCREEN	
00:02:21	CPD	
00:02:21	A	
00:02:21	INSTR	
00:02:22	SCREEN	
00:02:23	CPD	

Research context

Research question

Methodology

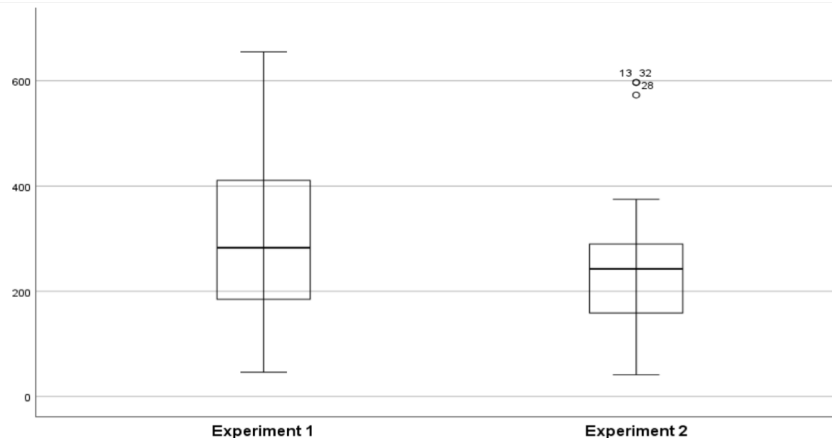
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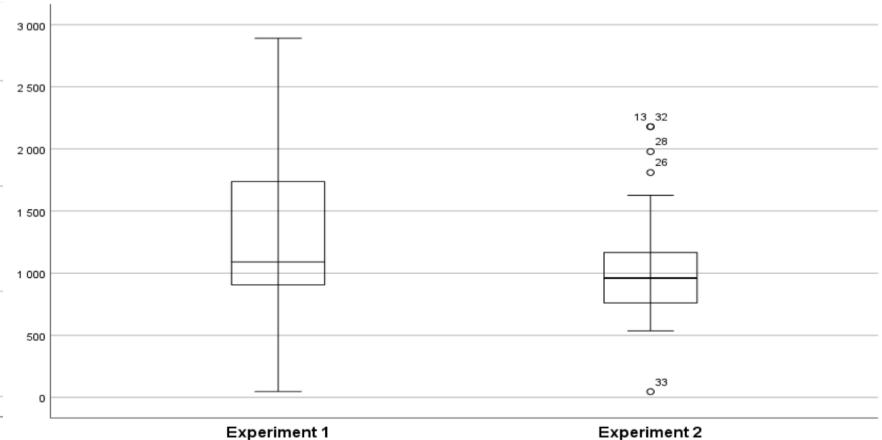


Have the students become more efficient following the modelling course? ($N=28$)

- Significant decrease ($p < 0.01$) in completion time following first-term courses.
- Non-significant ($p = 0.089$) decrease in number of actions.



Number of automatically encoded actions

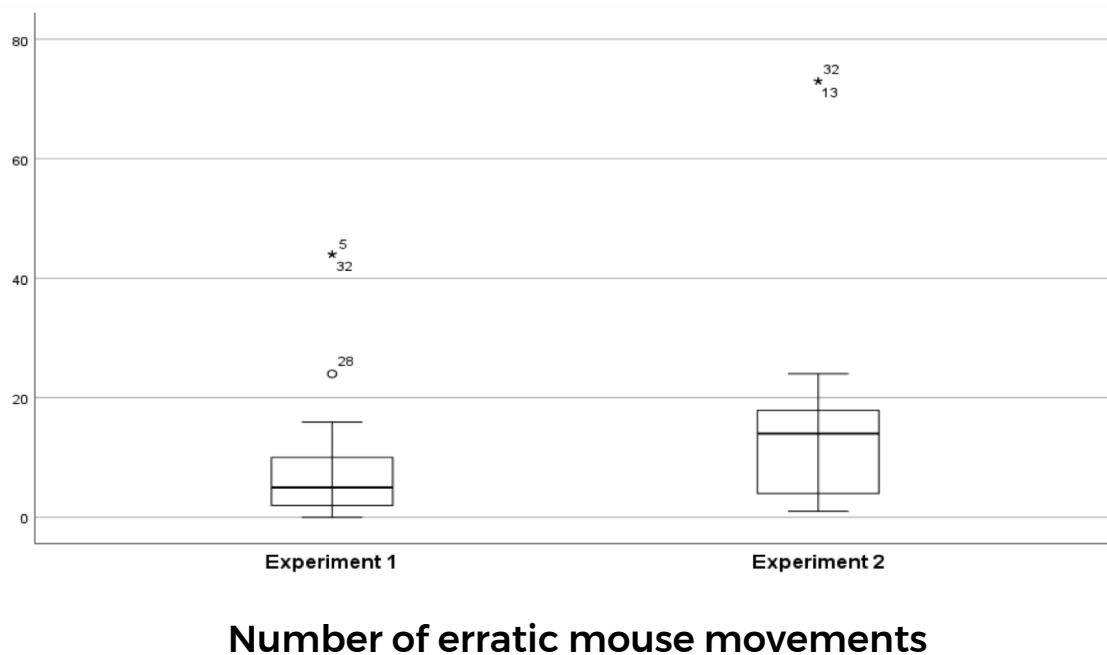


Task completion time in seconds



Have the students become more efficient following the modelling course? ($N=28$)

- Significant increase ($p < 0.05$) in erratic mouse movements following first-term courses.



Research context

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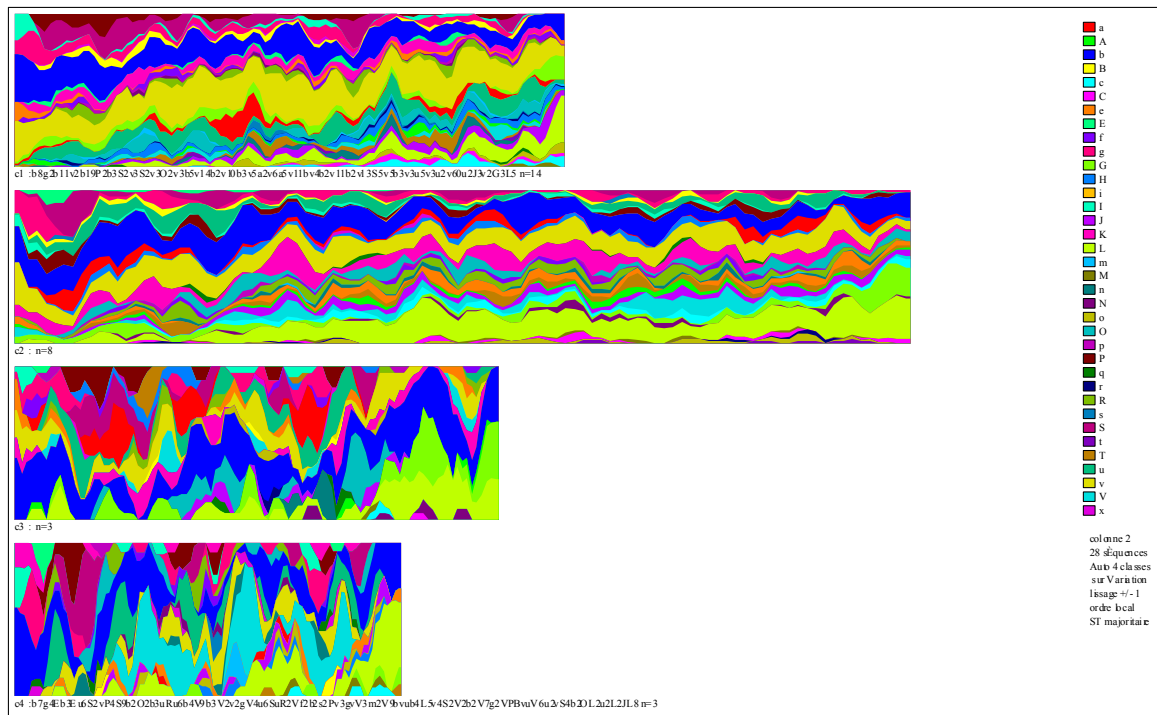
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Sequence analysis (N = 28)



Research context

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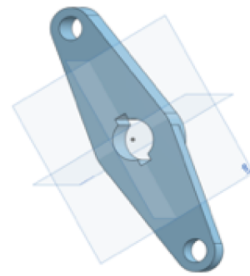
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Typology of rectangles ($N = 28$)



Unique rectangle	2 horizontal rectangles	2 vertical rectangles	2 semi-rectangles

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Manual encoding over the automated encoding ($N = 4$)

Timestamp	Code	Action	Element acted upon	Element/constraint produced	Dimension in mm
00:20:53	CPR	Center Point Rectangle	-	-	-
00:20:55	CPD		-	-	-
00:20:58	CPD		-	-	-
00:20:59	A		-	UR 4	-
00:21:01	DIM	Dimension*2	-	-	-
00:21:02	CPD		Upper segment	-	-
00:21:03	DIMENSION		-	-	45
00:21:05	ENTER		-	-	-
00:21:05	A		-	Length	-
00:21:06	CPD		Left segment	-	-
00:21:08	DIMENSION		-	-	10
00:21:09	ENTER		-	-	-
00:21:09	A		-	Width	-



The trial-and-error strategy

Rectangle	Function used	Change made	Problem encountered	Condition	Accuracy
1/2 LR & 1/2 RR -> UR 1		-	Manipulation	Deleted	0/4
UR 2		Geometry	Manipulation	Deleted	2/4
UR 3 & UR 4		Function	Manipulation	Deleted	0/4
UR 5		Manipulation	-	Kept	4/4

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Research question

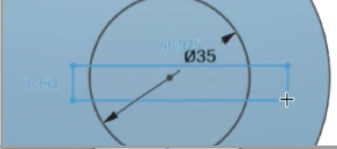

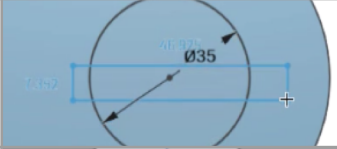

Methodology

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The return strategy

Rectangle	Function used	Change made	Problem encountered	Condition	Accuracy
UR 1		-	Manipulation	Deleted	0/4
LR & RR 1		<ul style="list-style-type: none"> • Geometry • Function 	-	Kept	3/4
UR 2 -> LR & RR 2		-	Geometry	Kept	3/4
LR 3		-	-	Kept	3/4



Conclusion and perspectives

- Development of a semi-automated encoding of students' modelling videos to characterise their strategies and performance, that saves times and limits the number of encoding mistakes.
- Need to complete this methodology with sequence analysis, by encoding more videos but limiting our study to the modelling of the key groove.