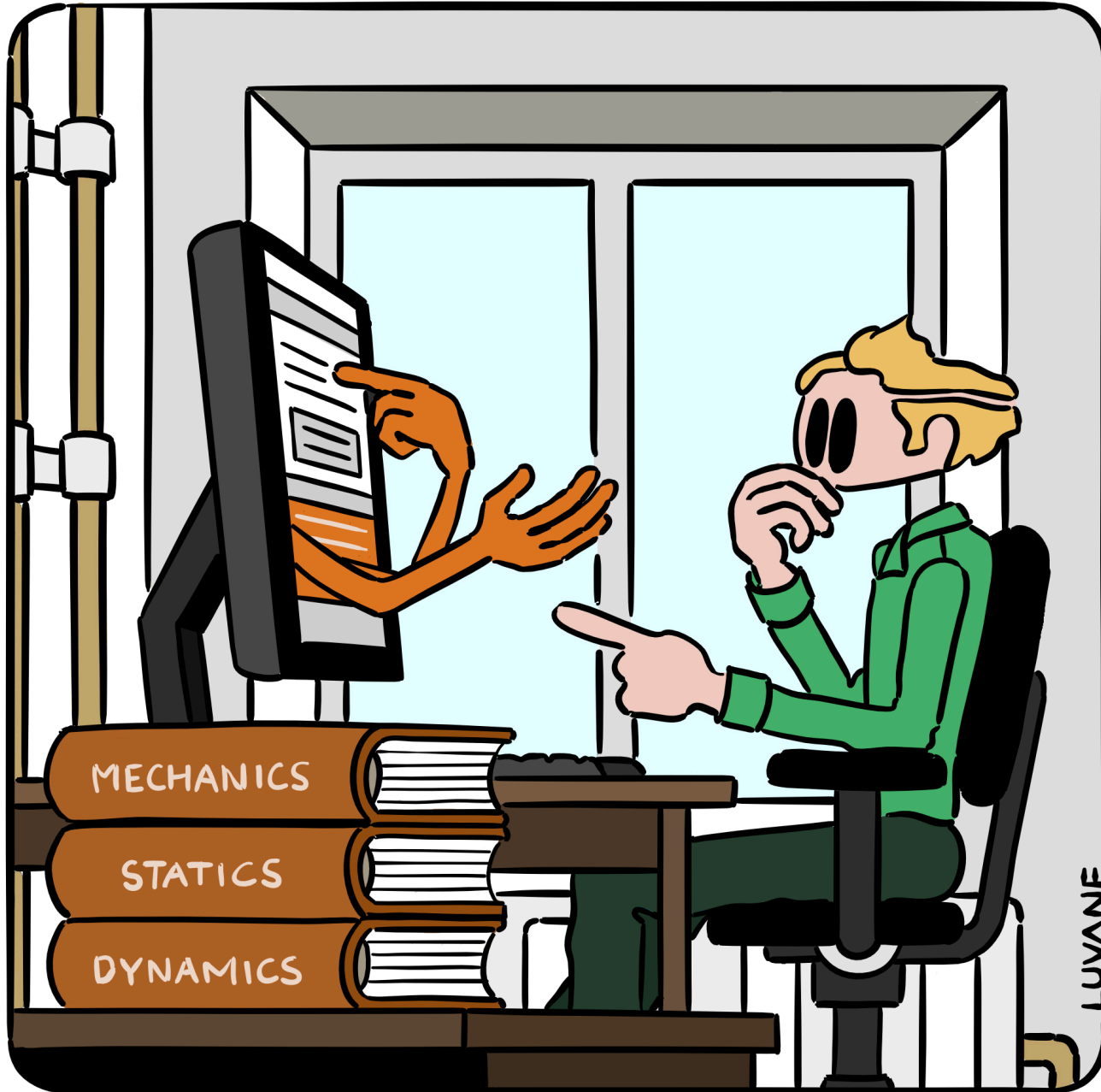


# INTERACTIVE TOOLS FOR ENGINEERING EDUCATION

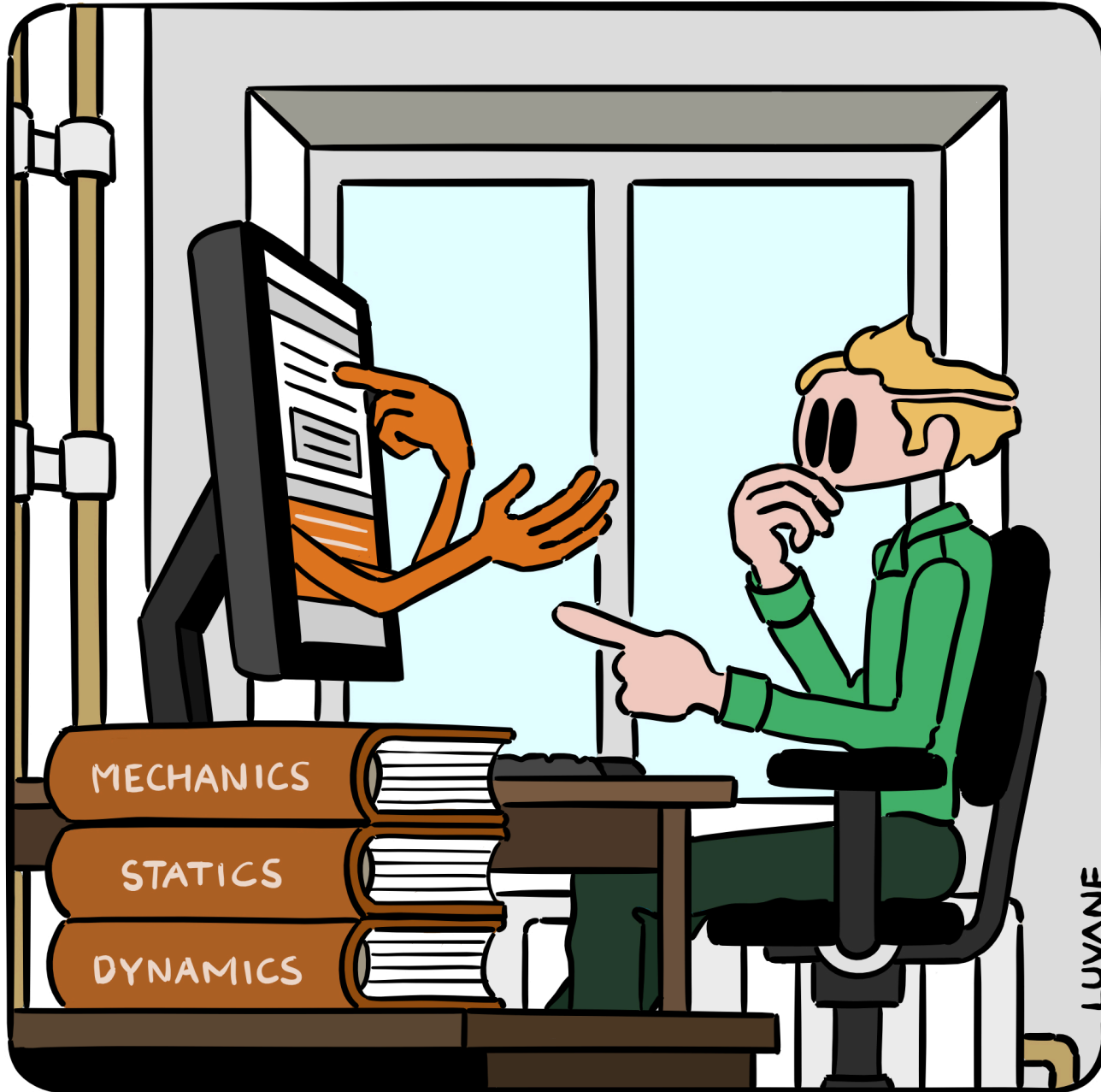
Pieter Roos, TELT-talk, 16 January 2025



# INTERACTIVE TOOLS FOR ENGINEERING EDUCATION

GRASPLE WORKS FOR MATH,  
BUT WHAT ABOUT ENGINEERING?

Pieter Roos, TELT-talk, 16 January 2025



HOW FAR SHOULD WE GO  
TO HELP OUR STUDENTS?

INTERACTIVE TOOLS FOR  
ENGINEERING EDUCATION

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Pieter Roos, TELT-talk, 16 January 2025





**MATH VS  
ENGINEERING**



**WHAT IS  
GRASPLE?**



**PILOT STUDY:  
FLUID MECHANICS**



**DISCUSSION:  
YOUR OPINION?**





# MATH VS ENGINEERING





# MATH VS ENGINEERING

**MATHEMATICS  
COURSES**

**ENGINEERING  
COURSES**





# MATH VS ENGINEERING

## MATHEMATICS COURSES

## ENGINEERING COURSES

NO PHYSICAL UNITS

FOCUS ON PROOFS

THEOREMS

THEORETICAL

LOGICAL REASONING

ANSWER IS AN EXPRESSION

DERIVATIONS

FORMULAS

PRACTICE IS CRUCIAL!

SYSTEMATIC PROBLEM SOLVING (MULTISTEP)

CHECKING ASSUMPTIONS

PRACTICAL

ANSWER IS A VALUE

PHYSICAL UNITS

SIGNIFICANT DIGITS

APPLYING LAWS

MAIN SYMBOLS

PHYSICAL REASONING







# WHAT IS GRASPLE?

## GRASPLE

- Interactive online practice platform
- For mathematics and statistics
- UT is client
- Formative and summative testing
- Sharing exercises among teachers
- Strong point: symbolic algebra

Grasple

OPEN RESOURCES • LEARNING PLATFORM • COMMUNITY • ABOUT US • CREATE TEACHER ACCOUNT • LOGIN

### Open interactive math & statistic exercises

Grasple is an online platform that enables teachers in Higher Education to find and create openly licensed exercises and easily share them with colleagues and students.

[Learn More](#) [Book Live Demo](#)

Trusted by 40+ institutions worldwide

IT UNIVERSITY OF COPENHAGEN • Hogeschool van Amsterdam • UNIVERSITY OF TWENTE • UACM • NHTV

*"For me, this is the killer feature: Grasple offers an uniquely well-thought infrastructure to content development, curation, and distribution. Content is the hard part of teaching, and only Grasple"*

[Book Live Demo](#)





## WHAT IS GRASPLE?

**Example:** The four expressions

$$V = \sqrt{2g(z_2 - z_1)}$$

$$V = \sqrt{2gz_2 - 2gz_1}$$

$$V = \sqrt{2(gz_2 - gz_1)}$$

$$V = (2g(z_2 - z_1))^{1/2}$$

are all **mathematically equivalent**, but they differ in syntax.

Grasple's **Computer Algebra System** automatically detects this equivalence, which aids the digital assessment of student's answers.

## GRASPLE

- Interactive online practice platform
- For mathematics and statistics
- UT is client
- Formative and summative testing
- Sharing exercises among teachers
- Strong point: **symbolic algebra**
- Another strong point: **conditional logic**
- Question: "Grasple works for **math**, but what about **engineering**?"





# WHAT IS GRASPLE?

## MATHEMATICS COURSES

## ENGINEERING COURSES

NO PHYSICAL UNITS

APPLYING LAWS

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FORMULAS

FOCUS ON PRO

# PRACTICE IS CRUCIAL!



ASSUMPTIONS

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PHYSICAL

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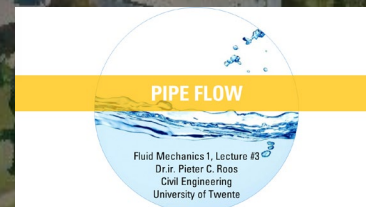
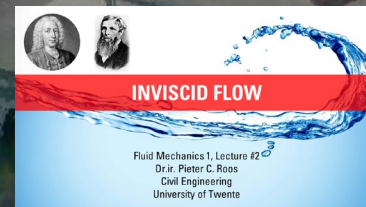
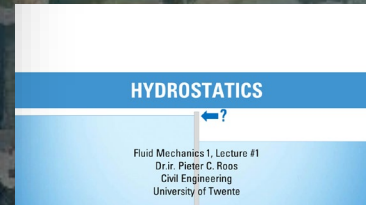
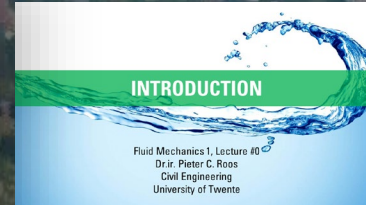
SIGNIFICANT DIGITS





**Goal:**  
to explore how  
Grasple can support  
self-study in Fluid  
Mechanics 1

<< N.B.: not intended to replace tutorials! >>



## FLUID MECHANICS 1

1<sup>st</sup> year BSc Civil Engineering

Number of students: ~100

Study load: 2 EC

4x Lecture, 3x Tutorial

- General Principles
- Hydrostatics
- Inviscid Flow
- Pipe Flow

Assessment: written exam





# PILOT STUDY: FLUID MECHANICS

1

Literature  
review

2

Teaching FM1  
in 2022/23

3

Interviewing  
FM-teachers

4

Exploring  
Grasple

5

Panel meeting  
with students

6

Develop and  
test new tool

7

Teaching FM1  
in 2023/24

G

8

Evaluation of  
new tool





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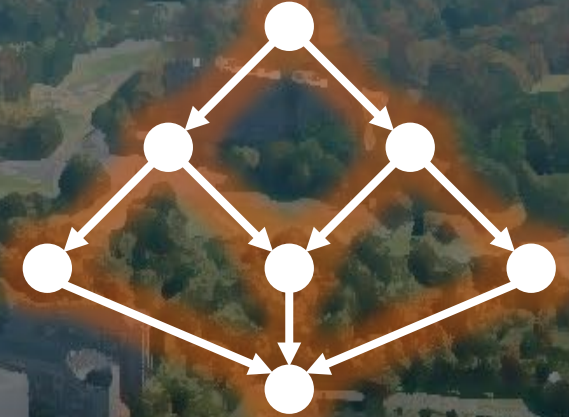




# PILOT STUDY: FLUID MECHANICS

## Main challenges:

- Resemble self-study setting that students would have without a computer
- Stimulate 'good behaviour'
- Systematic problem-solving
- Allow for multiple solution paths (conditional logic)
- Do not give away answers!
- Avoid visual confusion



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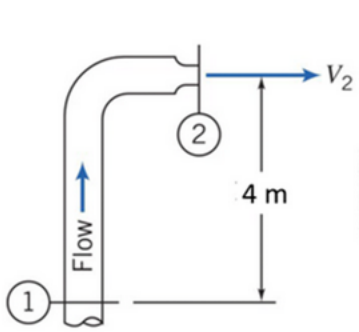


Flow through pipe with nozzle 3 / 6 [edit](#) [Report mistake](#)

You are done with this question. A follow-up question is shown below.

QUESTION #87353 | ATTEMPTS USED: 0 OUT OF 2

**Problem description:** Water flows steadily through the vertical 0.10 m diameter pipe and out the 0.050 m in diameter nozzle to the atmosphere. See figure below, showing a side view with gravity pointing downward. Determine the minimum gage pressure required at section 1 to produce a velocity at the nozzle exit (section 2) of 20 m/s.



elevation difference is known:  
 $z_2 - z_1 = h = 4 \text{ m}$

$$\frac{p_1}{\rho} + gz_1 + \frac{1}{2}V_1^2 = \frac{p_2}{\rho} + gz_2 + \frac{1}{2}V_2^2$$

I II III IV V VI  
 $\frac{p_1}{\rho} + gz_1 + \frac{1}{2}V_1^2 = \frac{p_2}{\rho} + gz_2 + \frac{1}{2}V_2^2$   
contains primary unknown not directly known, but can be found from continuity

Step 3.5: Let us now turn to Term IV in the *Bernoulli equation* above.

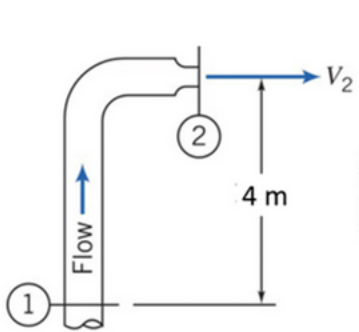
In one word, what can you say about the pressure  $p_2$  in term IV?

atmospheric

[Check my answer](#)

QUESTION #87354 | ATTEMPTS USED: 0 OUT OF 2

**Problem description:** Water flows steadily through the vertical 0.10 m diameter pipe and out the 0.050 m in diameter nozzle to the atmosphere. See figure below, showing a side view with gravity pointing downward. Determine the minimum gage pressure required at section 1 to produce a velocity at the nozzle exit (section 2) of 20 m/s.



elevation difference is known:  
 $z_2 - z_1 = h = 4 \text{ m}$

I $\frac{p_1}{\rho}$	+	II $gz_1$	+	III $\frac{1}{2}V_1^2$	=	IV $\frac{p_2}{\rho}$	+	V $gz_2$	+	VI $\frac{1}{2}V_2^2$
contains primary unknown		not directly known, but can be found from continuity		not directly known, but can be found from continuity		nozzle open to atmosphere, so $p_2 = p_{atm}$		nozzle open to atmosphere, so $p_2 = p_{atm}$		↑

Step 3.6: Finally, we analyse term VI in the *Bernoulli equation* above.

What can you say about the quantity  $V_2$  in term VI?

- Directly given in problem description
- Not directly known, but can be obtained from physical principle
- Fully unknown



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26 verzonden antwoorden

# What is your opinion on the learning effect of Grasple in Fluid Mechanics 1?

strongly disagree disagree neutral agree strongly agree

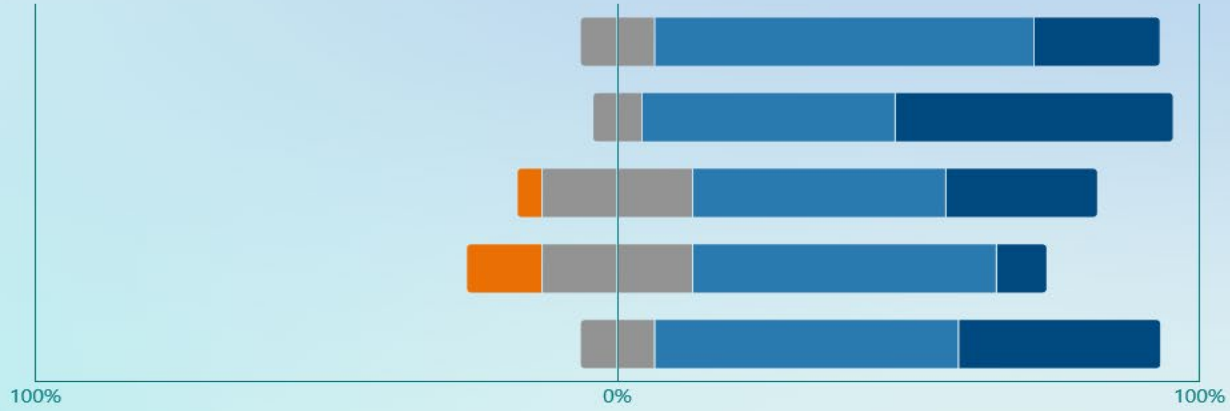
It supported my general understanding of the theory.

It helped me understand the steps to solve a Fluid Mechanics problem.

It sharpened my problem-solving skills.

It motivated me to spend time on self-study.

It helped me prepare for the exam.





# PILOT STUDY: FLUID MECHANICS

## Main conclusions:

- Promising tool
- Students satisfied
- Multistep solutions
- Multiple solution paths
- GraspLe needs further modification (physical units, significant digits, ...)
- Time-consuming
- (Un)desired side effects...?

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**DISCUSSION:  
YOUR OPINION?**

**Main conclusions:**

- Promising tool
- Students satisfied
- Multistep solutions
- Multiple solution paths
- Grasple needs further modification (physical units, significant digits, ...)
- Time-consuming
- (Un)desired side effects...?



**IF FM1 WERE  
CYCLING,  
THEN USING  
GRASPLE IS....**

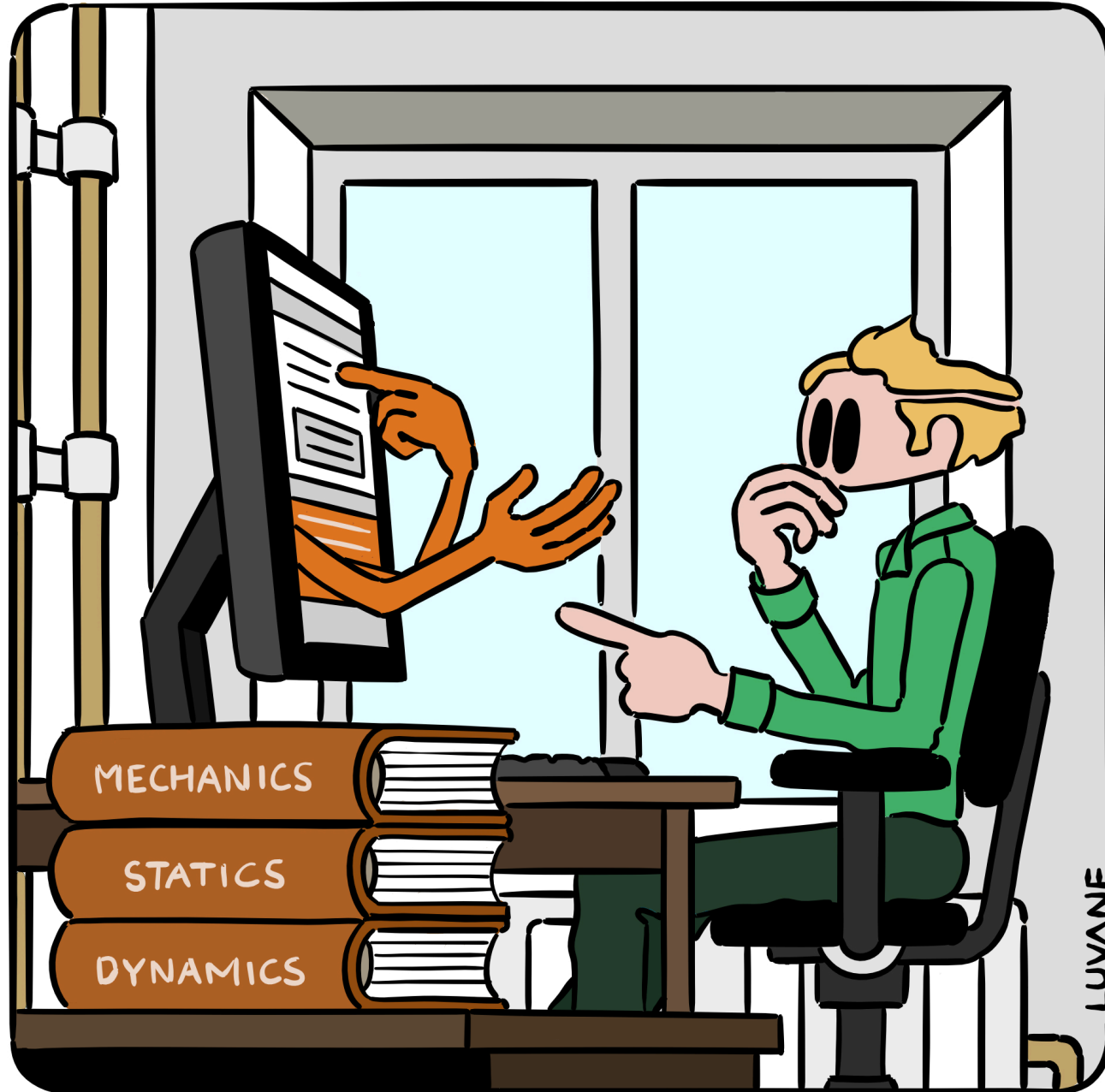




**IF FM1 WERE BOWLING, THEN USING GRASPLE IS...**



Thanks to Cas Jansen, Jolanda van de Kooij, Sofie Bastiaansen, Robin van Emmerloot, Cornelise Vreman-de Olde, Cindy Poortman, Kirsten Stadermann, UT's Fluid Mechanics teachers, FM1-students and TAs.



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