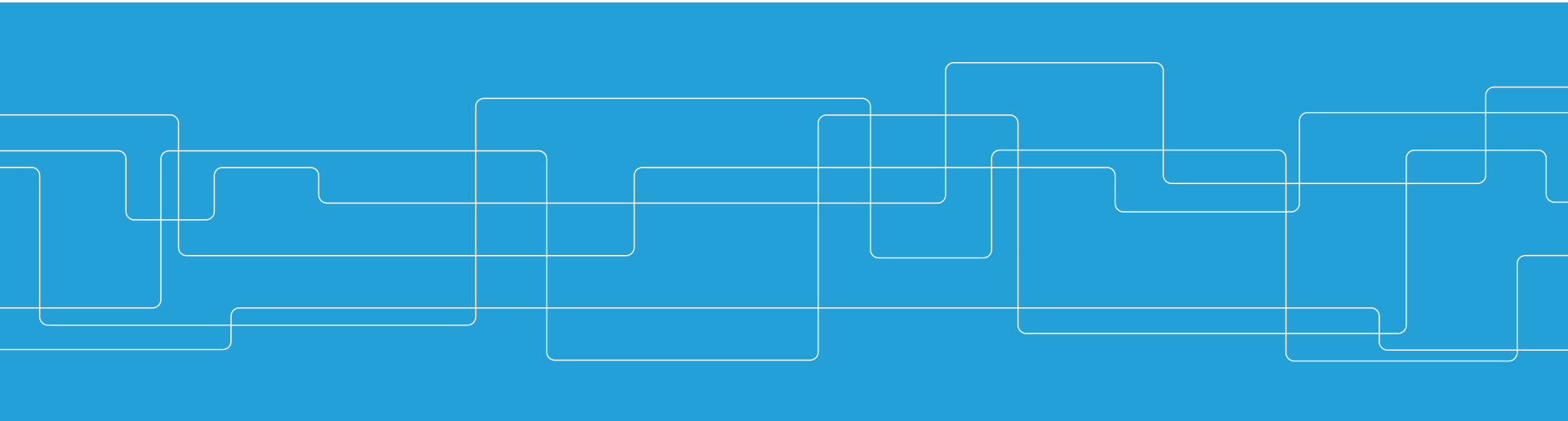
KTH ROYAL INSTITUTE
OF TECHNOLOGY

Research methodology

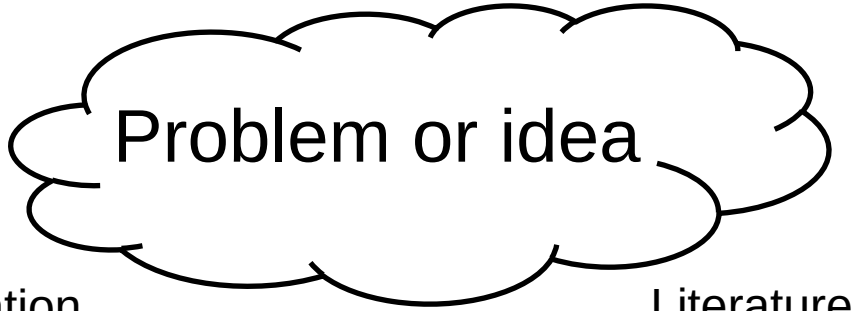
Ellen Bergseth, System and Component Design at Machine Design



About myself

- Researcher at KTH since 2013
- Research interests include prediction of friction and wear, mechanical interfacial modelling and design engineering methodology
- About 10 articles/reports published
- Teaching in several Batchelor level courses and one Master level course at Machine Design
- Assistant supervisor for 2 PhD students in progress
- Currently involved in a EU project named Quiet-track. The goal is to predict severe wear in the subway by using sound measurements, then use the results to create a maintenance tool
- Currently involved in one commissioned research project (swe: uppdragsforskning)

Research approach



Motivation

Do not reinvent the wheel

Literature Review

A state of the art survey, which will include initial hypotheses

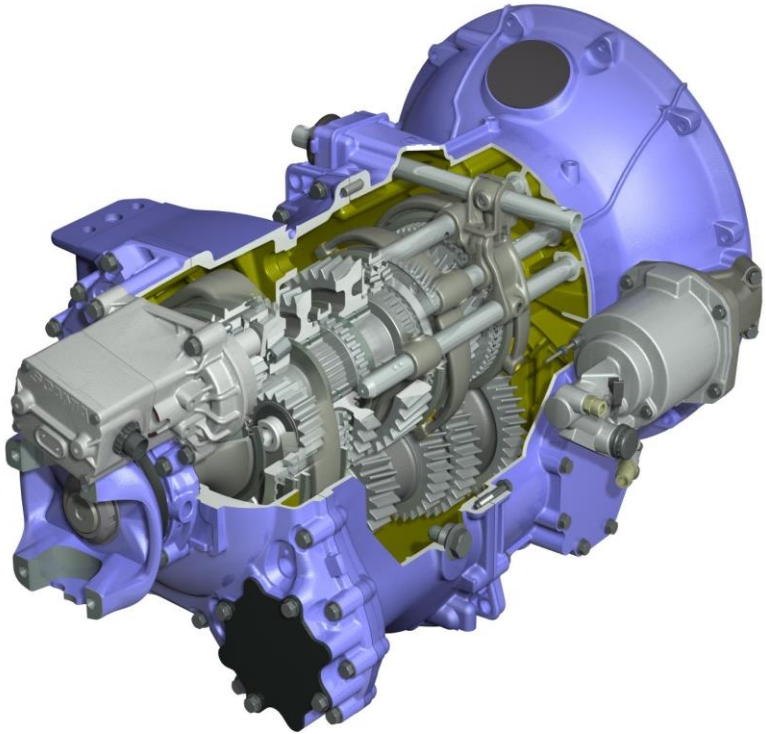
Imitate the real system
- By computer models and/or experiments

Verify the model, is the model right?

Validate the model, does the model answer our questions? Are we doing the right things?

Start to write a paper, it helps you develop your idea

Research approach – example 1



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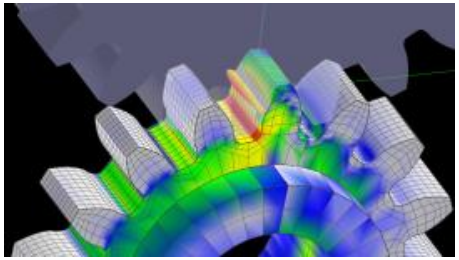

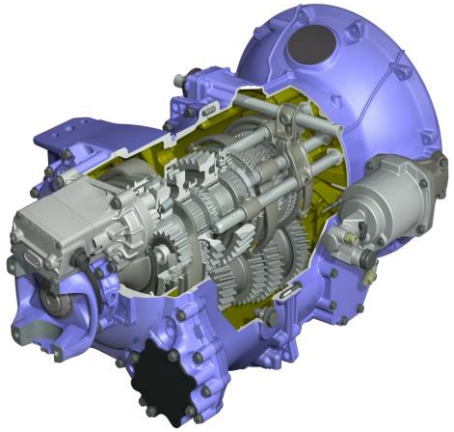

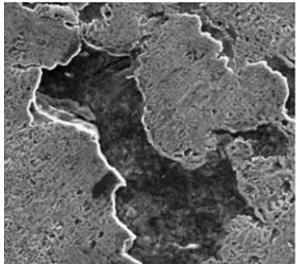

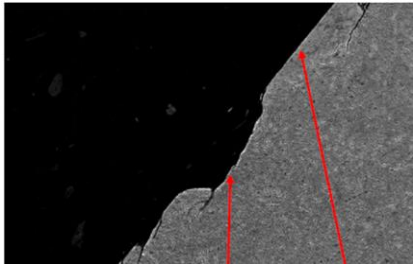

Research approach – example 2

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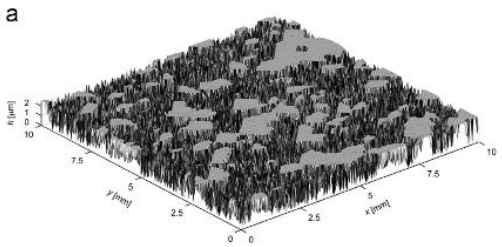
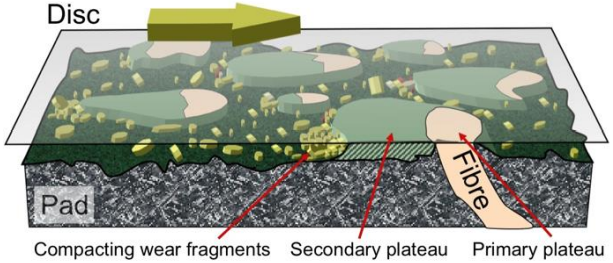
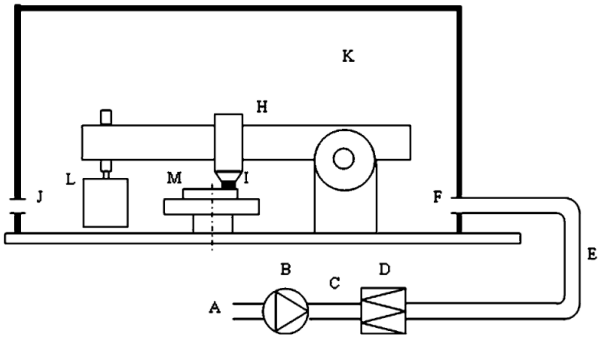
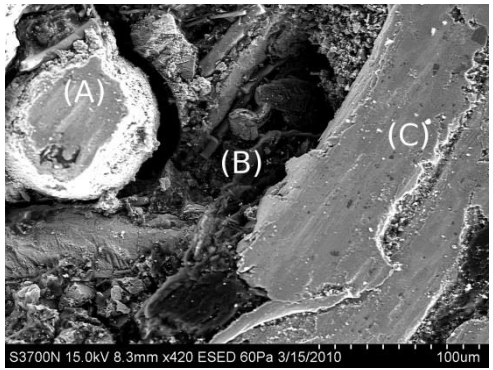
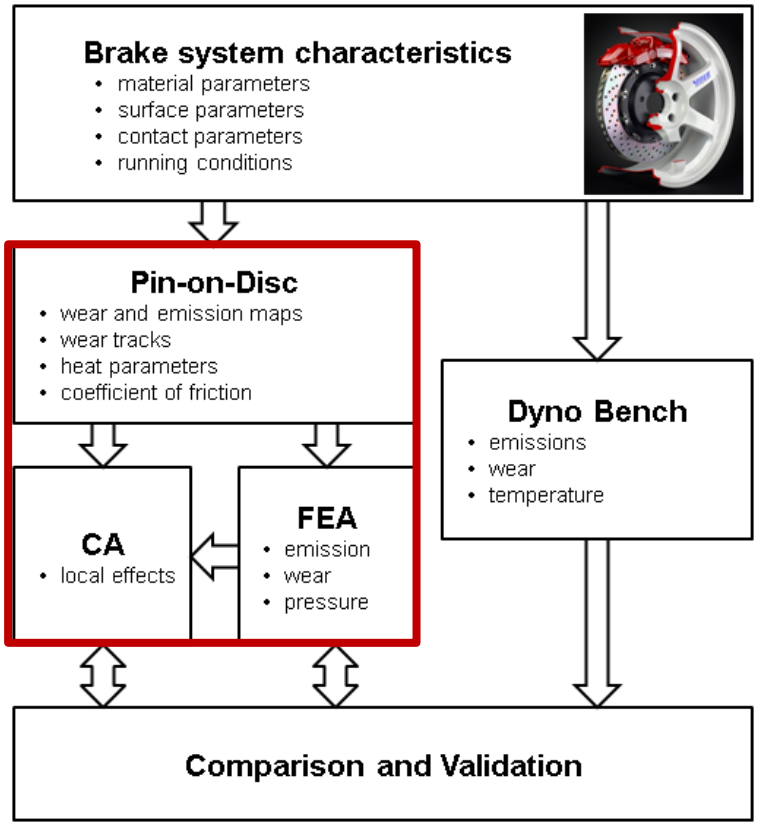








Modeling and Simulation



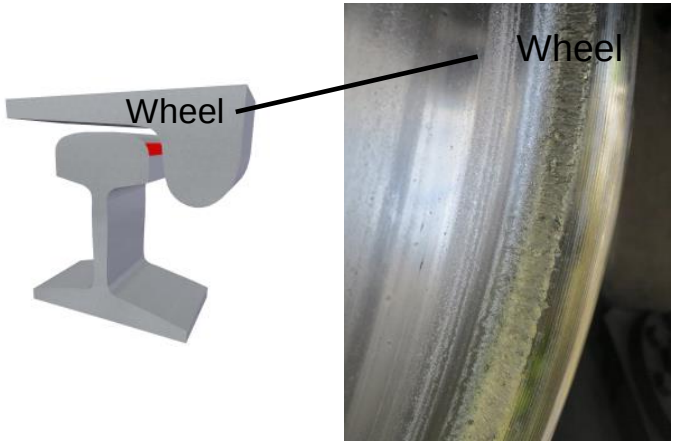
Ongoing project

Noise

Noise from the wheel-rail contact

- Positive
  - Traffic in operation
  - Work (need of maintenance)
- Negative
  - Annoying
  - Restrict urban planning
- Interesting
  - Problems to be solved
  - Contains information

Wear



Motiviation

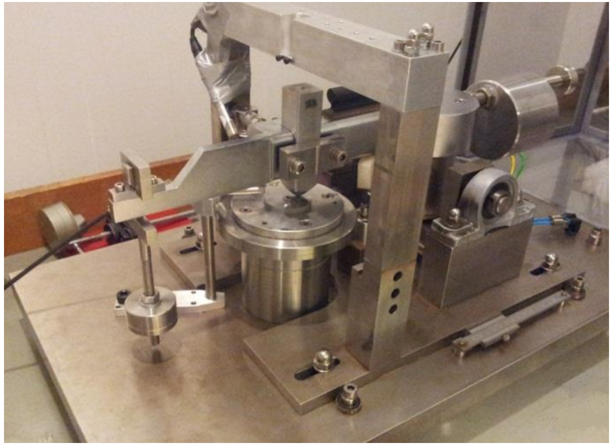
- The public - A lot of people are disturbed by high noise levels
- The law - The European Noise Directive (END) requires noise maps in the cities
- The economy

QUIET-TRACK

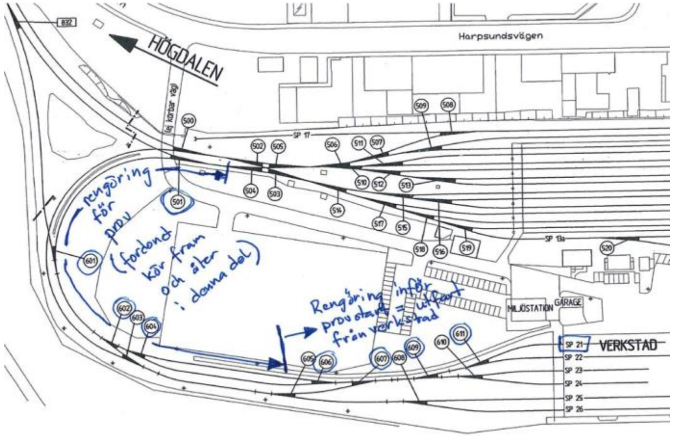
Concept

Laboratory study — Measurement in depot — Test in traffic

Laboratory study	Measurement in depot	Test in traffic
Test the hypothesis and create a first model	Verify the model	Validate the model

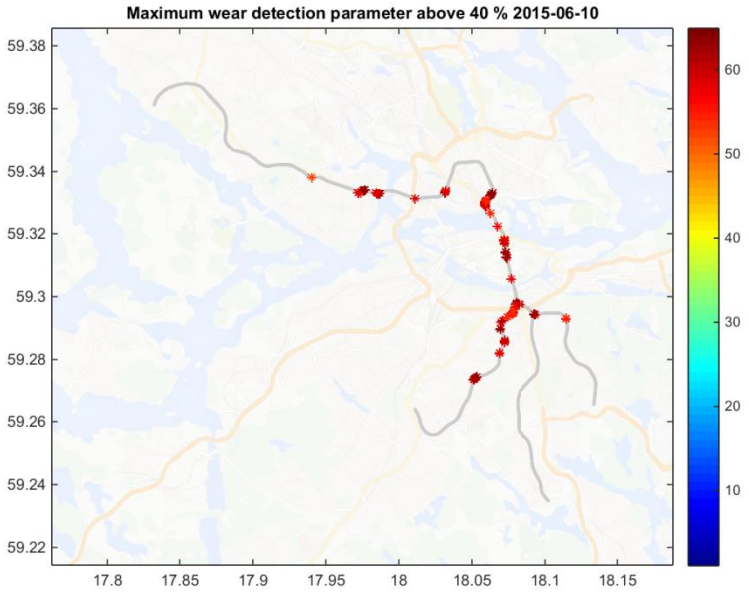


Hypothesis: The noise level increase just before severe wear in the wheel-rail gauge contact?

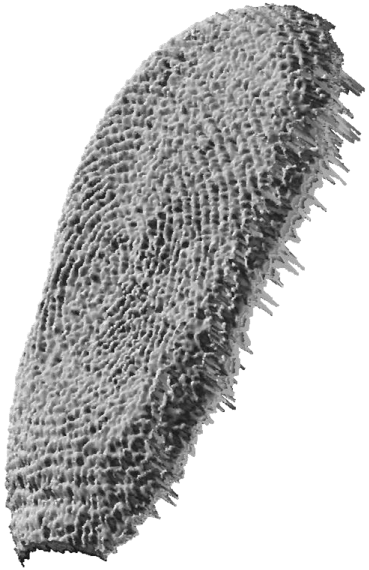


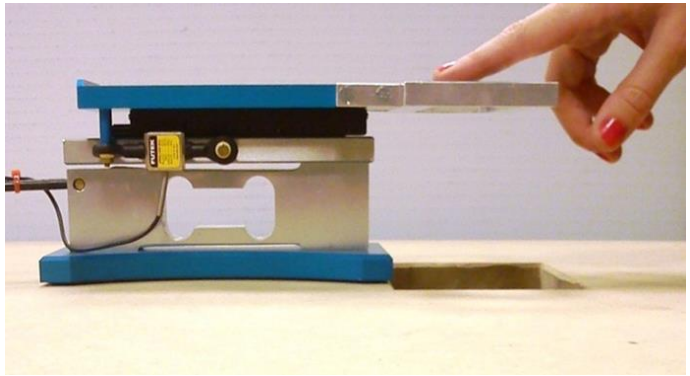
Stockholm Metro line 1

Results so far



Quantitative & qualitative





Lab Test Plan Quiet Track

Purpose of testing: What about the noise level just before seizure in the wheel-rail gauge contact?

Test equipment: Pin-on-disc machine/Sound measurements

Material: Rail steel 300-320 HV in both bodies in contact

How: A total of 15 "sharp" tests are going to be run, 15 discs with different roughness and 5 pins with equal roughness, 3 tests on each pin (I, II, III). Sound measurements according to Tyréns suggestions and their experience from the wear tests run in November 2013.

Run-in of test set-up: In order to run-in the test set-up (see *suggestion* in Table 1) a total of 5 old discs (already run discs at radius 16 and/or 17.5 mm) and 9 new pins are available. The best is if we can make use of two radii on the discs if anything goes wrong, but this is not a requirement.

Experience from previous tests run with smaller pin radius instead of pin/mushroom with 25 mm radius (i.e. the maximum contact pressure was significantly higher or contact area significantly smaller): Increased sliding speed decrease the time to seizure. The polished (mirror-like) surface resulted in seizure earlier than the rough transverse ground surface which was a bit of a surprise

Table 1. Preliminary test setup in the pin-on-disc machine.

Pin radius [mm]	Weight [kg]	Max contact pressure [MPa]	Sliding speed [m/s]	Track radius [mm]	Rounds per min [rpm]
25	Weight 5 kg?	750	0.2	19?	Depends on the track radius.

Preparation of the sharp tests

1) Before discs are sent to oxidation clean them, dry them and pack them carefully in anti-rust paper in plastic bags. Ask Mario or Patrick where to find it in the clean room.
2) The pins without any oxide layer should be cleaned (note that they have to rest at least for an hour before weighing).
3) Measure a small area on at least three pins (e.g. 5x5 mm2 with 10 or 20 microns in y-direction and standard 4000 in x-direction (as standard).
4) The discs with the oxide layer should not be cleaned after the oxidation process.
5) Weigh all discs and pins to be used for the sharp tests, make sure you make use of the latest re-ground pins from Uhros (then we are fully sure the roughness is identical).

Test procedure

After each 1-5, 6-10 and 11-15 set of tests according to Table 2:

1) Clean them and let them rest for at least one hour before weighing the discs and pins. Notice the mass loss.
2) Take photos of the pins and discs using 2.5x and 5x magnification.
3) Measure the wear scar in 3D on the pin using the Talysurf

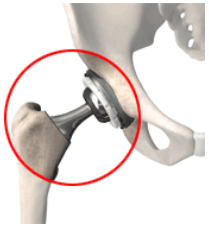
Structure your work

Table 2. Preliminary test schedule – 5 surfaces are considered and each test is repeated three times. Test 1-5, 6-10 and 11-15 should be done at one occasion preferable.

Test no	Disc	Pin	H [%]	T [°C]	Disc initial mass [g]	Pin initial mass [g]	Disc mass loss [mg]	Pin mass loss [mg]	Diameter of pin wear scar in two opposite directions respectively [mm]	Comment
1	Rough Transverse	Pin 1_I								
2	Medium Rough Transverse	Pin 2_I								
3	Rough Circumferential	Pin 3_I								
4	Medium Circumferential	Pin 4_I								
5	Polished	Pin 5_I								
6	Rough Transverse	Pin 1_II								
7	Medium Rough Transverse	Pin 2_II								
8	Rough Circumferential	Pin 3_II								
9	Medium Circumferential	Pin 4_II								
10	Polished	Pin 5_II								
11	Rough Transverse	Pin 1_III								
12	Medium Rough Transverse	Pin 2_III								
13	Rough Circumferential	Pin 3_III								
14	Medium Circumferential	Pin 4_III								
15	Polished	Pin 5_III								

Research questions

- How can I change from a commercial lubricant to a bio lubricant in hand-held tools, without a change in product life or performance?



- What is the shape and size of the wear particles from an artificial hip joint?

Are you our upcoming PhD Student?