



This is what I am interested in: Why does he fall a sleep in his breaks? Why is he so tired when he comes home after work and why does his body ache all the time?

Presenter Kjerstin Vogel



1972 Meat cutter

1984 Registered Physiotherapist

1986 RPT in Occupational Safety & Health Service, mostly industry

2004 MSc in Ergonomics

2009 PhD student in Technology and Health

Meat cutters' work situation - industry support, work environment, MSD and efficient production

This is me and what I've been doing in my life.

KTH – the Royal Institute of Technology



KTH is the largest and oldest technical university in Sweden, educating primarily engineers and has got an extensive research in technical and natural sciences

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I come from KTH, that has several schools, spread over the city of Stockholm. There are a total of almost 14,000 undergraduate students including bachelor and master students and more than 1,700 active postgraduate students. KTH has just over 4,600 employees.

KTH – School of Technology and Health



Unit of Ergonomics

- Ergonomics is a domain of interdisciplinary research and application which, with a holistic approach, handles the interactions between humans, technology and organization.
- The aim is to, through human capabilities and needs, understand and develop theories, principles and methods for designing work systems that are **healthy and efficient**
- Staff: 11 senior incl. 4 professors, 12 PhD students incl. industrial, and 7 associate researchers/lecturers

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Ergonomics or Human factors is a much misunderstood discipline. Most people know that it concerns man at work, but think it is limited to physical loads. But it is so much more:

It takes a holistic view and tries to understand how humans, technology and organization interact. With organizations we understand all organizations, from small groups, to industry and society.

Here we look at all sorts of ergonomics as for example lighting, climate, organization, information and of course physical ergonomics.

The aim of ergonomics is to by organizing healthy workplaces also gain efficient production.

In our department we are at current all in all about 30 people.

Ongoing projects at our unit, Ergonomics



- Lean and ergonomics: Lean in industry incl SME, hospitals, and farming
- Stress prevention
- Applied behavioural analysis in management
- Assessment tools for practical use at companies
- Analyzing and risk assessing work tasks
- A program on the future of occupational health services
- Education in knife sharpness and working technique
- **Meat cutters work situation, an interactive research program for industry support and development of measures**

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Apart from lecturing and teaching future engineers and masters in ergonomics, we do a lot of various research projects. Among them there are four on Lean, two on risk assessments and my two on meat cutters. Today I will speak of the one we just finished. Meat cutters and what we learned about their work.

“Fit work to people”

Improving work conditions in deboning

- an interactive research program**
- to fit work to people while taking profitability in account**



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We firmly believe that to be able to reach and speak with companies, we have to talk of possibilities, not work-related musculoskeletal disorders.

We also have to stand on two legs: good work environment and good profits.

Because good ergonomics is good economics.

The meat cutter project was formed in cooperation



Initiative The Swedish Meat Industry Association

The interactive research approach included employers, unions and researchers



A representative from the Swedish Work Environment Authority Authority was invited to participate in the steering group meetings

We, the researchers of KTH and Jönköping Technical University, did not do this work alone. It started by the Swedish Meat Industry Association taking contact, being concerned of their problems – and I'll come to that soon.

We were in a close cooperation, in a participative approach, with employers, companies and union. The Authority for Work Environment was informed and followed our work.

Meat industry problems in 2007, leading to the Meat Cutter project



- Low profitability
- Difficult import competition
- Recruitment problems
- Work related diseases and work injuries
- The requirements from the Swedish Work Environment Authority

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And the industry really had a lot of problems: Low profit, cheap import from Ireland, Brazil and New Zealand, few wanting to work in the industry because of the negative physical side of it and on top of that, requirements from the authority that they did not know how to handle.



The purpose of the project was to contribute to

1. Improved working conditions and health for meat cutters
2. Efficient production without disturbances

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So, we started with two issues:
Improve the working conditions for meat cutters, and
Considering production and profitability.

Some sub-projects



- A literature overview of international research and experiences
- A handbook of practical work environment improvements identified
- Assessment of the 6-hour change project
- Studies on knife sharpness and lifting aids
- A comparison between meat cutting on pace line and single tables
- Speed accuracy/trade off
- Information dissemination
- LIA – The food industry information system on work environment

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During the five year program, we did achieve a lot.

Some of the researchers made a literature overview. Myself I translated a report of Dr Tappin, that showed the similarities of Swedish and NZ meat cutting industries and a report that was well received in the business.

We introduced an information system, free of charge, to monitor and report disturbances and to share solutions.

Through the KTH website and that of the Swedish Meat Industry Association, we disseminated all our results, including one special thing, a handbook, where we published all of the good solutions to difficulties, small and large, that we met at our company visits. The idea was to share one solution and get several back. We collected about 40 useful tips. Here I'll show you some of them. About our studies, I'll go into that soon.

The handbook:



Bullerreduktion av medbringare hos conveyor

Nyckelord: Transport, conveyor, buller, medbringare



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Problem:

Då en conveyor är i drift uppstår impulsljud varje gång en medbringare av metall löper över en krok. Totalt sett ökar bullernivån i lokalen markant pga detta buller.

Lösning:

Medbringarna kan tillverkas i nylon istället för av metall. På detta sätt blir klickjuden väsentligt mjukare och tystare.

Tillämpningsområden:

Denna lösning är tillämpbar i conveyoranläggningar som har medbringare av metall.

Teknisk beskrivning:

För en teknisk beskrivning hänvisas till kontaktpersonen.

Utförda tester, och kommentarer:

Detta typ av lösning har utvecklats vid Atria i Malmö och har utprovats där med gott resultat. Lösningen har inte provats under en längre tidsperiod, så slitage på de nya medbringarna är fortfarande inte helt klarlagt.

This is just to show how the handbook is organized. The problem, the solution and its applicability and a technical description. Also who can provide more information.

The handbook:



A cradle
for
band
saws

Problem

Manual work with
band saws are very
risky.



This is an example when we found a solution for a very dangerous work, the use of a band saw. With this you don't have to put your hand near the saw blade and minimize the risk to cut off any fingers.

The
handbook:



Device for
unloading
pig hams

Problem

The task to lift and
unload hams is
heavy and repetitive



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In some pork plants, details are stored hanging on what is called a tree. Both loading and unloading is a murderously heavy job. The simple solution was to make a cradle, that easily can be put horizontally to be loaded and unloaded

The Swedish Work Environment Authority



- In 2006 a new supervision strategy was formed with joint inspections and requirements to the 10 largest meat cutting companies (which included over 90 % of all meat production)
- The focus was on meat cutters work environment and in particular musculoskeletal issues
- The Swedish Government verified the requirement standards in 2007

The Swedish Work Environment Authority were very worried about the high incidence of work related illness and accidents. They thus launched a new strategy, focussing on this and starting with the largest companies under the threat of large sums in fines if they did not follow the requirements.

The requirement standards



A maximum of six hours monotonous and repetitive work (additional two hours were defined by the industry as "knife-free time")

Conduct ergonomic risk assessments with support of external expertise

Offer the employees targeted health controls based on the occupational risks

Scheduled breaks for recovery

Job rotation

Technical improvements

Organizational improvements

For example horizontal and vertical job enlargement, and increased individual job control

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The requirement core point is what in the business was known as "Six hours". That the repetitiveness of meat cutting work had to come to an end. Other demands were to make risk assessments and offer health controls. Also other organizational improvements.

The strategy of the authority is to tell what they want for a result, but it is up to the company to choose their own solutions.

"6 hours" change project in one company



- The change project was conducted in a participative manner
- There were good possibilities for the individual employee to have his/her voice heard
- A disturbance was experienced in the flow of work

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The change project was a both top-down and down-up approach. The company had a steering group, coordination their work and there were several groups in department level, dealing with the daily routines and giving feedback to the management.

The main problem was to organize work, to provide knife-free work for the meat cutters

And the meat cutters who appreciated to have a more varied job also experienced a disturbance in their flow of work

Effects from the 6 hour change project (n=247)



- Maximum 6 hours work using a knife and job rotation with knife-free work
- Good local collaboration between unions and the company in the change process
- Most meat cutters preferred the new way of working
- Mental and physical tiredness decreased
- Higher qualification demands due to job rotation

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The largest impact on work was the maximization of work with knife in hand, this leading to the need for other tasks to rotate to.

One major factor to the success was the collaboration between union and company.

It is not surprising that most meat cutters appreciated to be able to vary their work as both mental and physical tiredness decreased. As some of them said: Now I am not as tired when I come home in the afternoon, I have the energy to be with my kids and family.

What is also important: profits remained.

The knife and its sharpness

A sharp knife decreases cutting forces with 20 %. The following factors influence this:



The knife blade material

Knife sharpening

Working technique of the meat cutter

(McGorry et al. 2003)

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Everybody in the industry talks of the importance of knife sharpness,
We know that there are several factors influencing this:

The knife and the material it is made of

How sharp it is

And of course the person who uses it.

That is why we conducted a study on knife sharpness.

Knife sharpness measurements



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We used the Anago sharpening tester, made here in New Zealand.

Methods



- 2 ordinary meat cutting knives and one from a steel used in machines
- 12 meat cutters
- 1 day respectively working with each knife
- Normal industrial work, cutting beef

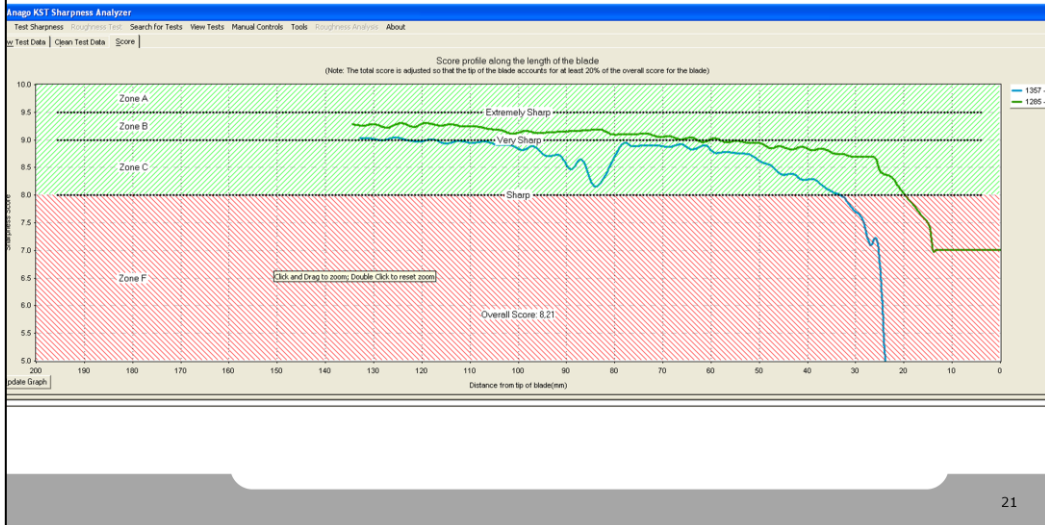
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The two ordinary knives are commonly used in the business, the third was specially made for this study, and the material was a powder steel with higher chromium content and hardened by nitride particles instead of carbide.

The setting was normal industrial work, and we made no interference with that.

They got a freshly sharpened knife, measured by us, in the morning. Worked with it until dull, only using a cross-steel. When dull, we measured and had some questions. They had a total of three knives per day, after that, they used their own knives.

Results from knife sharpness measurements



This is a protocol that really did interest the meat cutters, because it was personal.

The green line is a sharp knife, quite even along the edge

The blue line represents a less sharp edge with a dent on it as well.

The meat cutters compared scores.

Results



- The nitride hardened steel did not perform better
- The differences between the 2 other knives were small and not significant (2 %)
- The difference between the meat cutters was significant

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The nitride hardened steel blade is not yet suitable for meat cutting knives, although it performs very well in machinery.

It does not matter much what knife you use, most are of good quality. You choose length and stiffness and other parameters and all knives will be just as good.

The average of "service life" of a knife was 1 h and 47 min \pm 55 min

But!

The differences were large between the meat cutters

In time per knife was up to 269 %

Reduction in sharpness/minute was up to 400 %

Stress in meat cutting work



- Conditions: single table and pace line, 8 deboners of pork
- The participants worked one week by single tables, and one week by a machine paced line
- Measuring "Stress-energy-formula" and heart rate

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We also studied stress.

Eight meat cutters worked alternating between working at a single table choosing his own working pace at piece rate wage and

The next week at a machine paced line with salary set from the pace of the line



This is a paced work, you perform a fragment of the work and the next person continues.



And these are single tables where you cut either a whole carcass or the total of a detail

Results



- Single table: higher workload, measured with heart-rate
- Pace line: more stress and more discomfort in neck/shoulder/back
- Other factors than actual mechanic work load contributes to the deboners' perception of discomfort

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Results are interesting:

It is not the workload that stresses. It is not being able to control your work

Is meat cutting a sustainable job?

We know at a detailed level:



- EMG activity - high
- Movement velocity – extremely high

(Arvidsson et al. 2010, McGorry et al. 2003, Claudon 2006)

What about its physiological aspects from a wider perspective?

- Using pulse measurements from several of our studies

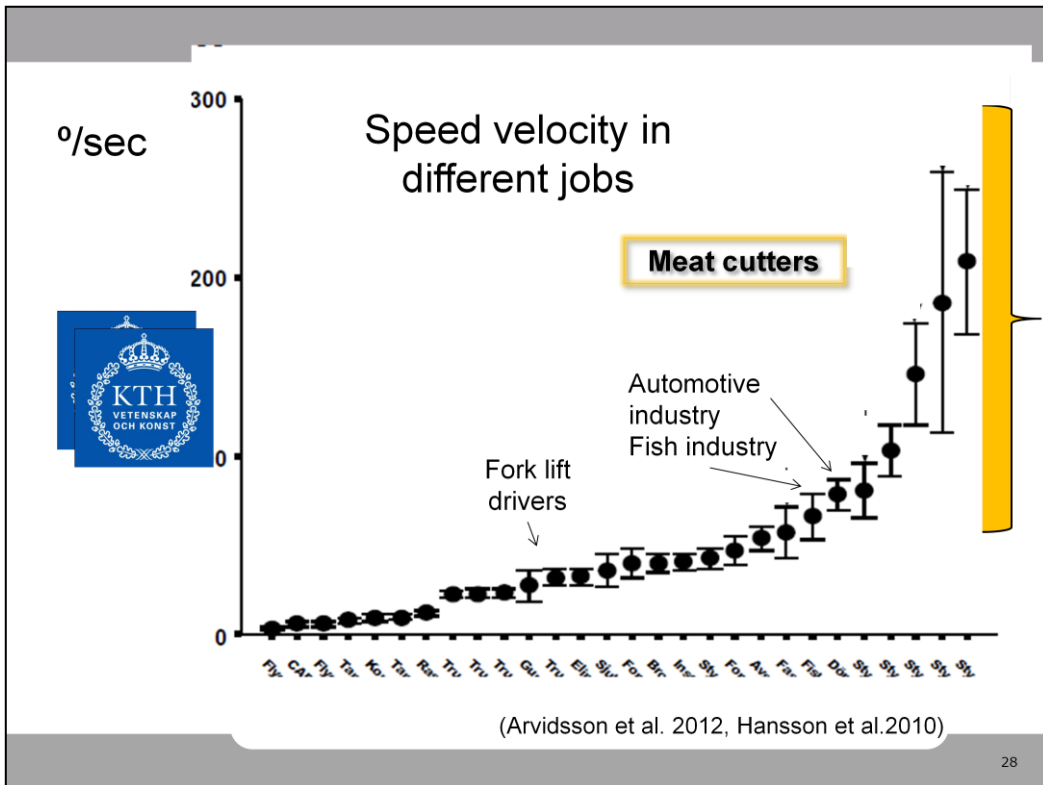
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Why is a meat cutter so tired then?

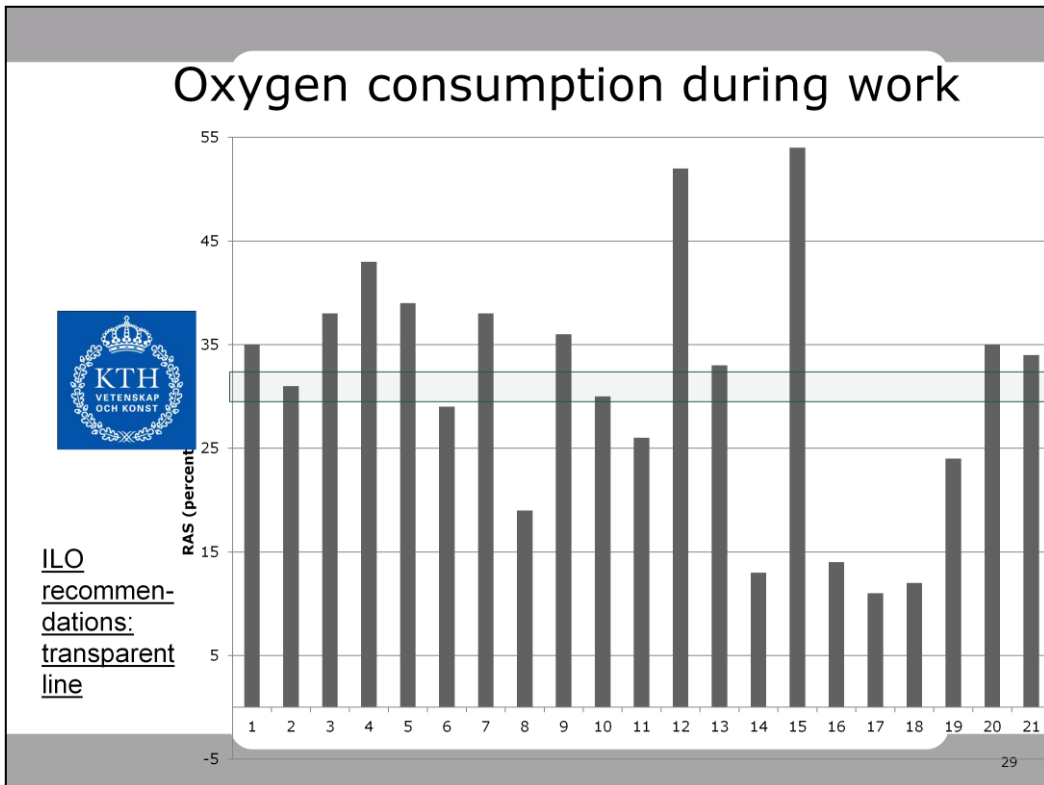
We know that the job is heavy, static, and repetitive in awkward positions and in a cold environment handling cold meat.

A lot of studies on a detailed level has provided results on detailed muscular level and on movement speed.

We wanted to know what the work means in a wider perspective, so we chosed to use pulse. We used percent of max oxygen consumption during work expressed as Relative Aerobic Strain - RAS



Speed velocity in different jobs, in degree/second. Meat cutters work is the fastest. Long behind and much slower are the fish industry, and fork lift drivers



The International Labour Organization (ILO) and the researchers they refer to, claims that Relative Aerobic Strain not should exceed 30-33 % for the individual, depending on what work is performed. That is represented by the transparent grey line.

We found that for 21 meat cutters, 13 were on or exceeding the ILO recommendations.

Beef cutting was heavier than pork.

Longer work experience is related to lower Relative Aerobic Strain.

Is this a healthy worker effect depending on

Good working technique?

Sharp knives?

We don't know.

Speed accuracy / trade off



- Flow of production considered most important
- Productivity versus quality
- Other studies verified relation between good ergonomics and good quality in production

(Eklund, 1997, Falck et al. 2010)

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The concept of speed accuracy / trade off interested us as it is well known in other industries, but not much discussed in the meat cutting industry.

We know of some French research in meat cutting and wanted to see if the same was applicable in Swedish industry.

So, in cooperation with one company we had the opportunity to make a study in real production.

Meat cutting - geese



A french study decreased work pace by 40%, employed more meat cutters and focused on better quality and yield for goose liver. Yield improved 5 grams per goose, which improved profitability of the company.

(Daniellou, 2008)

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In geese cutting where the liver is so valuable, it was possible to improve yield and profit by decreasing pace and focus on quality rather than quantity.

Meat cutting - ducks



- Work pace was decreased from 51 ducks per hour to 42 per hour
- Duck breast weight increased from 331 gr to 358 gr
- The ratio of highest quality duck breasts increased from 75% to 95%
- Income increased by 0.42 € per duck, and costs increased by 0.06 € per duck
- Musculoskeletal problems and tiredness decreased substantially

(Coutarel et al., 2008)

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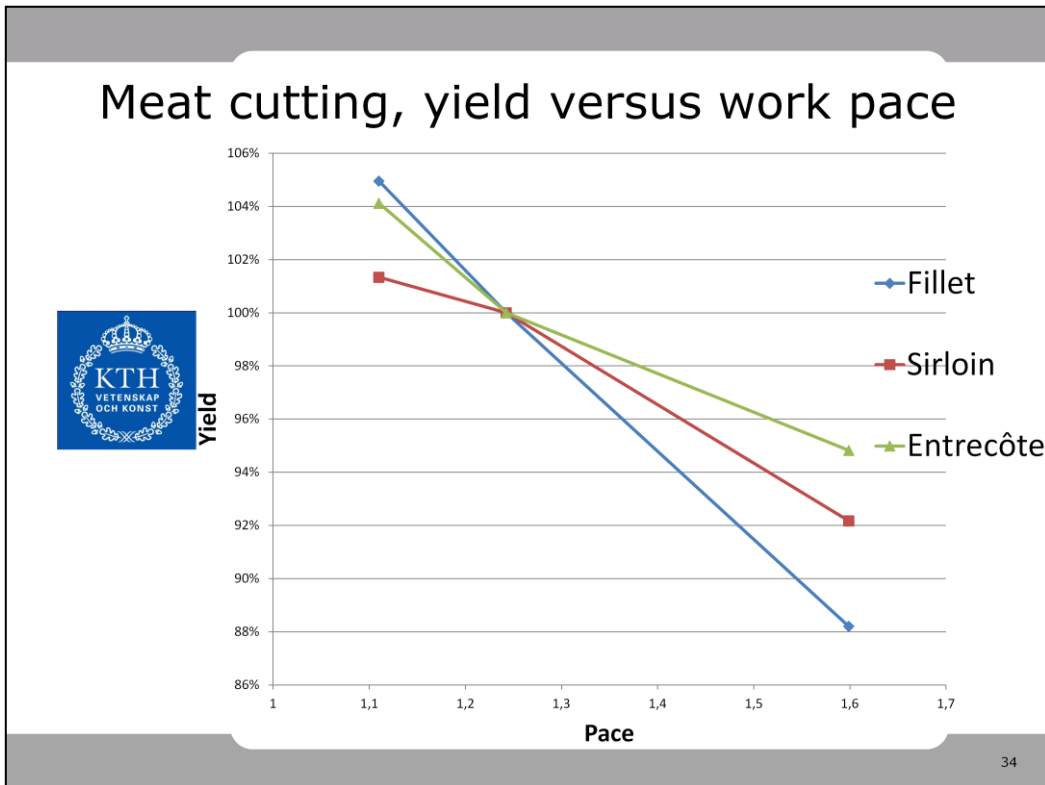
Another study on ducks showed the same result: decreasing pace was beneficial both for worker health and company profit.



This is our setting.

In our study in beef cutting we had 6 meat cutters working full time, we measured three valuable details, weight and quality for the whole day.

A total of approximately 40 carcasses per day. We got a total amount of 420 details per day.



Baseline = they cut **1.29 carcasses/meat cutter/hour** 100 %


Quantity focus **"Go home when you are finished"** = 1.63 carcasses/meat cutter/hour **126 %**

Quality focus **"Focus on quality"** = 1.12 carcasses/meat cutter/hour **87 %**

Quality was as expected:

Both at Baseline and on Quality focus 3 % of the details were non-standard
 But on Quantity focus **89 %** were found with errors

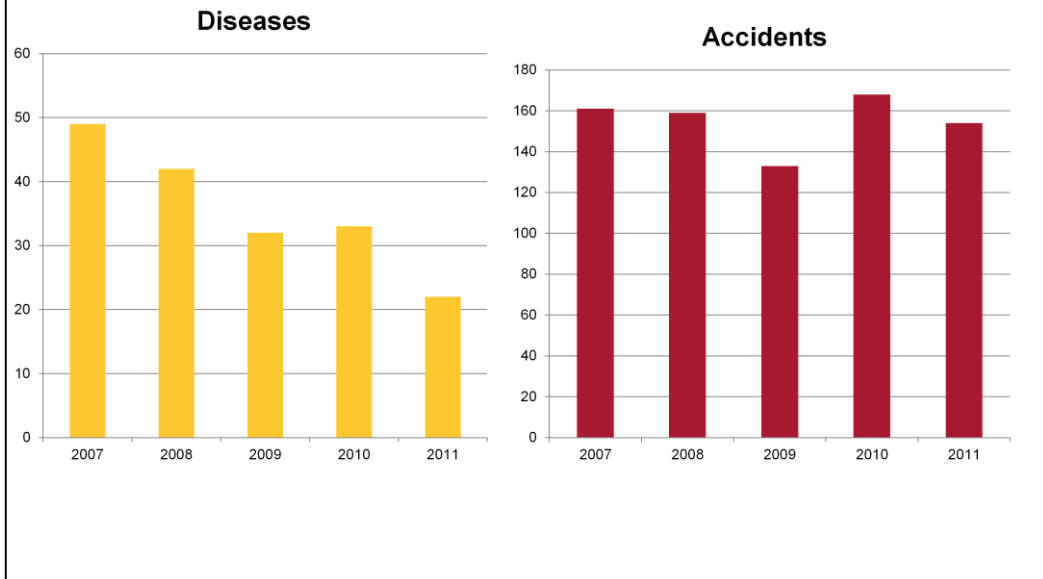
Economic results of higher pace, beef

Results	Difference to Baseline per detail Quantity focus [SEK]			
	Weight [g]	Revenue [SEK]	Labor Cost [SEK]	Total Cost [NZD]
 Fillet	-188.8	-34.33	2.25	-5.54 NZD [-32.08]
Sirloin	-544.8	-46.10	4.18	-7.25 NZD [-41.92]
Entre- côte	-194.7	-18.68	2.36	-2.82 NZD [-16.31]

Six meat cutters, one working day, resulting in 140 pieces of each detail
 Fillet weight mean 2.1 kg, Sirloin mean 4 kg, Entrecôte 3.5 kg

As you can see: work at quantity pace means losing money on each detail, compared to Baseline.

Work related diseases and accidents 2006-2011



The changes from "Six hours" now applied in the whole business, so far has proved also fine figures when it comes to work related diseases and accidents, especially on diseases which mostly is musculoskeletal and knife related. Preliminary figures shows higher figures for work related diseases in 2012.

Good ergonomics and good economics in meat cutting



- The knife – is it sharp enough?
- Does the meat cutter know how to keep it sharp?
- The work – does it give the opportunity to variation?
- The organization – does it provide participation?
- The pace – does it focus on quality?

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So, if we conclude our findings I would like to say:

The meat cutter needs a sharp knife, all day long and he needs to know how to keep it sharp.

His work has to be varied in tasks and muscular load.

He also needs to be seen as person and to be allowed to participate in decisions concerning his work.

And finally, to be truly profitable, focus should be on quality.



