
PIC®
SEMINARIO
EJECUTIVO
LATINOAMÉRICA
MIAMI 2019
1st- 4th OCTOBER

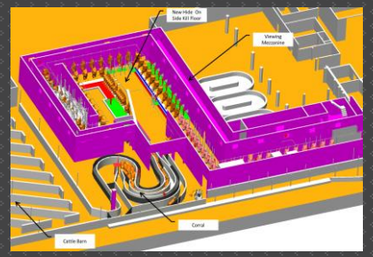
# AUTOMATION. Creating value for the meat processing

PIC SEMINARIO EJECUTIVO LATINOAMÉRICA MIAMI 2019
1st- 4th OCTOBER


## Koorosh Khodabandehloo (KK)

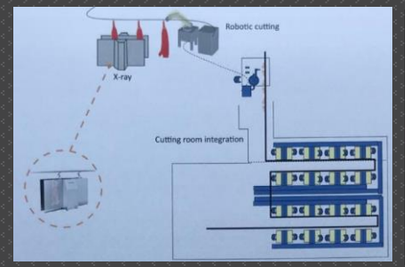
## BMC UK

Adjunct Professor University of Southern Queensland Australia

Beef

Lamb




Pork

EOL

Established 1997


bmcdevon@aol.com

# Koorosh Khodabandehloo

1979-82 Electrical Engineering Kings College, University of London
1982-85 Mechanical Engineering Imperial College, University of London
1985 Appointed at Univ. of Bristol

**University of Bristol**

- 85-91 Lecturer
- 91-93 Reader – Director of AMARC
- 93-97 Prof. of Manufacturing Eng.
  Dean of Engineering Research
  Chairman AMIE Ltd

1997-to date

- First development
- Business and operations
- Management of Change
- Advice on new automation
- Project management

## *Interests*

**Robotics and automation in the processing of non-rigid products**

**Sheet Material**

***Fabrics composite materials***

**Bulk Material**

***Meat, fish and poultry, dough products***

**Processes**

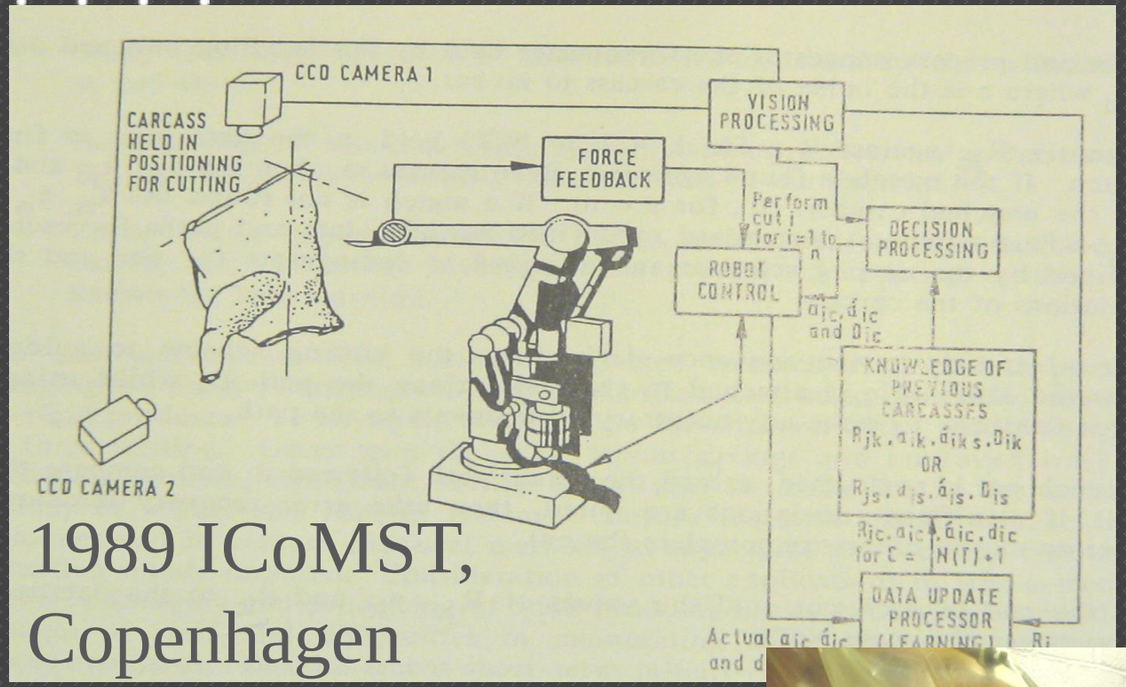
***Cutting***

***Handling***

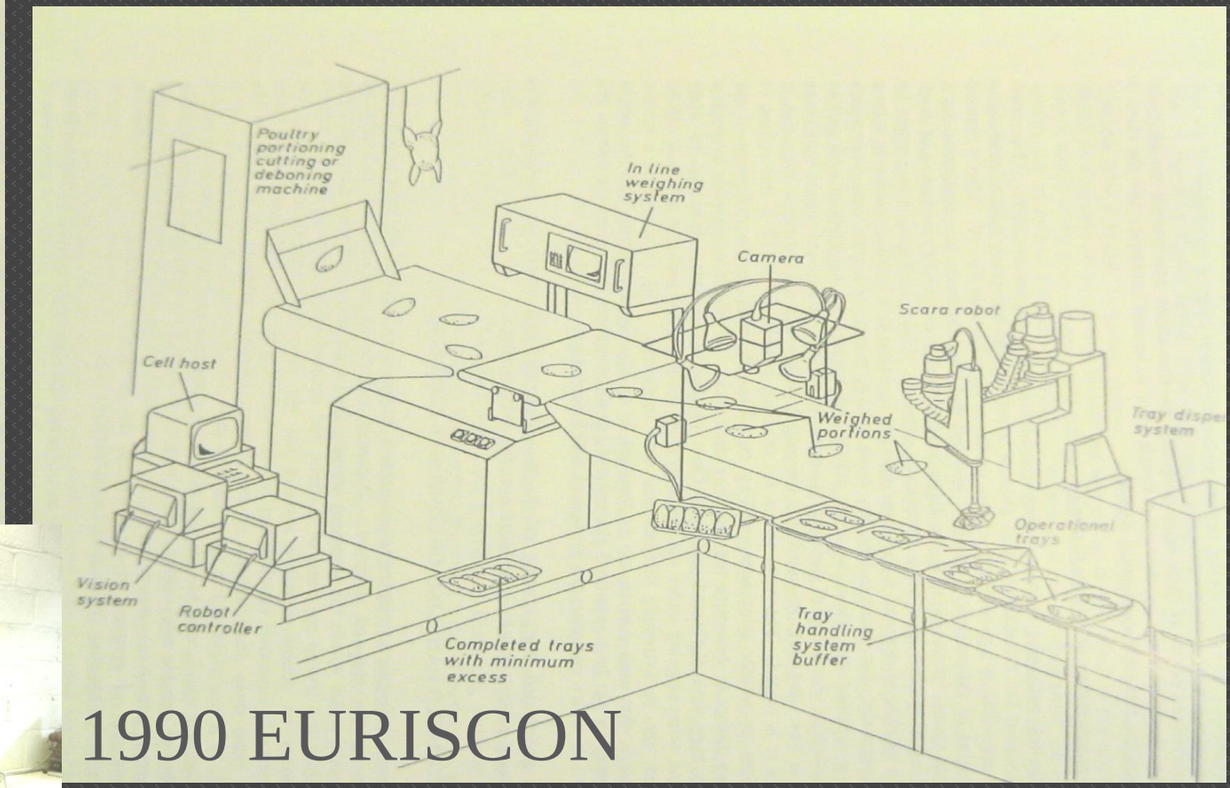
***Sensing including computer vision***

***Quality and total traceability***

# 30 years of meat robotics



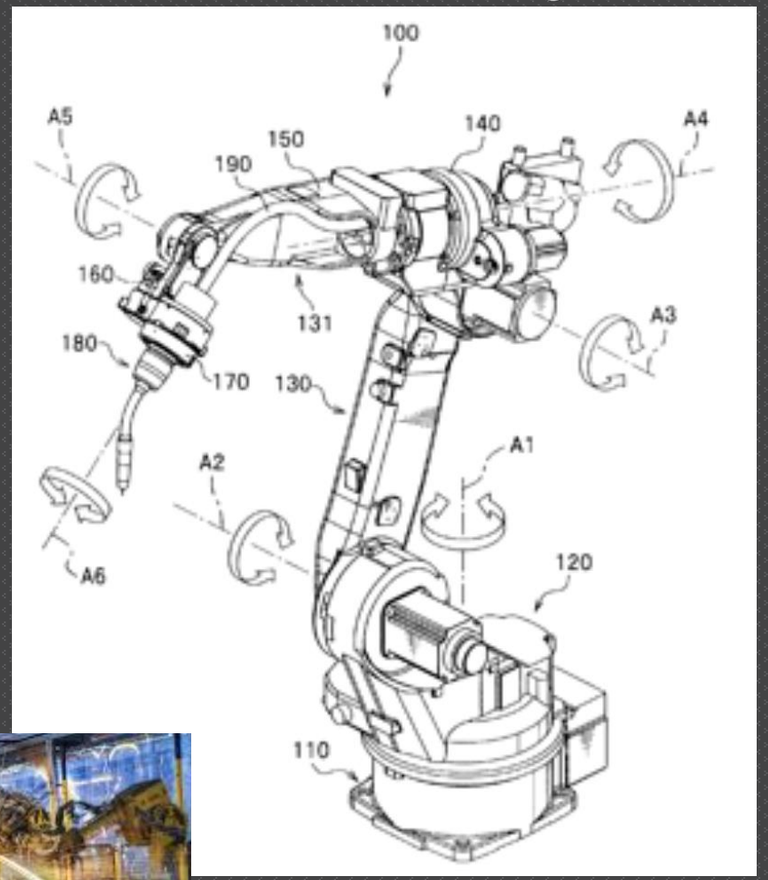

1989 ICoMST, Copenhagen



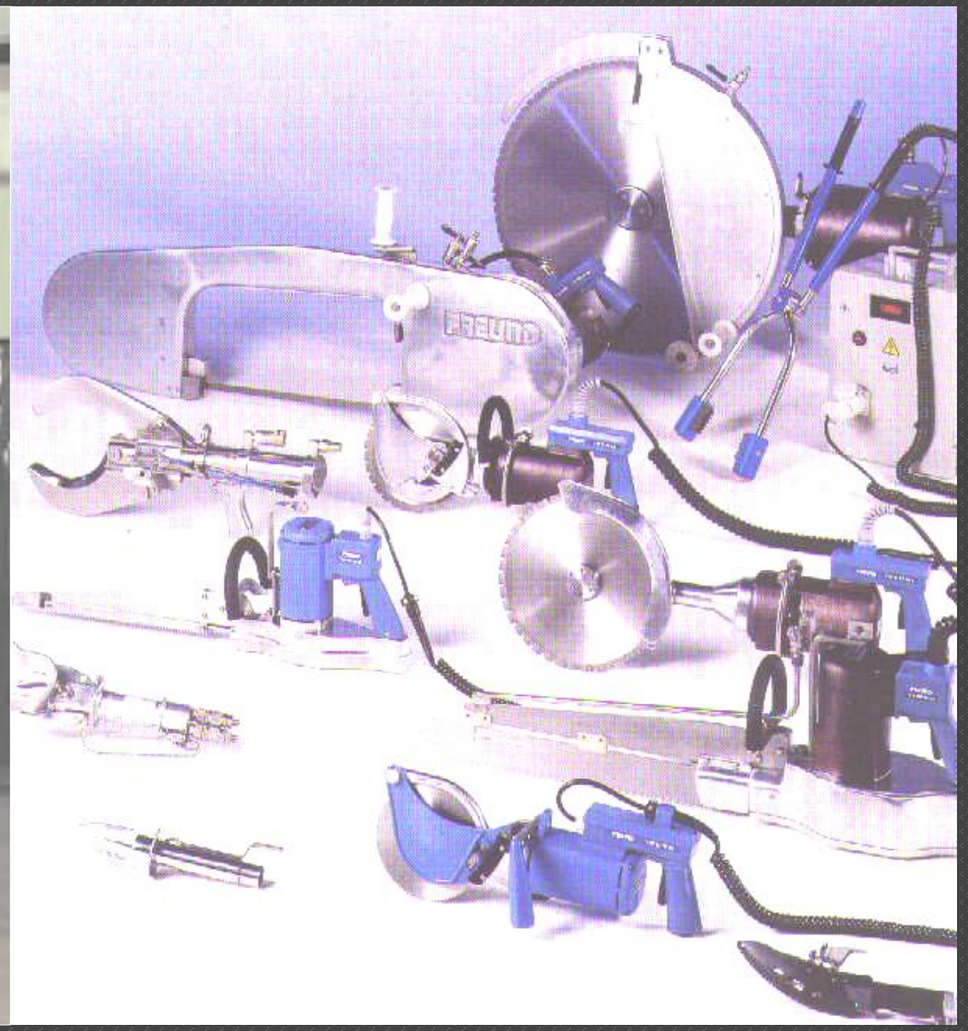

1990 EURISCON

# Robotics for Meat Production

The basics have not changed




# Robotics for Meat Production



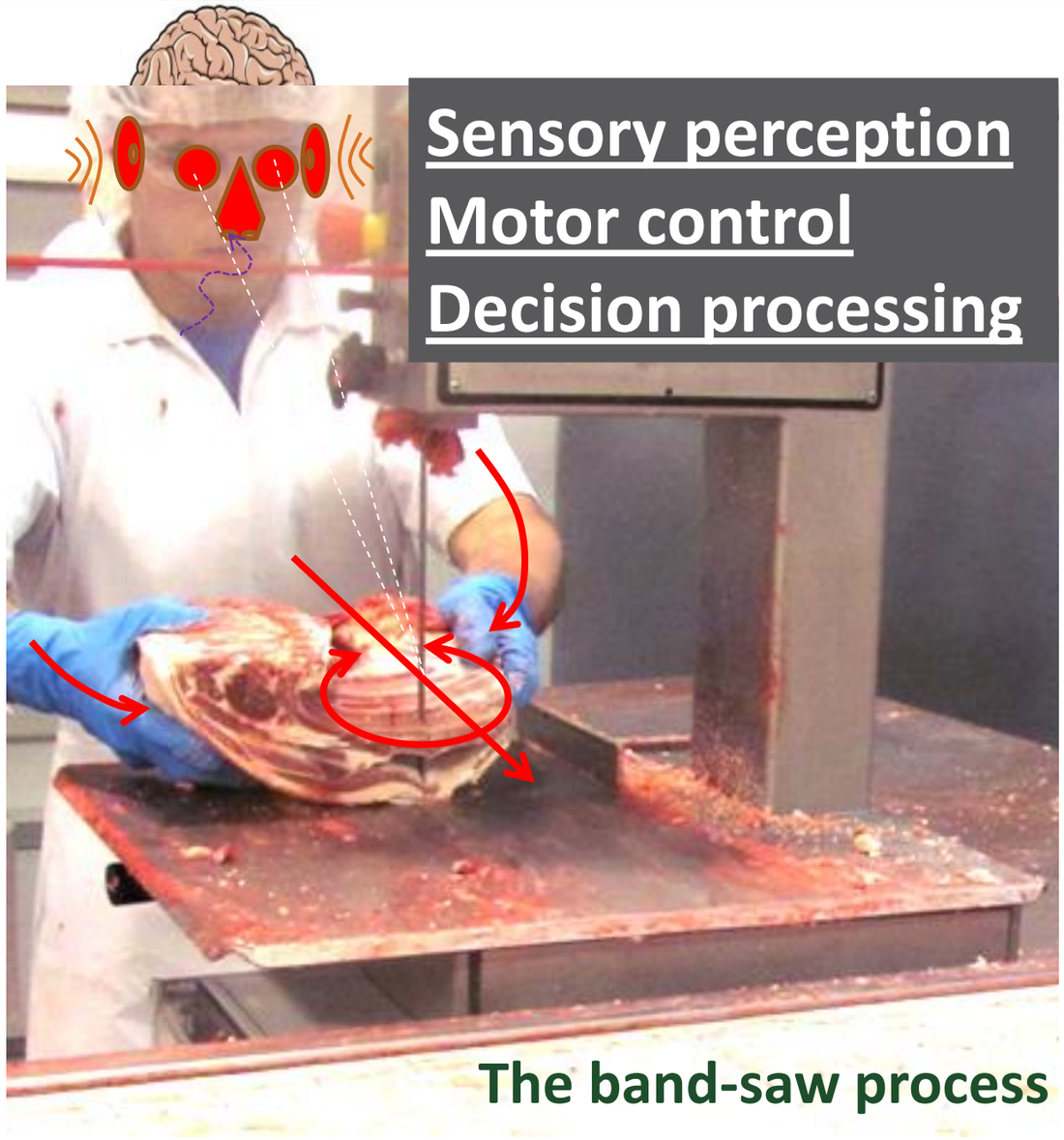
BMC

**Sensing capability:**

- *Vision*
- *Hearing*
- *Smell*
- *Force and torque*

**Motion and manipulation control:**

- attitude
- grip
- alignment
- feed rate
- applied force/torque
- path tracking




**The band-saw process**

Key motivating factors:

- Safety
- Quality and consistency
- Yield
- Operations cost
- Shortages of labour
- Training costs
- Other
  - Loss of productivity and efficiency
  - Operations Control
  - Electronic tracking
  - Agency and overheads costs
  - etc.

# Robot system developments and commercialisation

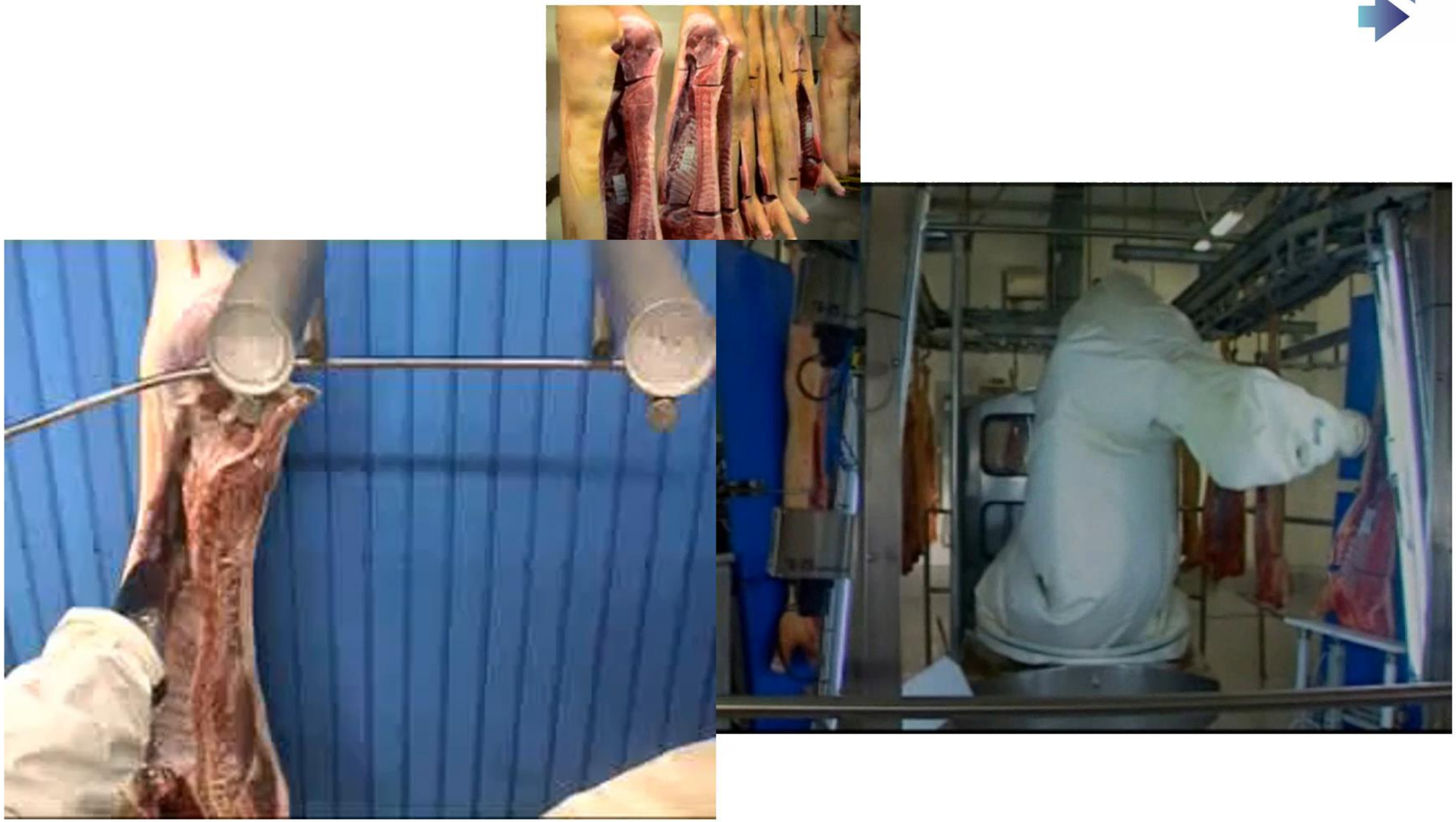
| | |
|---|---|
| 1986-1989 | De-boning of beef (awaiting use in specific applications) |
| 1987-1989 | Packaging Poultry (specific solution available now) |
| 1987-2000 | Robotic handling of pre-preg (part commercialised) |
| **1988-2002** | **Primal cutting of Pork (Commercialised)** |
| 1989-2001 | Fish processing (specific elements commercialised) |
| 1989-1993 | Slaughter line robots (now fully commercialised) |
| **1991-1993** | **Fixation of large non uniform products (commercialise)** |
| 1991-1994 | Non-rigid Material Modelling (Basic Research) |
| 1992-1996 | Handling, bagging and Packaging (elements commercialised) |
| 1998-2001 | Demonstration project for carcass breakup (commercialised) |
| 1999-2002 | Concerted Action (Meat Automation) |
| 1997-2006 | Processing sliced fish (awaiting commercialisation) |
| **1999-2001** | **RoboPrint (Commercialised)** |
| **2001-2005** | **RoboBurger (Commercialised)** |
| 2003-2004 | RoboProbe (in development) |
| 1999-2004 | Robotic cutting of Poultry (pilot installed, awaiting) |
| 2006-2012 | Robotic Ovine Cutting (Commercialised) |
| 2004- on | Automating food production plants |

European Commission

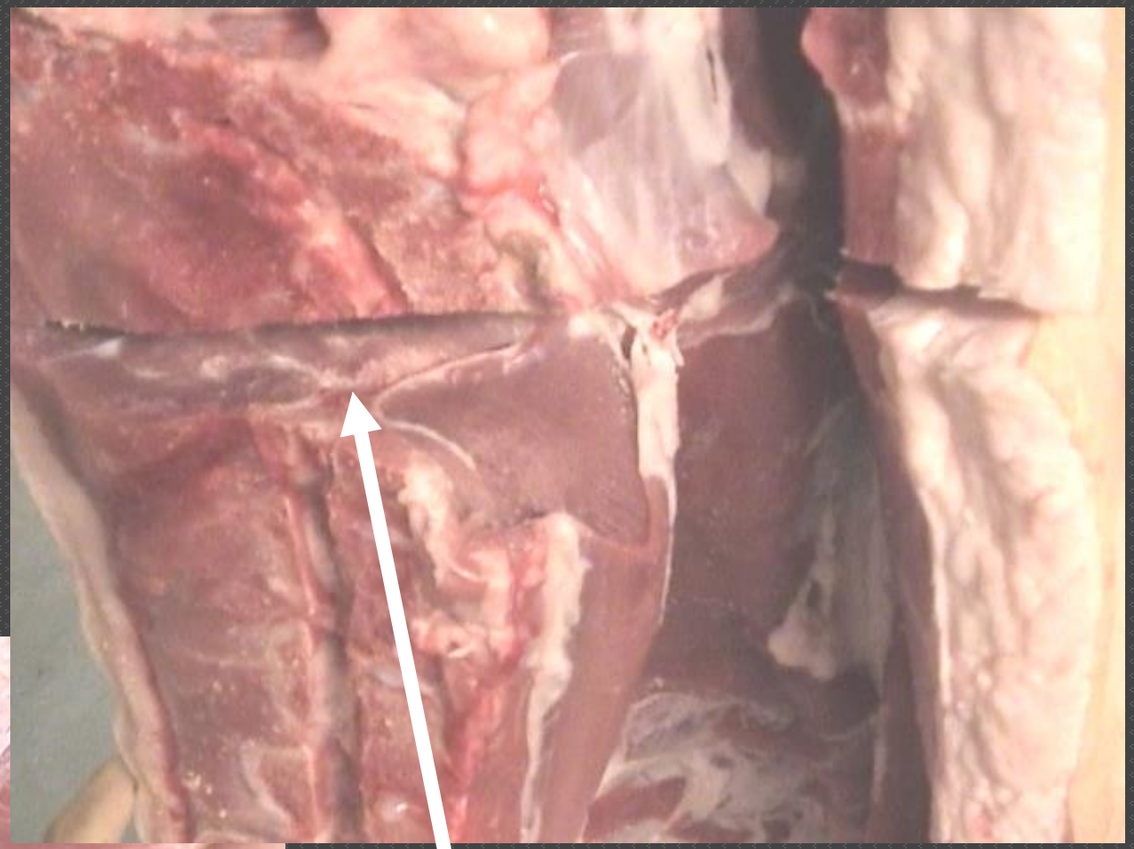
BMC

# Robotics in pork operations

# Robotic Cutting



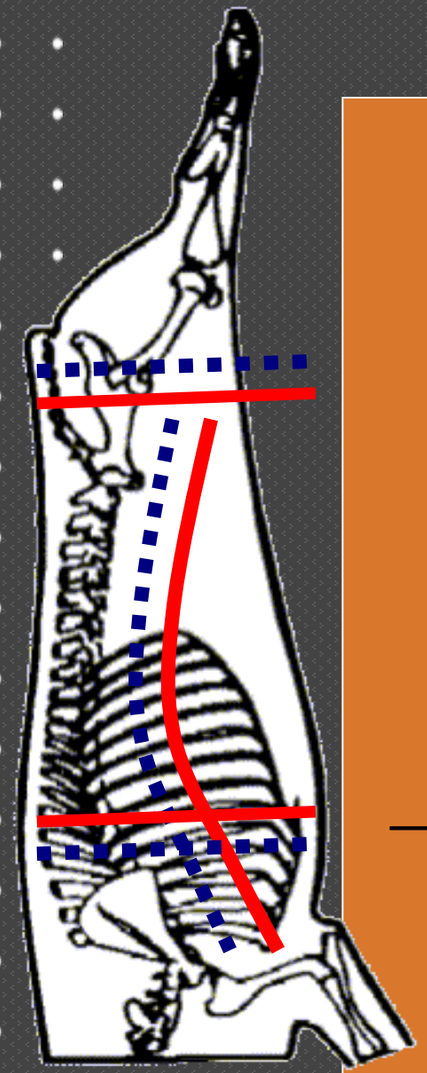
# Quality

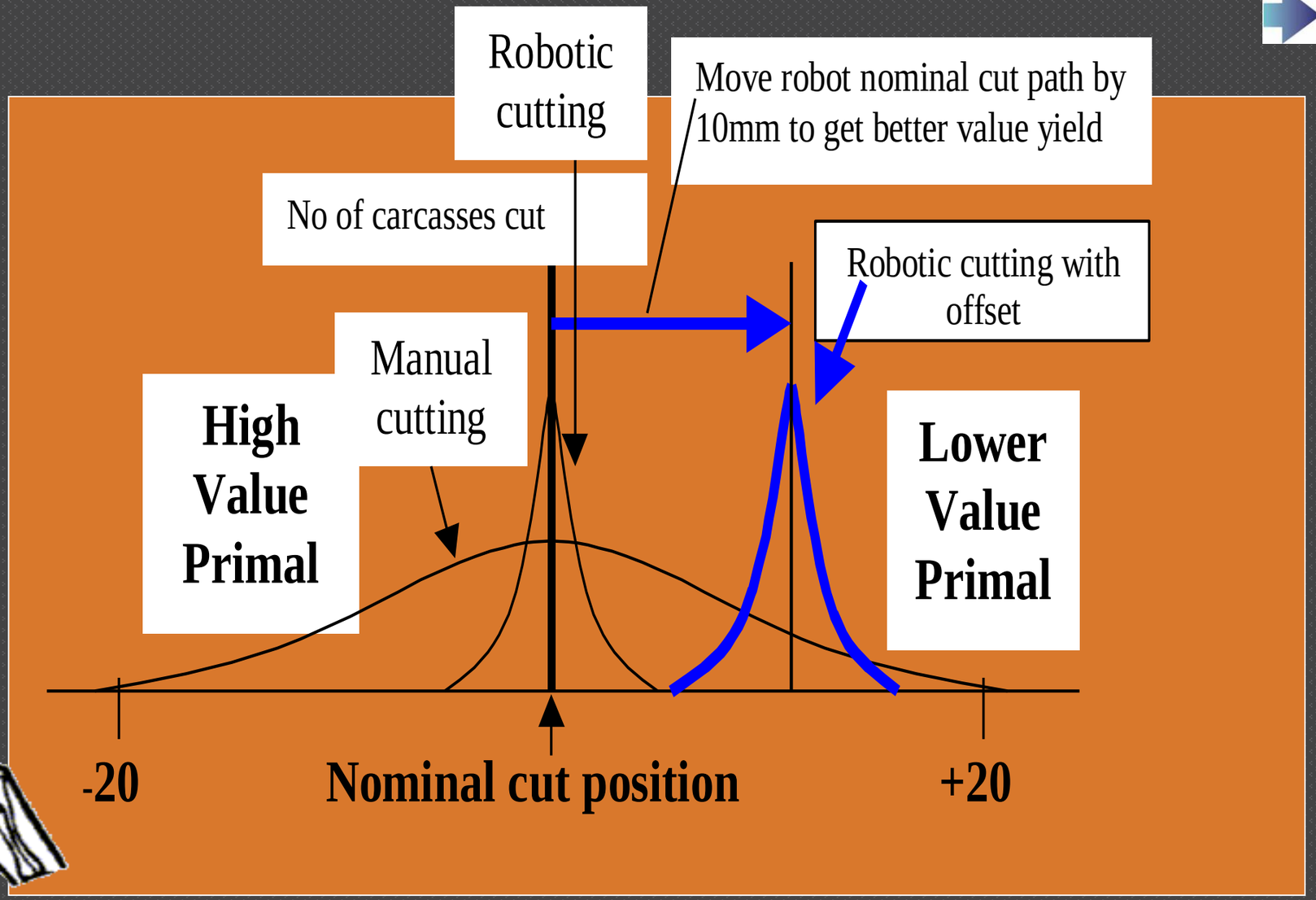


No bone dust

Bone dust

# Robotic Cutting - BENEFITS





# Robotic Cutting - BENEFITS

## Return on yield (Norway)

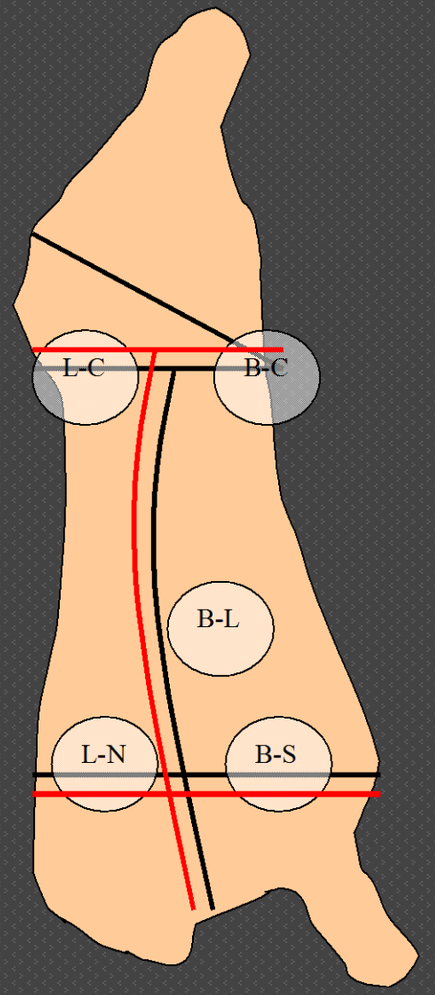
**Controlling cuts at 113 head per hour,**
**1720 hours/year.**

**B-L 1%-1.5% reported actual = 1,200,000 NOK**
**3.5 X 132,000 US$**

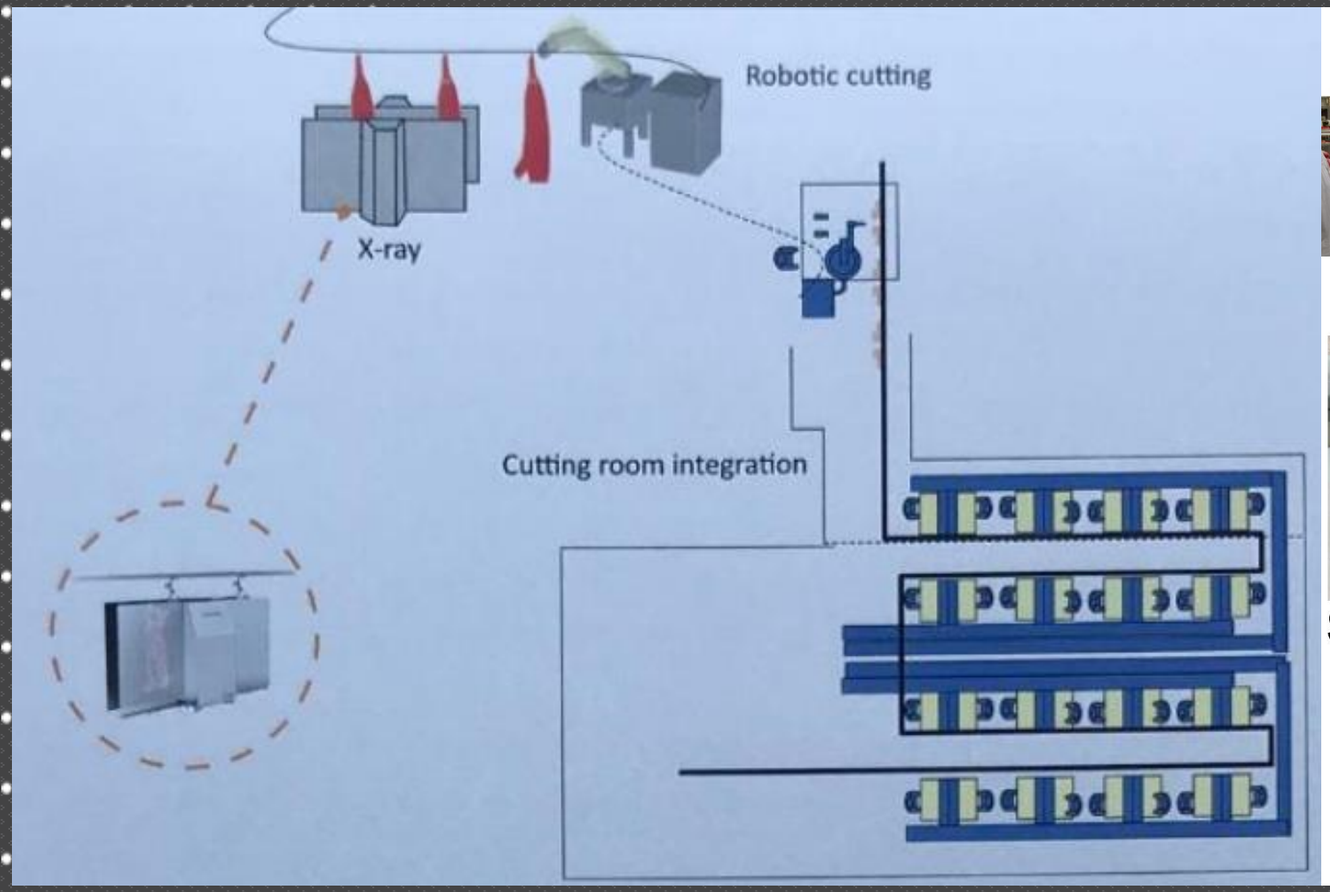
**AT 600 PER HOUR this is ~5 X = 660k US$/y**

| | | | |
|---|---|---|---|
| **Belly-Loin** | **B-L** | **339,593** | **$ 37k** |
| **Loin-Neck** | **L-N** | **703,218** | **$ 77k** |
| **Belly-Shoulder** | **B-S** | **194,003** | **$ 21k** |
| **Total against 10mm offset** | | **2,306,443** | **$252k** |

1 Norwegian Krone equals
0.11 United States Dollar
1 Oct, 07:24 UTC · Disclaimer



# Pork cutting operation and opportunities

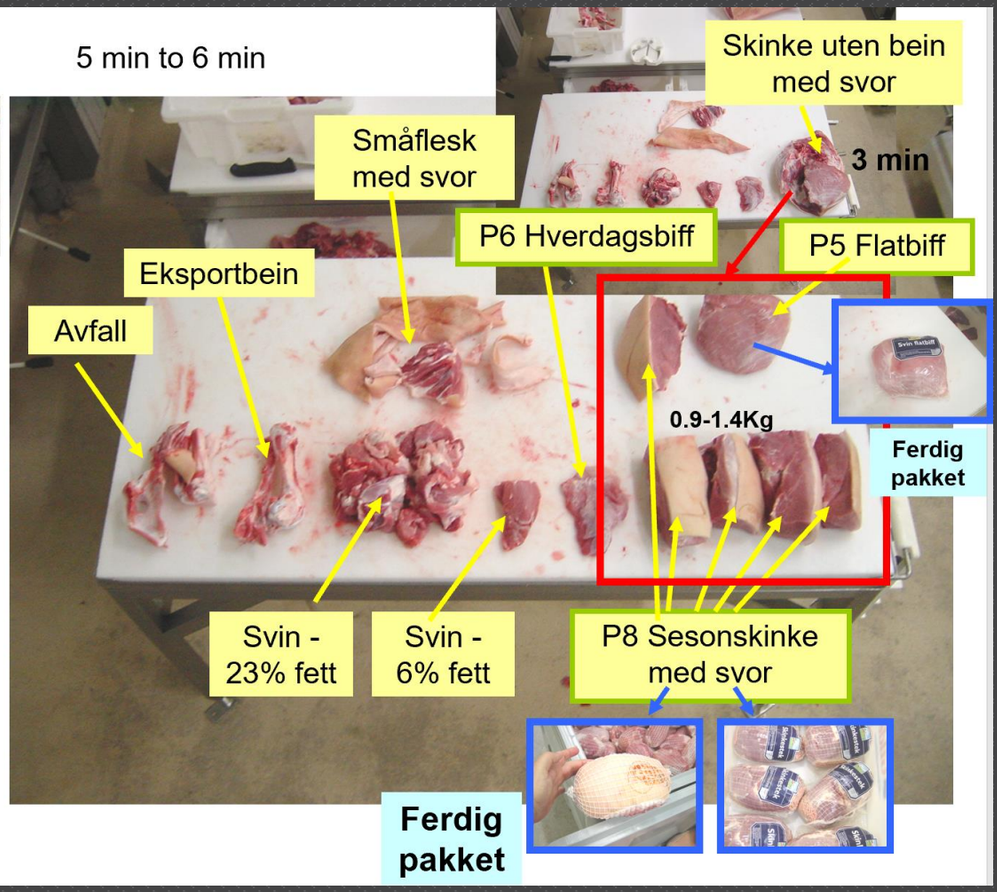



Gruppe 4:

5 min to 6 min

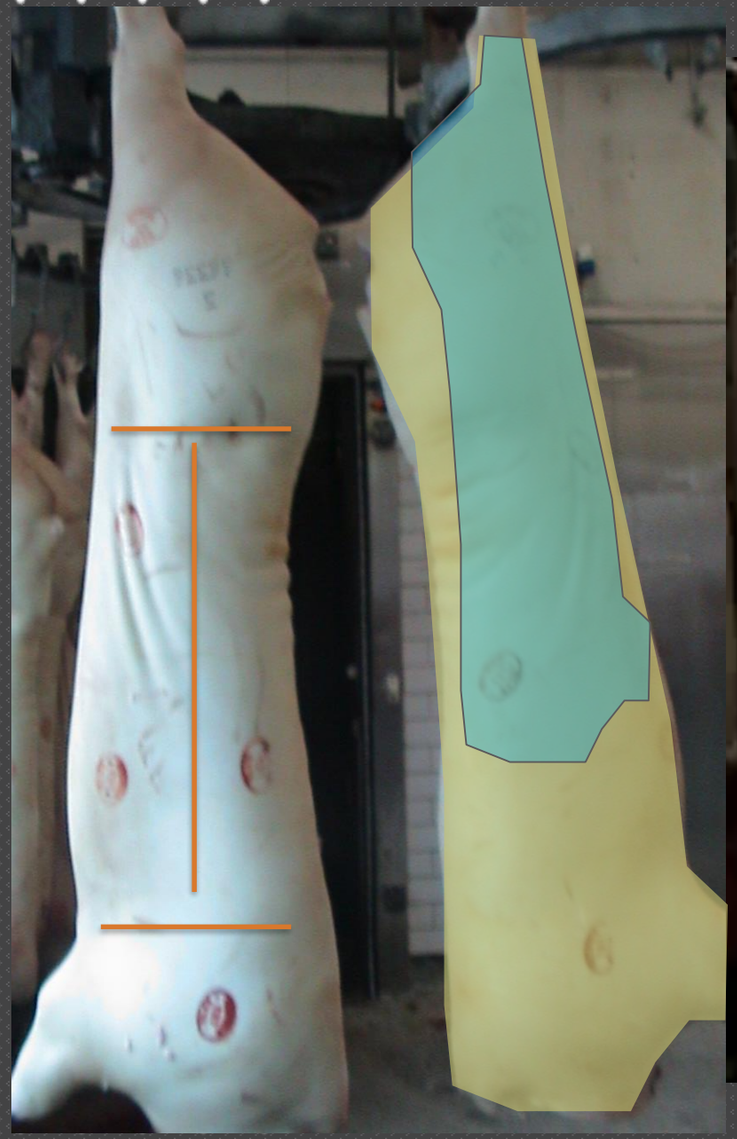
Weight Control

**Standard Skinke uten filet med mörbrad**

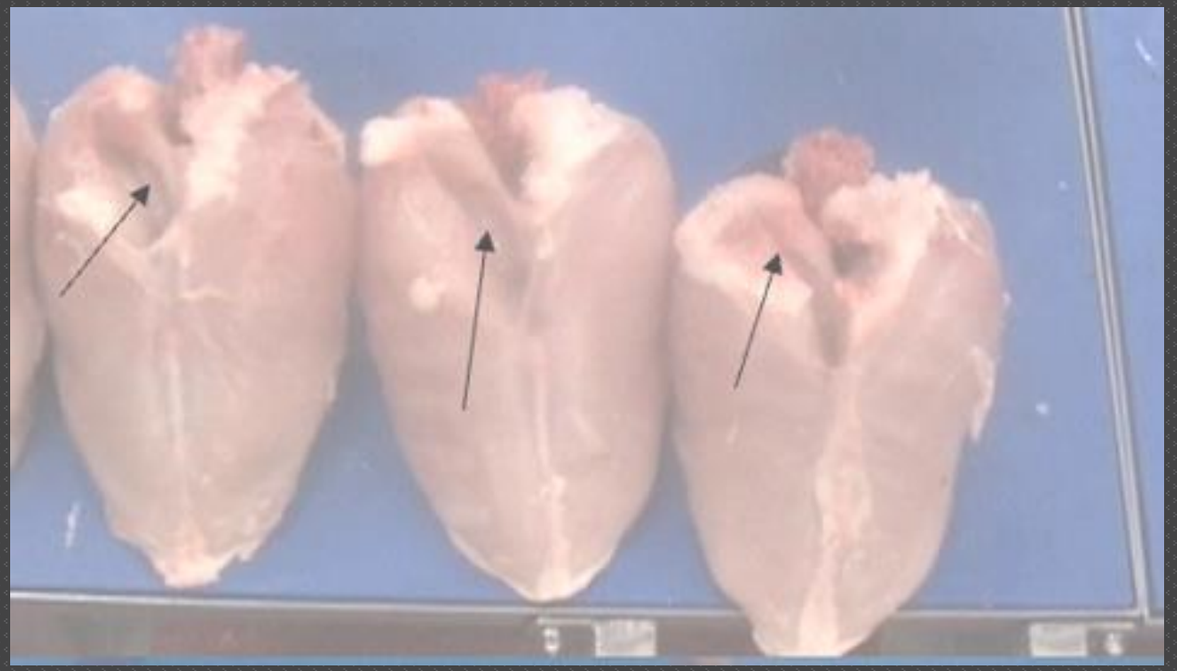



Control – yield – quality - other

# Robotic Printing

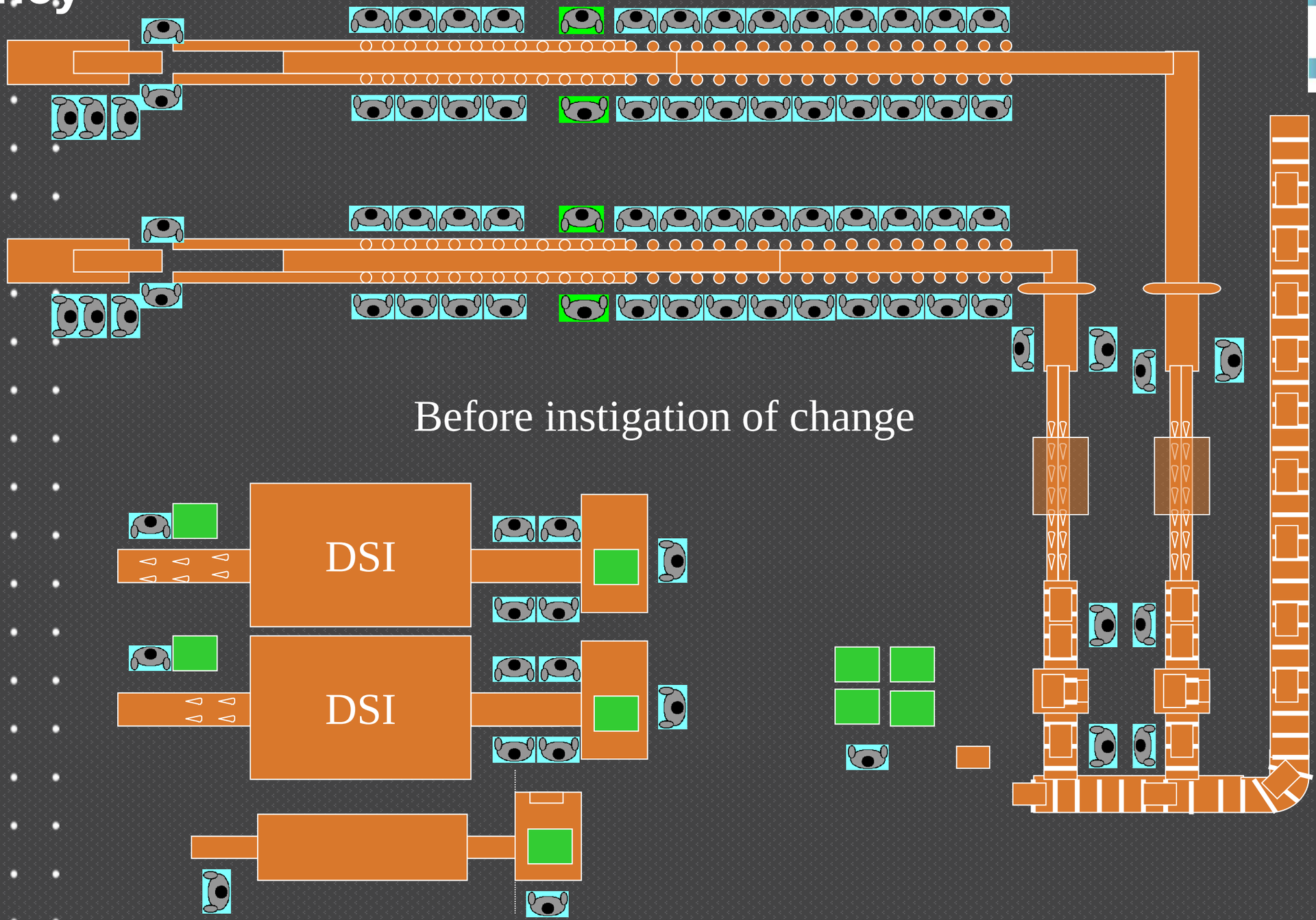


# Robotic Cutting - speed



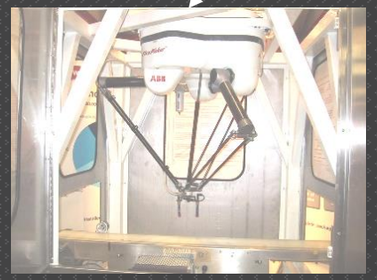
# Efficiency

Not to scale




Before instigation of change

Not to scale

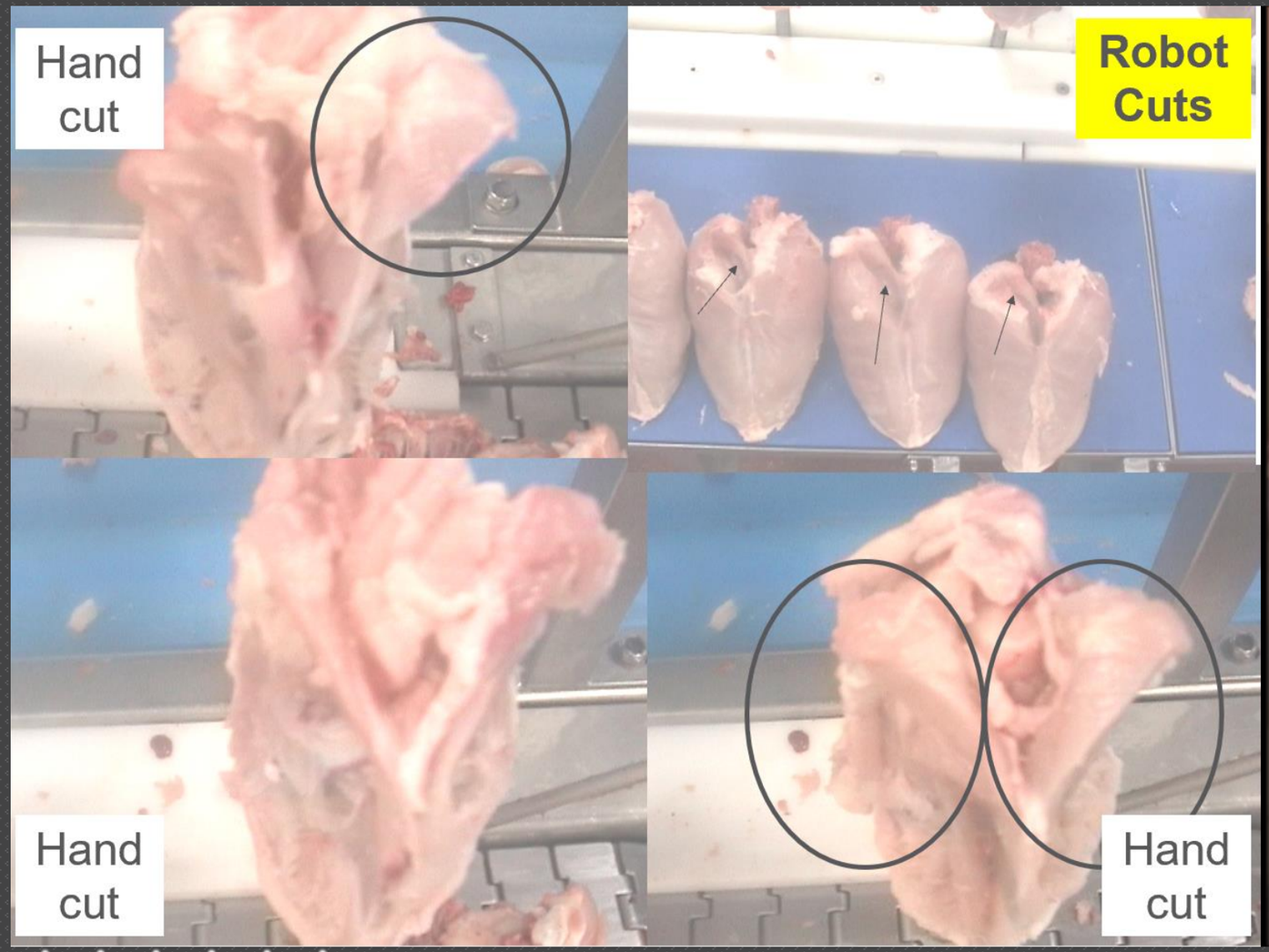


Labour saving

1 shift – 74 to 32 - 42 reduction

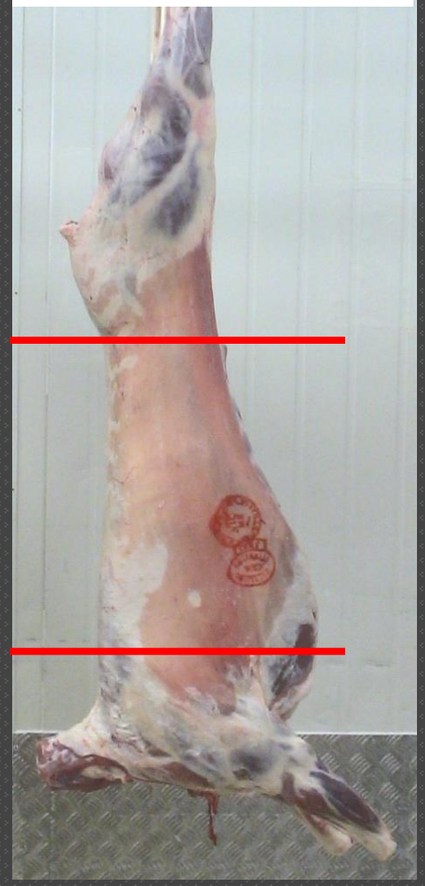
# Project targets

# Robotic Cutting - speed




| | |
|---|---|
| 5% | |
| 150 | gs/fillet |
| 7.5 | g/fillet |
| 32 | birds/min |
| 2 | fillets/bird |
| 60 | mins/hour |
| 29 | Kg/hour |
| 8 | hours |
| 230 | Kgs/day |
| 300 | days/y |
| 69,120 | Kgs/y |
| 2.10 | $/Kg |
| 145,152 | $/year per line |
| 4 | lines |
| **581** | **k$/year yiels** |
| 6 | people/line |
| 20 | k$ /year person |
| **480** | **k&/year labour** |
| **1,061** | **Tot/yer** |

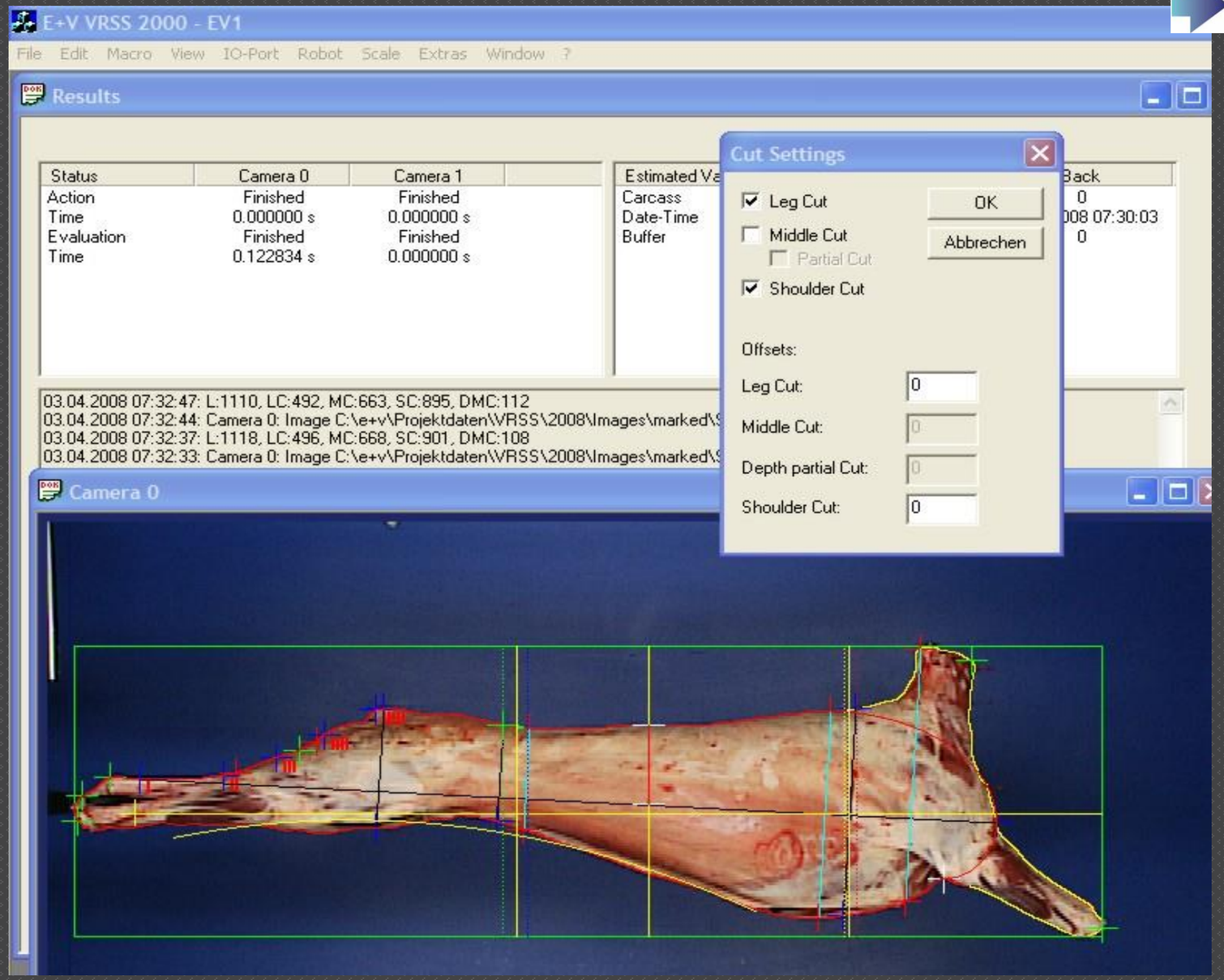
# Robotic Cutting



# Robotic Cutting

| Calculation on loss and shift of x mm plus direct labour saving and effeciency increase | | | | | yields on 18.3 KG carcass | | |
|---|---|---|---|---|---|---|---|
| | measured | weight in gs | | | AU$ | AU$ loss on | AU$ |
| mm cut | 25.00 | equiv. to 1 mm | AU$ Middle | AU$ | Diff/Kg | 1mm bone dust | on 1mm shift |
| | 307.00 | 12.28 | 6.00 | 5.00 | 1.00 | 0.061 | 0.012 |
| e | 328.40 | 13.14 | | | | | |
| hour R | 600 | | R | | | | |
| on 1mm | 60 | | | | | | |
| | 5 | | | | | | |
| x at Rate R/hour AU$ | 155 | | | | | | |
| | 7.50 | | | | | | |
| | 2 | | | | | | |
| | 5 | | | | | | |
| | 50 | | | | | | |
| | 3,750 | | | | | | |
| educed loss/year | 226,818 | AU$ | n | | | | |
| x mm/year | 581,490 | AU$ | u | | | | |
| ss and 5mm shift | 808,308 | | | | | | |
| | | | | | | | |
| | 3 | | | | | | |
| | 50,000.00 | | | | | | |
| ing per shift | 150,000.00 | | | | | | |
| n S shift | 300,000.00 | | | | | | |
| | | | | | | | |
| in boning and packing area | 54.00 | | | | | | |
| urrent | 8.50 | per minute | | | | | |
| fter robot | 10 | | | | | | |
| ghput % with no staff increase | 18% | | | | | | |
| it in labour equivalent on single shift | 10 | people | | | | | |
| S shifts | 952,941 | AU$ | | | | | |
| | | | | | | | |
| Total gain estimate | **2,061,249** | | | | | | |
| Price | 1,870,000 | | | | | | |
| ROI | **11** | | | | | | |

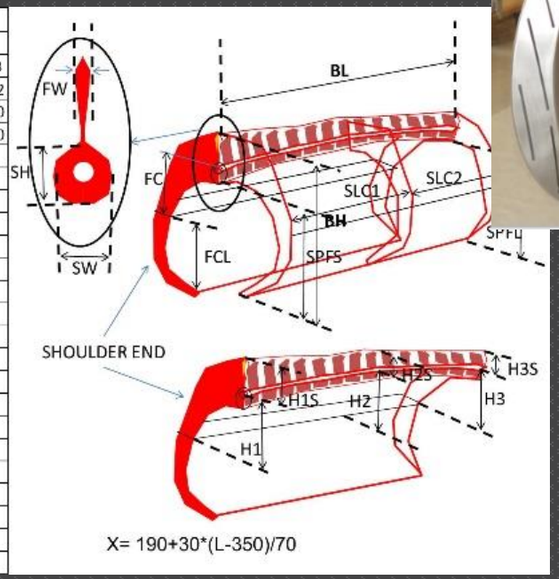

# Robotic Cutting

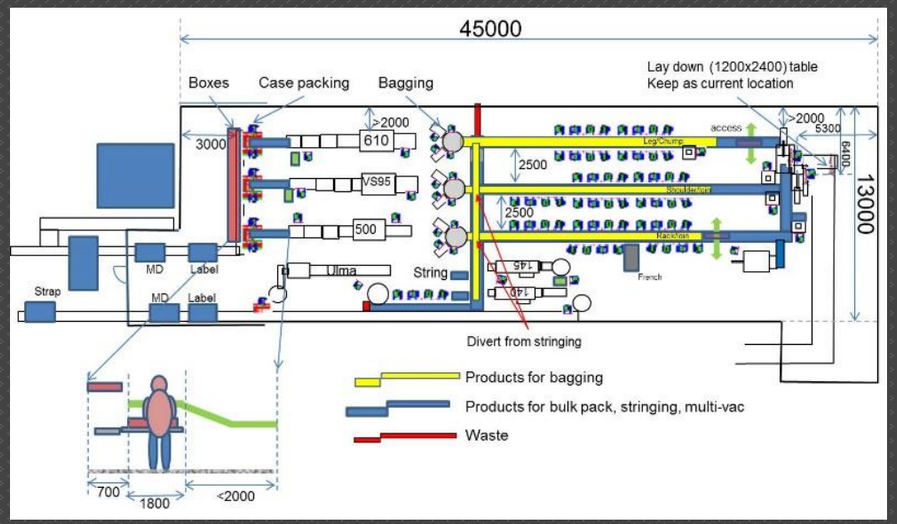


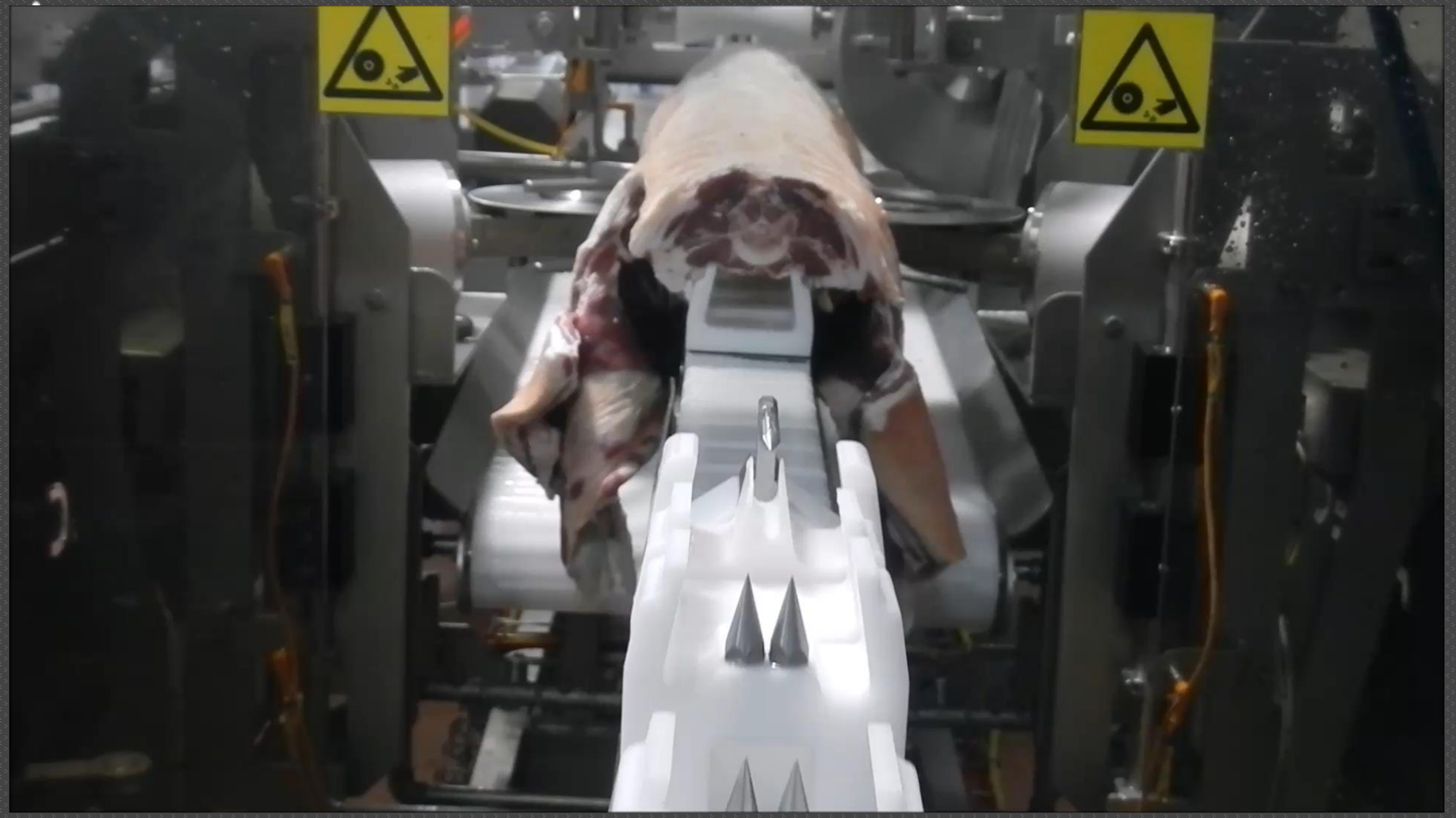
# Robotic Cutting

# Lamb solutions


| Junee WBM | | mm |
|---|---|---|
| Measurements Oct 2012 | | |
| | Carcass A | Carcass B |
| Kg | 13.9 | 32.2 |
| Lnght | 900 | 1180 |
| Wdth | 200 | 280 |
| Barrel measurements | | |
| Carc | A | B |
| BL | 350 | 420 |
| BH | 240 | 340 |
| SLC1 | 190 | 220 |
| SLC2 | 160 | 200 |
| SW | 35 | 45 |
| SH | 35 | 46 |
| FW | 8 | 13 |
| FC | 60 | 60 |
| H1 | 30 | 20 |
| H2 | 40 | 40 |
| H3 | 30 | 20 |
| H1S | 80 | 110 |
| H2S | 50 | 65 |
| H3S | 60 | 85 |
| SPFS | 145 | 230 |
| SPFL | 140 | 100 |
| FCL | 90 | 190 |



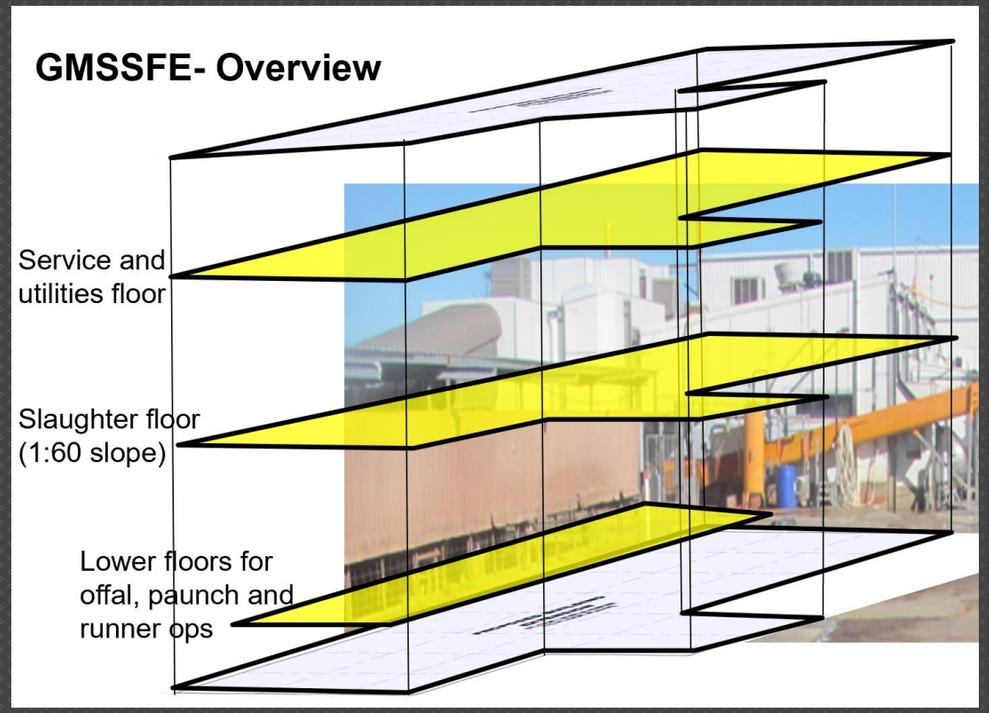



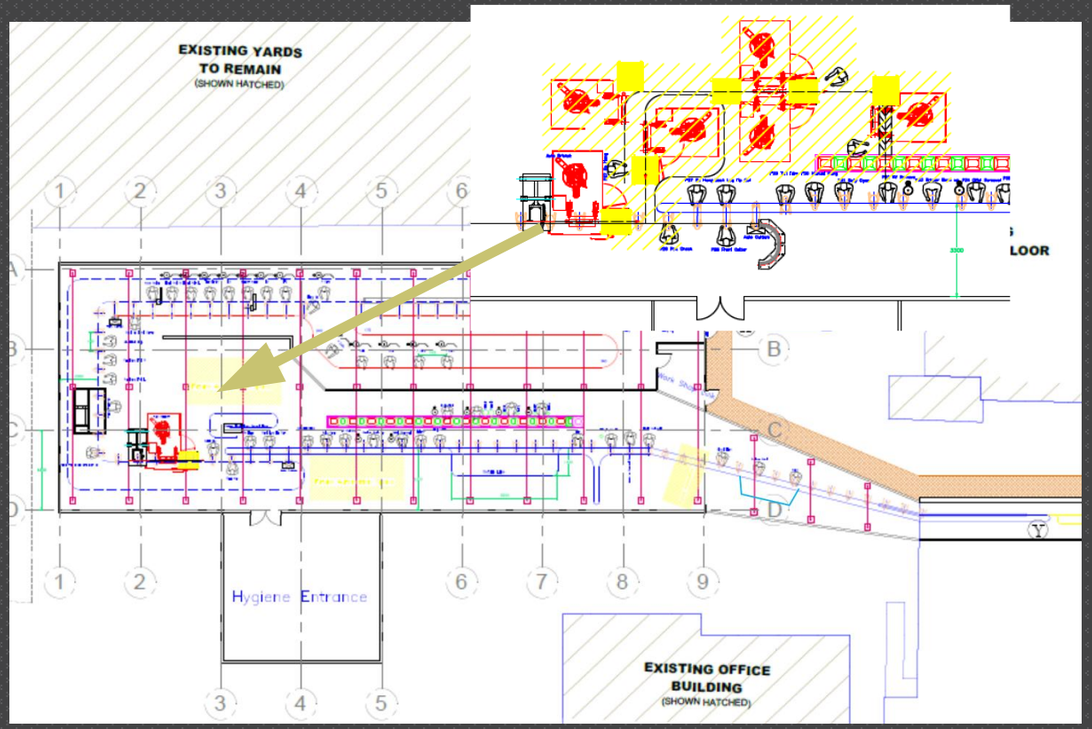


| Calculation on loss and shift of x mm plus direct labour saving and effeciency increase | | | | | yields on 18.3 KG carcass | | |
|---|---|---|---|---|---|---|---|
| | measured | weight in gs | | | AU$ | AU$ loss on | AU$ diff |
| mm cut | 25.00 | equiv. to 1 mm | AU$ Middle | AU$ | Diff/Kg | | |
| Leg/middle | 307.00 | 12.28 | 6.00 | 5.00 | 1.00 | | |
| Shoulder/middle | 328.40 | 13.14 | 6.00 | 3.00 | 3.00 | | |
| Carcasses per hour R | 600 | | Per carcass total | | AU$ | | |
| Loss/hour AU$ on 1mm | 60 | | | | | | |
| mm Shift x | 5 | | | | | | |
| Gain on shift of x at Rate R/hour AU$ | 155 | | | | | | |
| hours/shift | 7.50 | | | | | | |
| Shifts S | 2 | | | | | | |
| Days per week | 5 | | | | | | |
| Weeks/year | 50 | | | | | | |
| Total hours | 3,750 | | | | | | |
| Gain on 1 mm reduced loss/year | 226,818 | AU$ | note using lower value primal pri | | | | |
| Gain on shift of x mm/year | 581,490 | AU$ | using difference in price | | | | |
| Gain with no loss and 5mm shift | 808,308 | | | | | | |
| | | | | | | | |
| Labour per shift | 3 | | | | | | |
| Cost | 50,000.00 | | | | | | |
| Total labour saving per shift | 150,000.00 | | | | | | |
| Labour saving on S shift | 300,000.00 | | | | | | |
| | | | | | | | |
| Number of staff in boning and packing area | 54.00 | | | | | | |
| Rate of lambs current | 8.50 | per minute | | | | | |
| Rate of lambs after robot | 10 | | | | | | |
| Increased throughput % with no staff increase | 18% | | | | | | |
| Increased benefit in labour equivalent on single shift | 10 | people | | | | | |
| AU$ benefit on S shifts | 952,941 | AU$ | | | | | |
| | | | | | | | |
| Total gain estimate | **2,061,249** | | | | | | |
| Price | 1,870,000 | | | | | | |
| ROI | **11** | | - | | | | |

US$ 1.4m

# Lamb solutions




**In memory of Barry Noble**

# Beef cutting

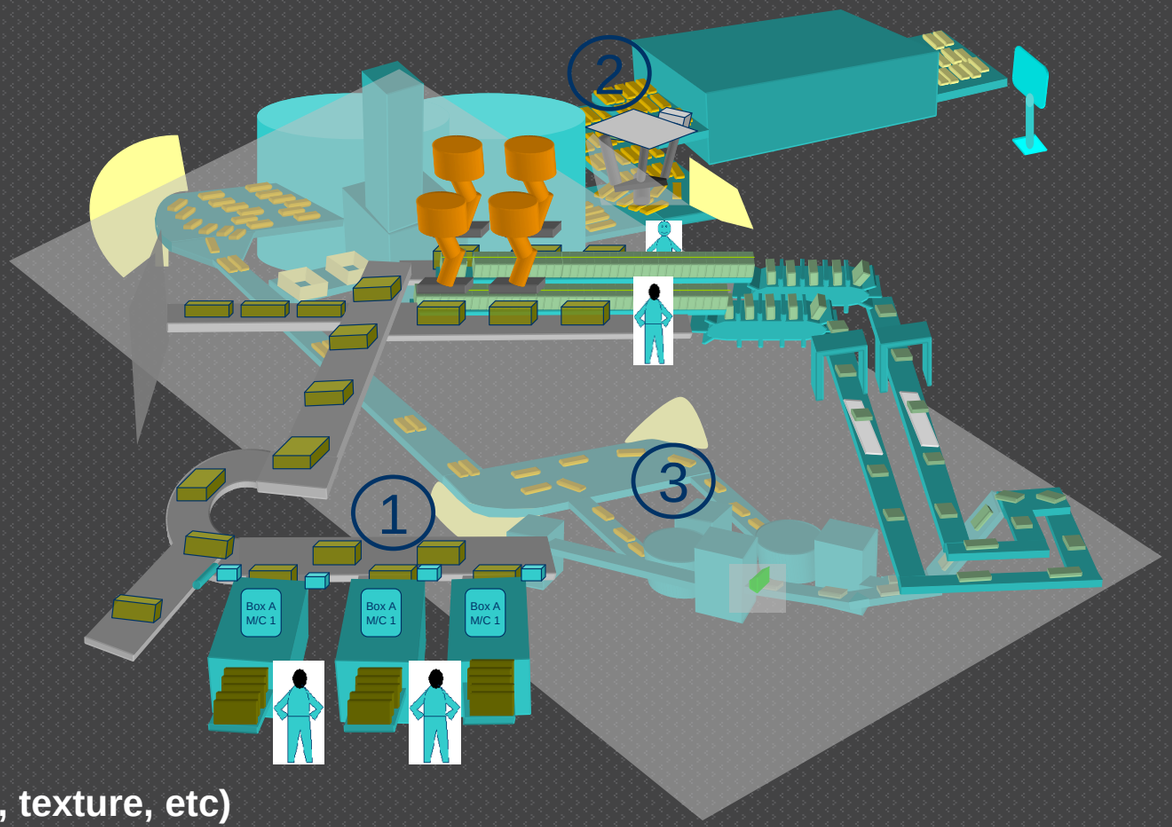
Shelf life extention

E+V Technology, Germany

Cutting line consistency and accuracy

# End of line

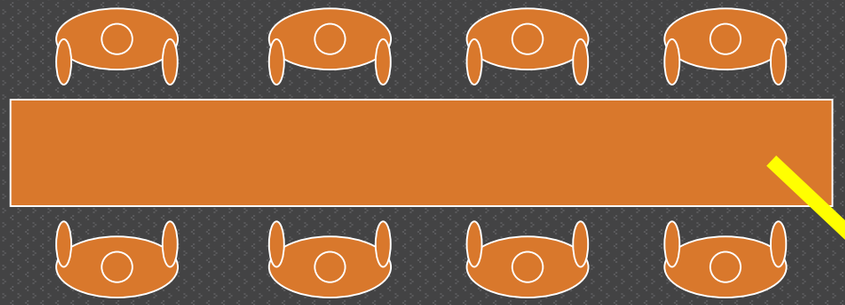
1. Packing
   - a) Box forming
   - b) Label printing
   - c) Box bar code check
   - d) Pack bar code/date check
   - e) Collating
   - f) Case loading
   - g) Lid closing and top sealing
   - h) bar code check and box count pre SBD
2. Quality
   - a) Pre- oven product data entry
   - b) Pre- chill quality checks (colour, pattern, texture, etc)
   - c) Pre flow-wrap weight check
3. Handling
   - a) Product alignment post chill
   - b) Twin pack tray denesting
   - c) Product alignment for twin packing
   - d) Product handling for twin pack or flow-wrap feed
   - e) Product buffering
   - f) Promotion labelling

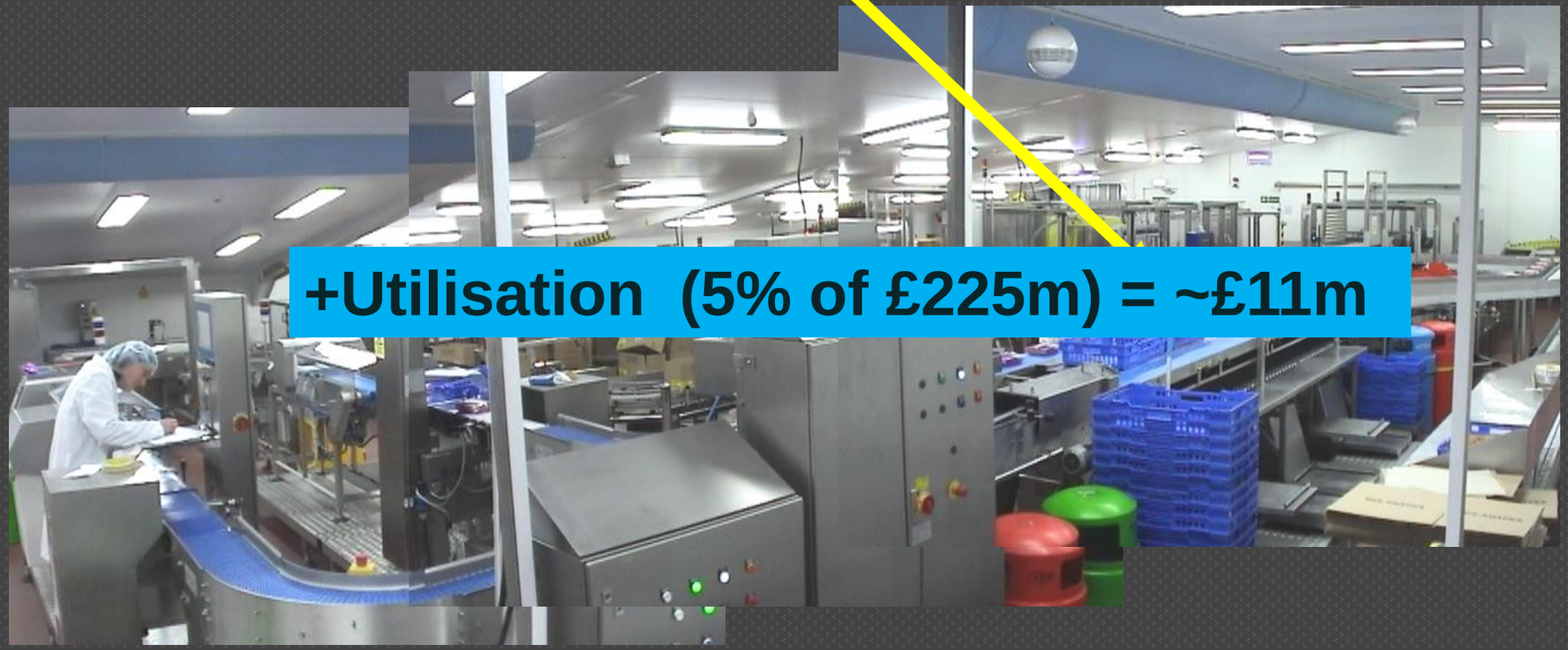



BMC

# Lines 1, 2 and 3 November 12, 2003

# End of line





**+Utilisation (5% of £225m) = ~£11m**

Saving 7 people on 4 Shifts = 28 people

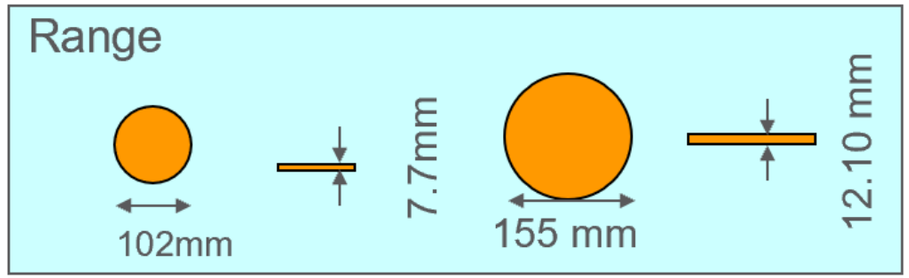
# End of Line

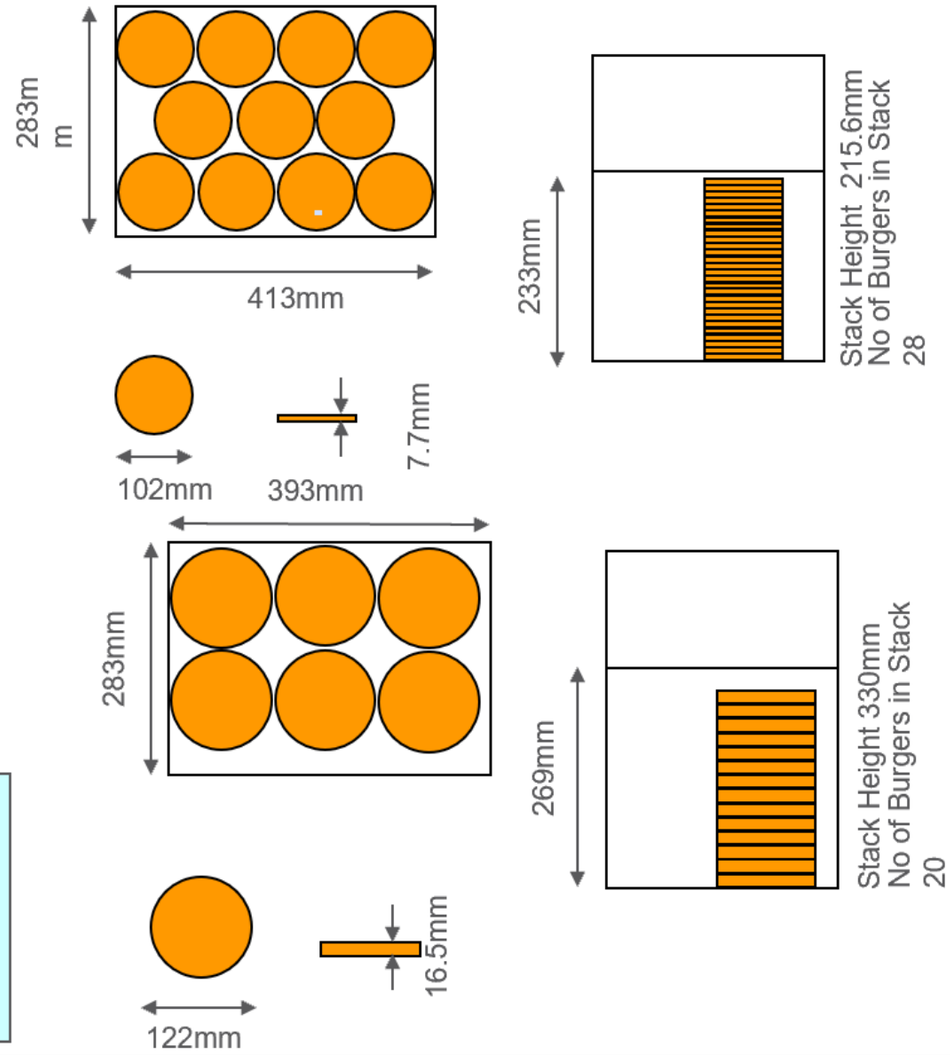
# RoboBurger™

# RoboBurger - Burger and Box Packing Specifications

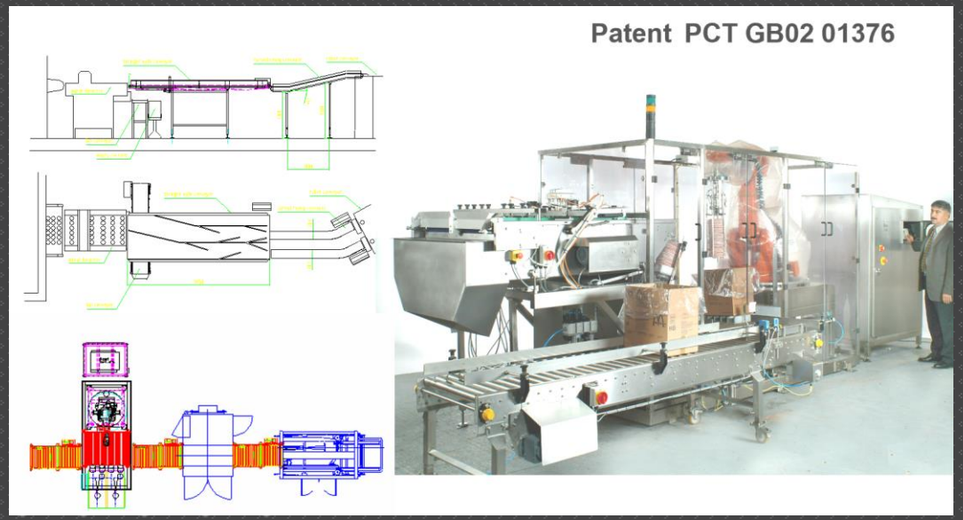
| Product Type | McD Hamburger | | |
|---|---|---|---|
| | Size | Thickness | Weight |
| Burger size (spec.) | 94/102 | 6.5/7.7 | |
| **Burger size (max.)** | **102** | **7.7** | |
| | No / stack | No of Stacks | No / Box |
| Packing Layout | 27/28 | 11 | 298-304 |
| | Length | Width | Height |
| Case (Internal) | 413 | 283 | 233 |
| Case (External) | | | |
| Case weight | 13.5 kg | | |
| **Robot – no of stacks** | **11** | | |
| **Robot – no per stack** | **28** | | |

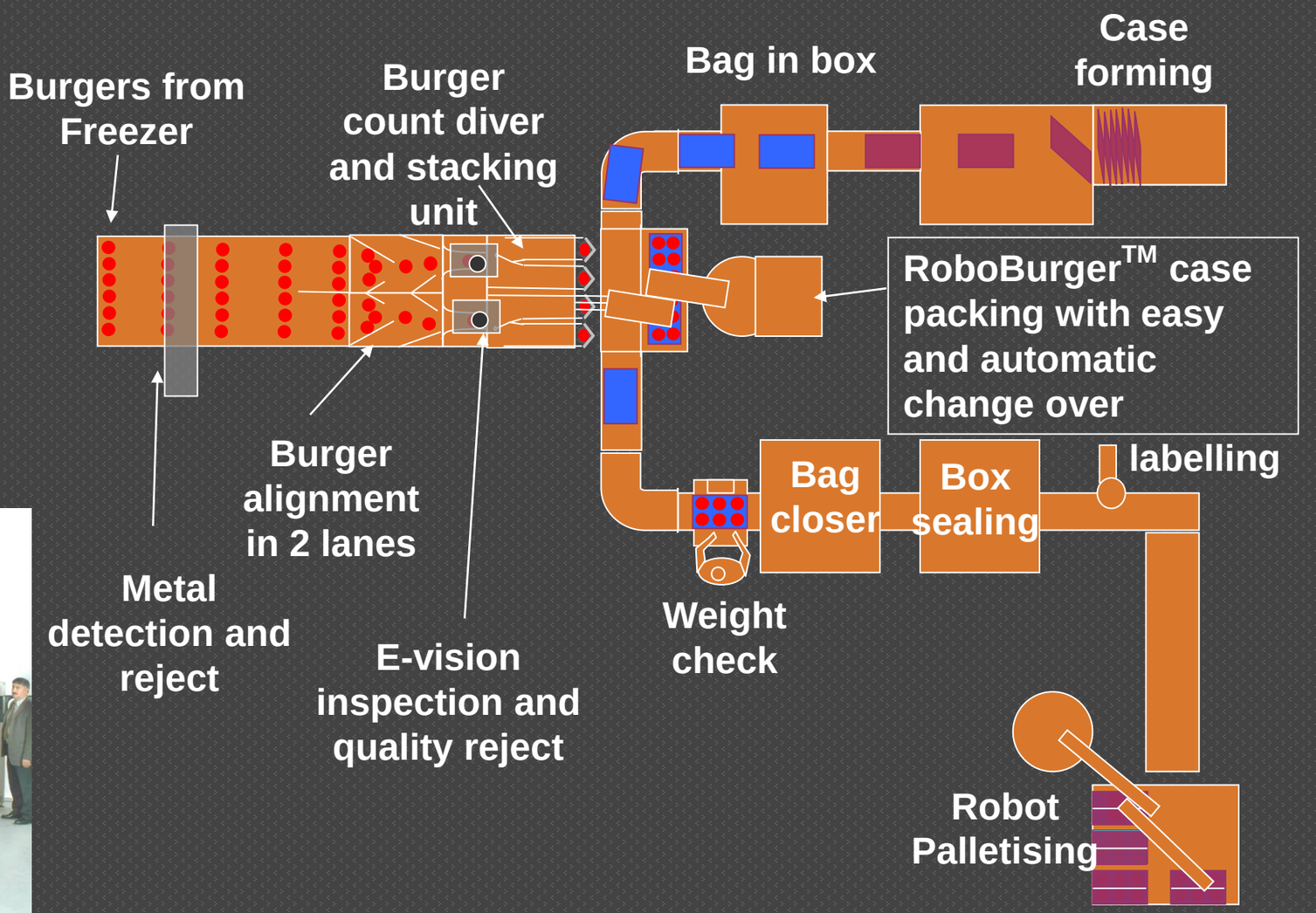
| Product Type | McD Qtr Pounder | | |
|---|---|---|---|
| | Size | Thickness | Weight |
| Burger size (spec.) | 110/122 | 13.5/16.5 | |
| **Burger size (max)** | **122** | **16.5** | |
| | No / stack | No of Stacks | No / Box |
| Packing Layout | 15+30extra | 6 | 118-120 |
| | Length | Width | Height |
| Case (Internal) | 393 | 283 | 269 |
| Case (External) | 397 | 287 | 283 |
| Case weight | 13.5 kg | | |
| **Robot – no of stacks** | **6** | | |
| **Robot – no per stack** | **20** | | |



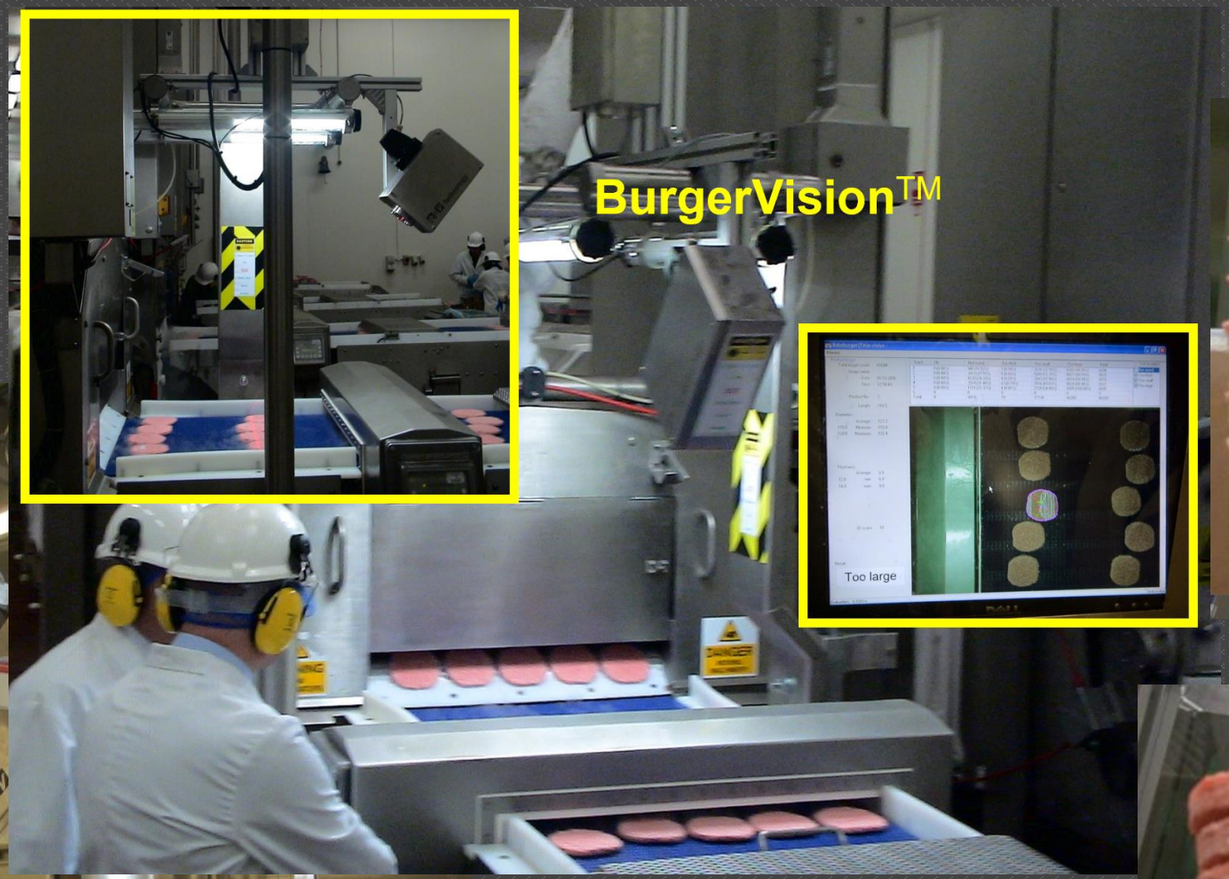



# RoboBurger™


Patent PCT GB02 01376


Burgers from Freezer
Burger count diver and stacking unit
Bag in box
Case forming
RoboBurger™ case packing with easy and automatic change over
Burger alignment in 2 lanes
Metal detection and reject
E-vision inspection and quality reject
Weight check
Bag closer
Box sealing
labelling
Robot Palletising

# Vision Inspection of Burgers









# RoboBurger™

# Automation vs Employment

Patterns of absence

- Average rates of absence across Europe are between 3% and 6% of working time.
- Es
- Er
  co
- Sp
  in

**20,000 robots per year may be installed with this money, but this would deal with only the absenteeism in Norway.**

**The installation work to install 20,000 robots would take over 10 years.**

**Assuming we know how to build robots to carry out skilled tasks**

%

European
orking Life

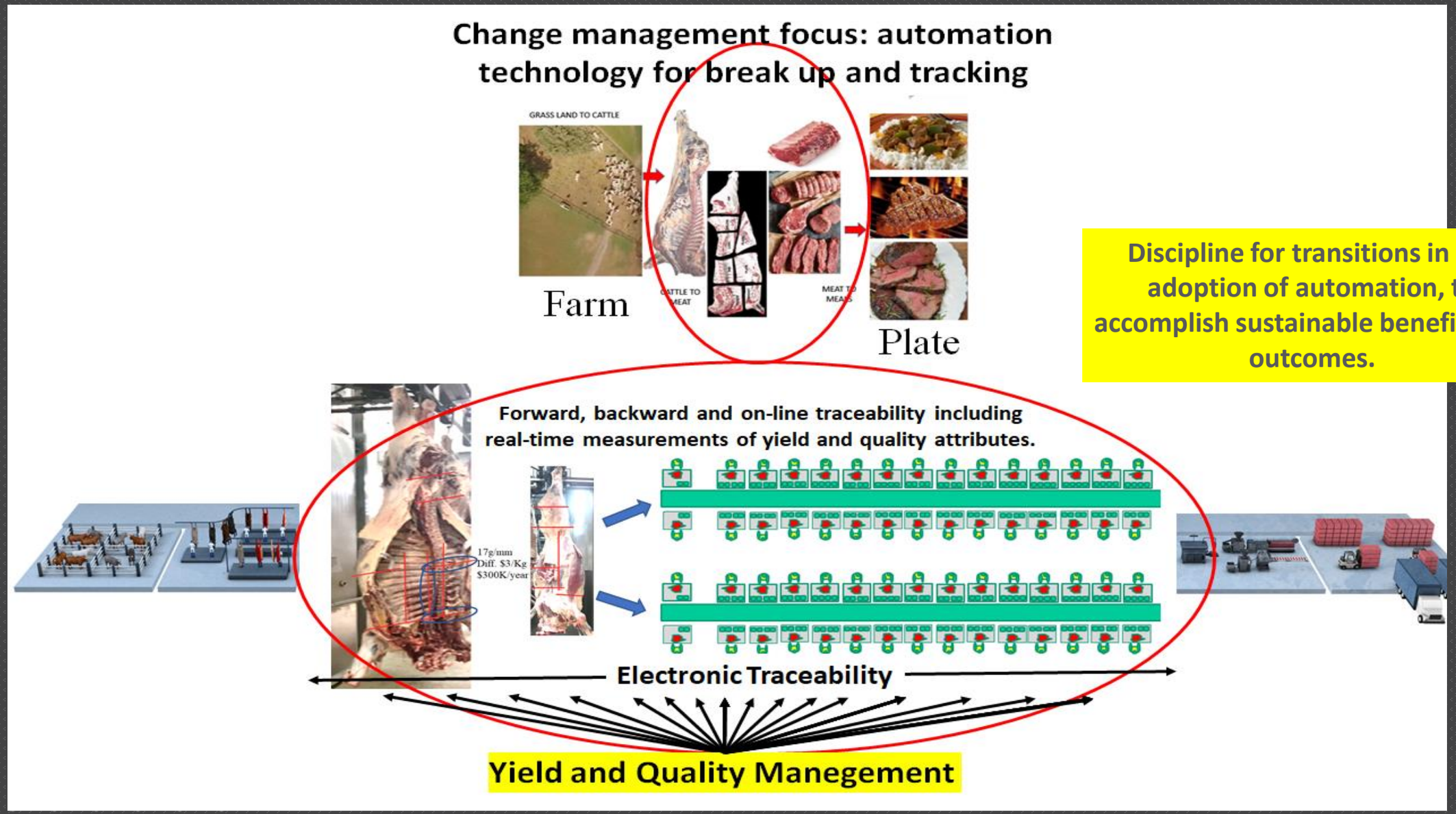
- US

Source: http://www.investopedia.com/articles/personal-finance/070513/causes-and-costs-absenteeism.asp

# Managing and delivering

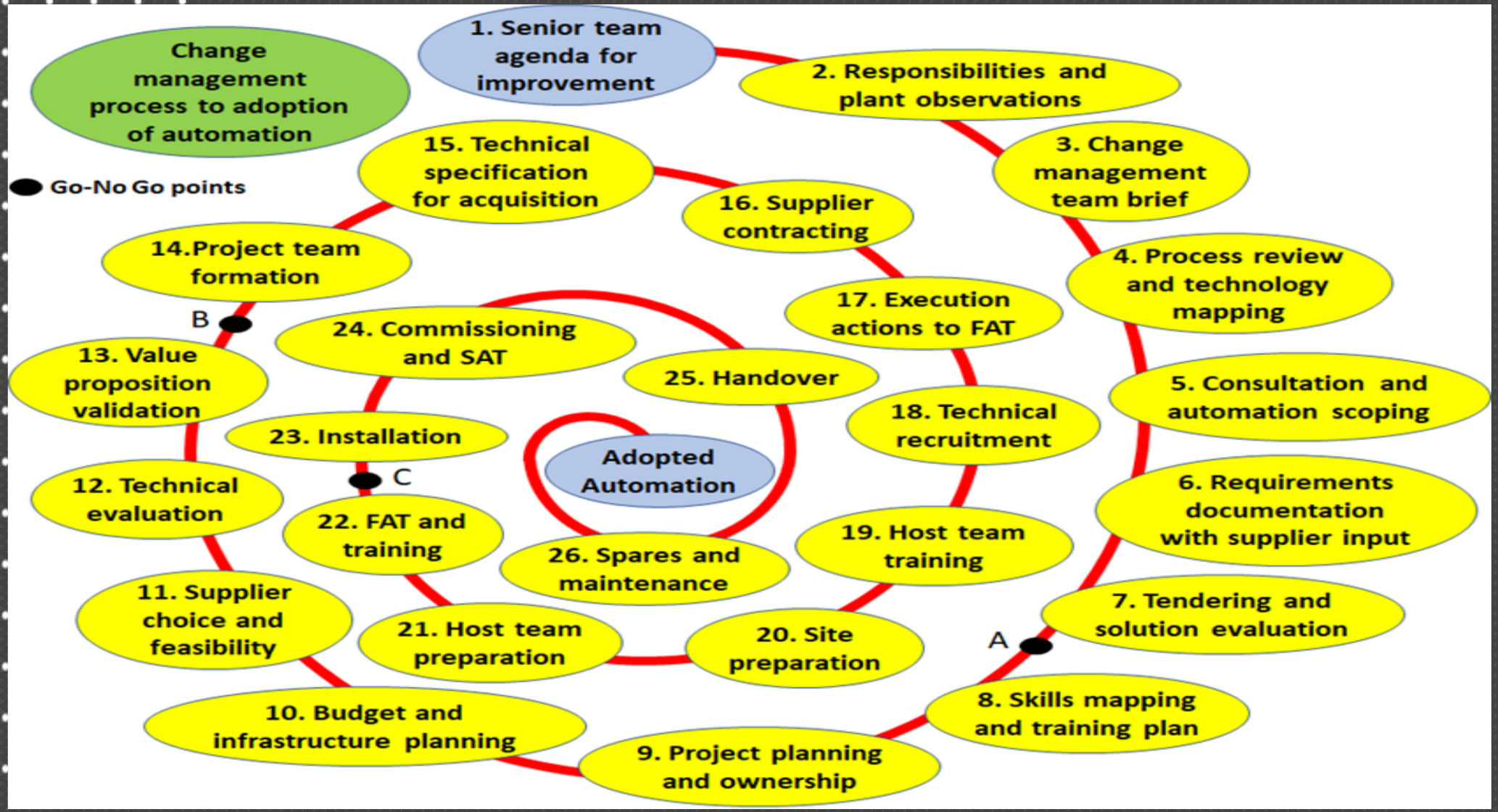

| STOP | PROCUREMENT PROCESS PLAN |
|---|---|
| Duration | preparation for automation downtime |
| < 5 min | operators trained to take recovery action |
| < 8 hours | maintenance staff trained to accomplish recovery |
| > 8 hours | call out response from suppliers |

# Beef operation and management of Change



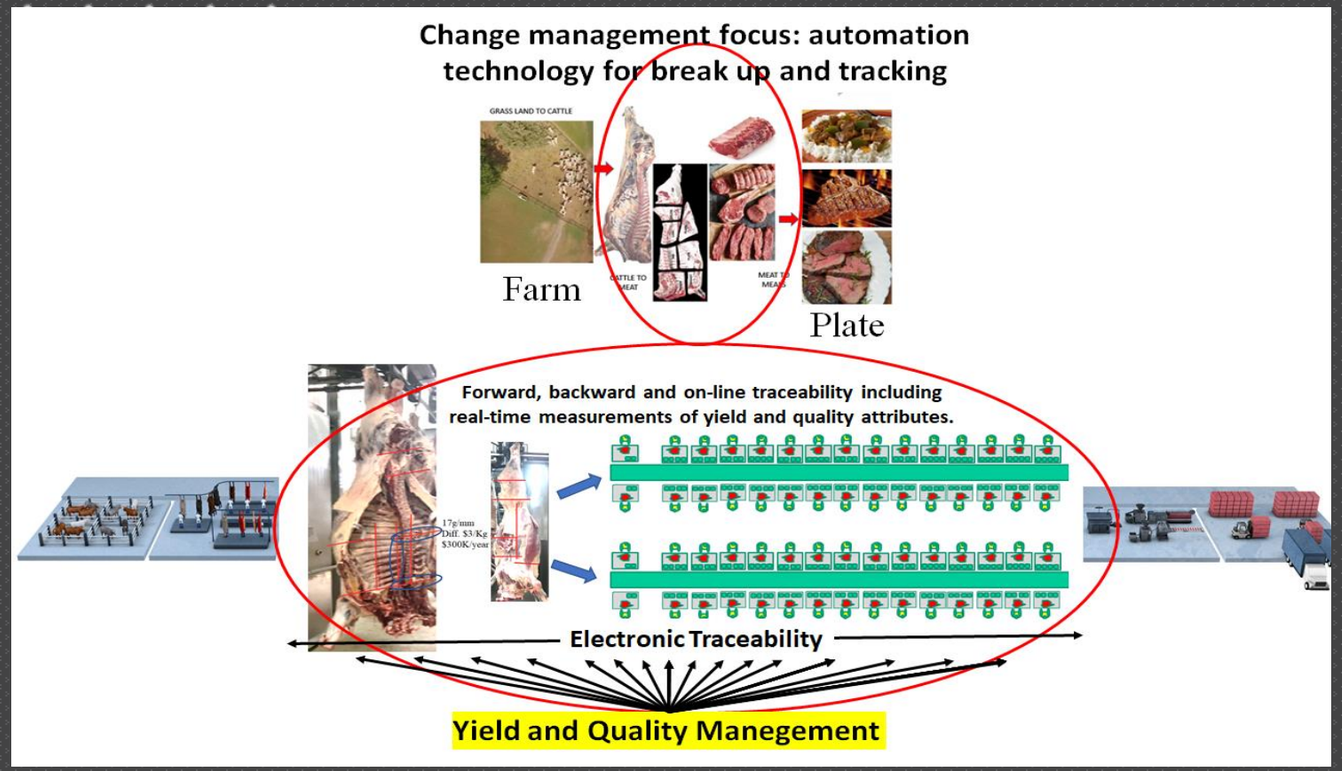

**Discipline for transitions in the adoption of automation, to accomplish sustainable benefits and outcomes.**

# Change Management & Procurement



# Change Management

**Discipline for transitions in the adoption of automation, to accomplish sustainable benefits and outcomes.**




## Important considerations

- Scope and benchmarking
- Change process requirements
- Skills requirements
- Resource requirements
- Infrastructure changes: space, training, etc.
- Mapping needs to supply capability
- Change management capacity

# Koorosh Khodabandehloo (KK)

**Business and Manufacturing Consultancy**

**Adjunct Professor, University of Southern Queensland**

**bmcdevon@aol.com**


**Established 1997**

BMC

USQ

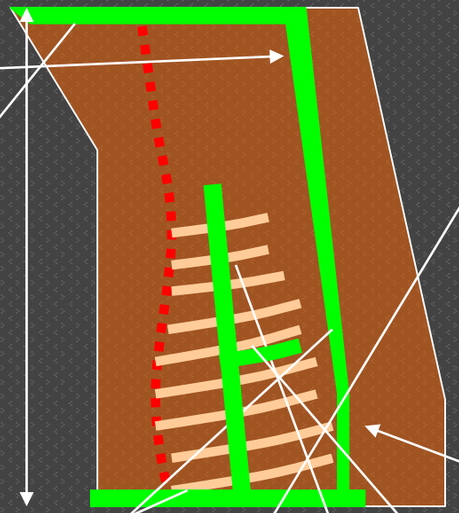
*Thank you*

International Food Automation Networking Conference

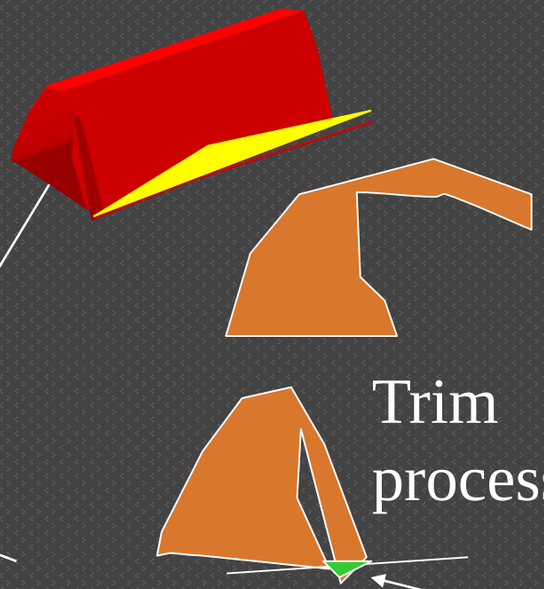
# Tests conducted

18 Kg lamb

Meat added to loin



Also maximising length by moving the shoulder and leg cuts apart

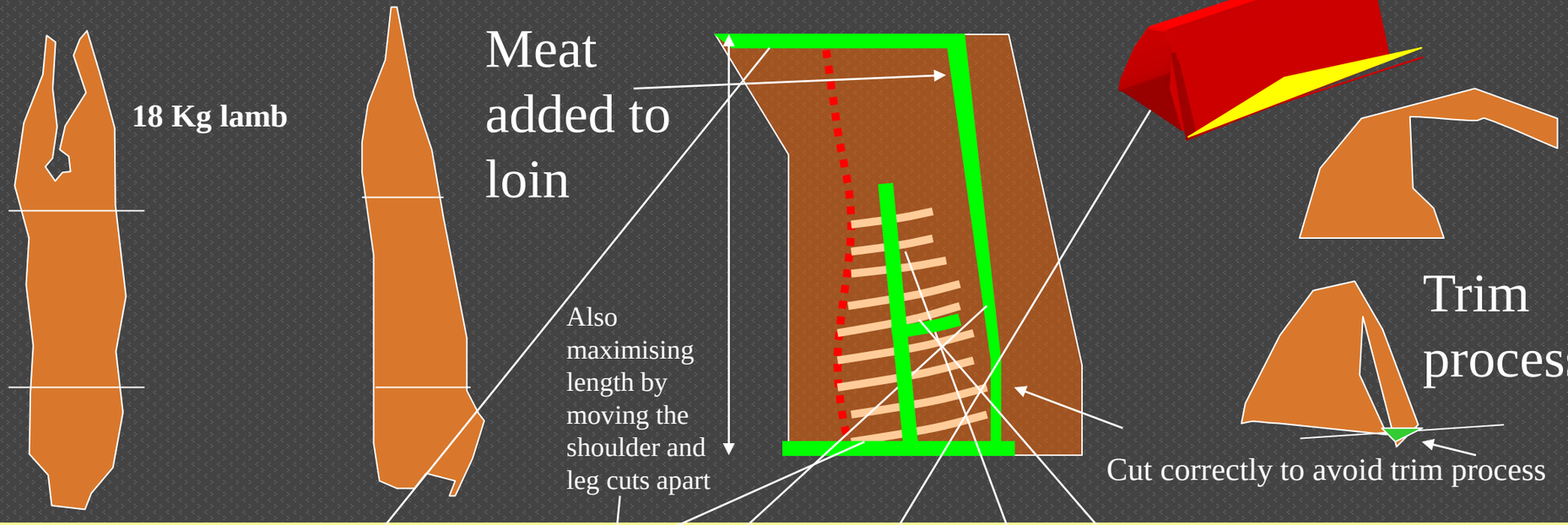


Trim process

Cut correctly to avoid trim process

| **Saving calculation against 5mm shift in cut** | | | | **and optimising yield on rib tip cuts** | | | 9th Oct 2001 |
|---|---|---|---|---|---|---|---|
| 18 | Kg carcass Measured | | | | | | |
| | A | B | C | D | E | F | |
| Gain | Leg-Loin | Shoulder-Loin | Brst - Loin | Trim-Loin | Rib Tip - Loin | Meat btwn Ribs | |
| £diff | =loin-leg | =loin-shoulder | =loin-Breast | =lion-Trim | =loin-breast | =loin-waste | |
| gs/5mm/half | 30 | 40 | 30 | 15 | 50 | 30 | |
| Lambs/year | 731000 | 731000 | 731000 | 731000 | 731000 | 731000 | |
| Kg/year/lamb | 43860 | 58480 | 43860 | 21930 | 73100 | 43860 | |
| DIFF £ | 1.75 | 3.71 | 4.76 | 4.18 | 4.76 | 6.19 | |
| £/year | 76,755 | 216,961 | 104,387 | 91,667 | 347,956 | 271,493 | |
| | | 5 mm extra | Extra Chop | **Total Saving** | | Leg | 4.44 |
| Prim. Cutting | A+B+C | 385,383 | 488,162 | **873,545** | | Shoulder | 2.48 |
| Rib tip Cut | 3*C+E+D | 765,503 | | **765,503** | | Chops | 6.19 |
| Meat btwn ribs | F | 271,493 | | **271,493** | | Breast | 1.43 |
| | | | | | | Trim | 2.01 |
| **Total saving per year from this approach** | | | | **1,910,542** | | Waste | - |

# Tests conducted




| **Saving calculation against 5mm shift in cut** | | | | **and optimising yield on rib tip cuts** | | | 16-Jan-02 |
|---|---|---|---|---|---|---|---|
| 18 | Kg carcass Measured | | | | | | |
| | A | B | C | D | E | F | |
| Gain | Leg-Loin | Shoulder-Loin | Brst - Loin | Trim-Loin | Rib Tip - Loin | Meat btwn Ribs | |
| £diff | =loin-leg | =loin-shoulder | =loin-Breast | =lion-Trim | =loin-breast | =loin-waste | |
| gs/5mm/half | 30 | 40 | 30 | 15 | 50 | 30 | |
| Lambs/year | 731000 | 731000 | 731000 | 731000 | 731000 | 731000 | |
| Kg/year/lamb | 43860 | 58480 | 43860 | 21930 | 73100 | 43860 | |
| DIFF £ | - 0.17 | 1.79 | 2.84 | 3.42 | 4.27 | 4.27 | |
| £/year | - 7,456 | 104,679 | 124,562 | 75,001 | 312,137 | 187,282 | |
| | | 5 mm extra | Extra Chop | **Total Saving** | | Leg | 4.44 |
| Prim. Cutting | A+B+C | 172,224 | 235,528 | **407,752** | | Shoulder | 2.48 |
| Rib tip Cut | 3*C+E+D | 760,825 | | **760,825** | | Chops | 4.27 |
| Meat btwn ribs | F | 187,282 | | **187,282** | | Breast | 1.43 |
| | | | | | | Trim | 0.85 |
| **Total saving per year from this approach** | | | | **1,355,859** | | Waste | - |

# Cut quality

# Primal cut layout