



PROJECT NO: FP6-017615

MEATGRADING

*Automatic non-invasive system for EUROP carcass grading of swine,
beef and lamb using cross sectional electrical conductivity*

Co-operative Research (Craft)

Horizontal Research Activities Involving SMEs

PUBLISHABLE FINAL ACTIVITY REPORT

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Version 01 - Draft

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1. PROJECT EXECUTION

PROJECT OBJECTIVES

Carcass classification is an important tool for correct functioning of the meat industry and is used as the basis for the financial transaction between the meat processor and the farmer. The current beef/sheep grading methods have been criticized for being subjective and inconsistent. Recommendations have been made by the industry to move toward mechanical carcass classification systems¹ which would be more acceptable as the basis of quality-based payments.

The key objective of this proposal is the development of a cost-effective, automatic, objective classification system to provide an accurate SEUROP classification for pigs and EUROP classification for beef and sheep carcasses, based on non-invasive and non-contact methods. In addition, given current trends in pig, sheep and beef sectors, a need exists for equipment that can accurately predict the meat composition and yield of primal cuts. In short this project delivers the following strategic objectives:

- Expand the knowledge of SMEs within the meat industry (livestock breeders, dealers, slaughterhouses, meat processors and packers) by enabling them to shift from resource intensive, human-judgment-based meat grading and classification methods towards objective technological systems, which will enable them to successfully determine meat specifications and thus improve their competitiveness in European and global markets by enabling them to raise the standards of the meat they supply.
- Developing a non-invasive low cost technology for classification of carcasses, based on magnetic induction tomography and pattern recognition of 3D shapes
- Perform pre-normative research in the area of carcass classification in order to arrive at a grading system which will pass the criteria proposed by the EU for approval of mechanical grading systems, e.g. the first criterion for fat class, namely that at least 88% of the predictions should be within 1 subclass of the reference panel score.
- Address common problems and challenges associated with raising the standards of meat quality across Europe and ensuring that uniform systems for carcass classification are implemented on a European-wide scale to safeguard the health and safety of European consumers.

The scientific objective of the project will be centered on the adaptation of Magnetic Induction Tomography (MIT) to provide a non-contact measure of carcass conductivity in multiple sections of a pig, beef and sheep carcasses. A further scientific objective lies in developing low cost Machine Vision methods to provide beef and sheep conformation data, and other carcass dimensions. Correlation equations will be developed to determine carcass fat class (and %yield) using carcass weight, conductivity, and geometric data (lengths, widths, volumes, etc.) from the Video Image Analysis (VIA) system, as inputs.

The overall technical objectives will be the development of an automatic grading machine to provide SEUROP pig classification and EUROP beef and sheep classification. The machine is to be compatible with industry requirements (i.e. where carcasses are hung from overhead tracks and processed at up to 1200 head per hour), and is to provide carcass classification using non-contact inspection methods. In order to achieve this, the following specific technical and operational objectives need to be fulfilled:

- Development of a magnetic induction sensor and associated electronics, to determine total conductivity of a cross section of carcass, to estimate fat/muscle composition in that cross section.
- Development of a module which contains multiple magnetic induction sensors to estimate the composition of muscle in multiple cross sections of the carcass. It is envisaged that each section sensor would be aligned with a different primal region, to provide fat/muscle composition information for meat cuts with high market value. This data would also be used to provide an overall figure for the carcass fatness class.
- To develop a low-cost Machine Vision system to determine EUROP conformation for beef and sheep carcasses, and to provide carcass geometric data (lengths, widths, volumes, etc) to aid accuracy of fatness class determination.
- To develop correlation equations based carcass weight and MIT and VIA measurements to provide an accurate EUROP grading.
- Integration of the above components into an industrial prototype for evaluation in commercial abattoirs.
- To ensure that the grading system achieves EU approval for use as a mechanical grading machine.
- To ensure that the system can be supplied to the market at a cost of below €50k, which makes it accessible to SMEs.

CO-ORDINATOR CONTACT DETAILS

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CONTRACTORS INVOLVED IN THE PROJECT

Partic. Role ¹	Partic. no.	Participant name	Participant short name	Country	Date enter project	Date exit project
CR	1	JMP Ingenieros	JMP	Spain	M1	M30
CR	2	JCB Electromecánica. S.L.	JCB	Spain	M1	M30
CR	3	E & V Technology	E+V	Germany	M1	M30
CR	4	Rovitech	ROVI	Belgium	M1	M30
CR	5	Gm Steel Fabrications	GMTEEL	Ireland	M1	M30
CR	6	Glendale Frozen Food Ltd	GLEN	UK	M1	M30
CR	7	Matadero Varderrobles	VARDE	Spain	M1	M30
CR	8	Nixon W & Sons LTD	NIXON	UK	M1	M30
CR	9	Dawn Meats	DAWN	Ireland	M1	M30
CR	10	Centre de Recerca i Investigació de Catalunya	CRIC	Spain	M1	M30
CO	11	Universitat Politècnica de Catalunya S.A.	UPC	Spain	M1	M30
CR	12	Feltaloi És Kutató Központ Szolgáltató Korlátolt Felelősségű Társaság - Innovation and Research Centre	FKK	Hungary	M1	M30
CR	13	TEAGASC – Irish agriculture and food development authority	TEAGASC	Ireland	M1	M30

¹ CO = Coordinator / CR = Contractor

WORK PERFORMED AND END RESULTS

Meatgrading project has studied the combination of two different non-contact technologies (i.e. Magnetic Induction and Video Image Analysis) for the assessment of S/EUROP grading of pig carcasses. Additionally, Magnetic Induction technology can be used to determine the % saleable meat in beef and sheep carcasses.

The project has followed a top-down design methodology, starting by an analysis of the market needs and deriving best-concept designs and specifications for the development of the system components which make up the system.

Each technology has been proposed to accomplish specific objectives:

- Magnetic Induction: this technology was selected to determine the conductance of the carcasses. As the conductance of the muscles is 20-30 times greater than fat, it is possible to determine the % lean of a carcass. The conductance measurement by means of MI technology can be applied to all types of biological tissues and therefore can be applied to different animal carcasses (pig, beef and sheeps).

- Video Image Analysis: this technology was employed to provide complementary information from pig carcasses like the angle of the ham and volume of the ham.

Both system has been designed, developed and characterised at laboratory scale taking into account practical considerations such as the operational environment, maintenance, cleaning and mechanical noise.

Both systems were tested in pig processing pilot plant at the National Food Center, TEAGASC (Ireland). 45 pigs were slaughtered and analysed with MI and VIA systems using a CT-scanner as a reference method. Results were satisfactory for both systems and next step was the testing at industrial level.

The MI system was installed in a beef processing plant (Dawn Meats, Middleton, Ireland) and more than 300 carcass were analysed. The objective was to determine the potential of the MI system to determine the % lean of beef carcasses. The reference method used was the VBS2000, a VIA system from E+V (Germany) that is capable to estimate the % lean for steers. The correlation between the MI system and the VBS2000 was satisfactory and is expected to extend the experiments using an authorised reference method (Ct-scanner for instance).

On the other hand, MI and VIA system has been tested in several pig abattoirs. System has been tested in Ireland (Dawn Meats), Belgium (Detry) and Spain (Varderobles). More than 4000 pig carcasses has been scanned and the results compared with the official grading methods (Hennessy Grading Probe and PIC2000). Results obtained indicates that Meatgrading (MI + VIA) could be used as a grading system in a pig abattoir.

The following table summarizes the advantages and limitation of the current state of the art grading system for pig carcasses as well as the advantages offered by the Meatgrading system.

Current State of the art pig grading systems	Advantages and limitations
Hennessy grading probe Fat-o-Meter Ultrafom 300	<ul style="list-style-type: none"> - Based in fat and muscle depth (indirect parameter) - Only suitable for pig carcasses - Relative Low cost 12.000-15.000€ (commercial cost) - Do not provide extra information about conformation of carcass - Requires an operator - Repeatability problems due to variatations in the probe insertion - Invasive (HGP and Fat-O-meter) or requires contact (Ultrafom) - Grading speed, up to 300 carcass/hour - This technology can not be used for individual pieces (ham,etc)
AUTOFOM	<ul style="list-style-type: none"> - Based in the measurment of fat and muscle depth at several points - Requires contact with the pig carcass (only useful for pigs carcasses) - High cost (250.000€) - Carcass grading up to 1200 carcass/hour - Allows the grading of individual parts (ham, loin, belly, etc) - Must be installed after the de-hairing process
VCS2000	<ul style="list-style-type: none"> - Based in Video Image analysis - Limited accuracy - Provides information of different parts of the carcass (ham, loin, belly, etc) - Relative high cost 120.000€
TOBEC	<ul style="list-style-type: none"> - Determine the total conductance of the carcass (Direct parameter) - Relative high cost (50.000€) - Requires contact with a conveyor belt - Carcass has to be de-attached and attached to pass it through a tunel. - Can be used to grade different main cuts (ham, loin, belly, ect) - Not suitable for determining % lean of whole beef carcasses (physical limitations of the tunnel diameter) - Do not provide info about conformation of the carcass
Meatgrading	<ul style="list-style-type: none"> - Non contact measurement - Grading based in the conductance of meat (direct parameter) - MI can be operated alone (without VIA system) to provide S/EUROP grading - In combination with VIA system, provides info about conformation

	<ul style="list-style-type: none">- Suitable for determining % lean of pig / beef / sheep carcasses.- Relative low cost (component cost): 10k€ for the MI and 10k€ for the VIA.- Low maintenance cost- Easy installation in the processing line.- Easy to calibrate- Excellent repeatability- Grading speed, more than 800 carcass/hour- Technology can be applied to grade individual parts (ham, loin, belly).- Dimensions MI: 60cm x 150cm x 3200cm- Requires a minimum distance between carcasses of 70 cm.- Can be operated automatically (without operator)
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2. PLAN FOR USING AND DISSEMINATING KNOWLEDGE

For the public dissemination of the results, a website is available (<http://meatgrading.cric-projects.com>).

Also a Multimedia Guide has been published by the Consortium, which explains in details the motivations and needs that resulted in this project, providing contact information about the partners.

The Consortium is willing to demonstrate the results to companies interested on collaborating in the development of the commercial prototype and/or its exploitation.

In this sense, the preferable exploitation path is the commercialization of the technology to manufacturers of speed drivers, which would benefit of a very low cost electronic embedded system to add diagnosis functionalities to these devices.

It is envisaged that this business will require a minimum investment on developments.

It is planned to make public the results in the following months, after applying for several patents.

Mr. Eduardo Ramirez from JMP Ingenieros was chosen the chairman of the SME consortium to manage the technology exploitation.