



Wood furniture sector outlook innovation, growth and development

La filiera legno-arredo: innovazione e sviluppo nel contesto internazionale

SIXTH FRAMEWORK PROGRAMME

HORIZONTAL RESEARCH ACTIVITIES INVOLVING SMES
CO-OPERATIVE RESEARCH

SHEET CUTTING AND PROCESS OPTIMIZATION
for furniture enterprises

Ferdinando Pezzella
pezzella@diiga.univpm.it

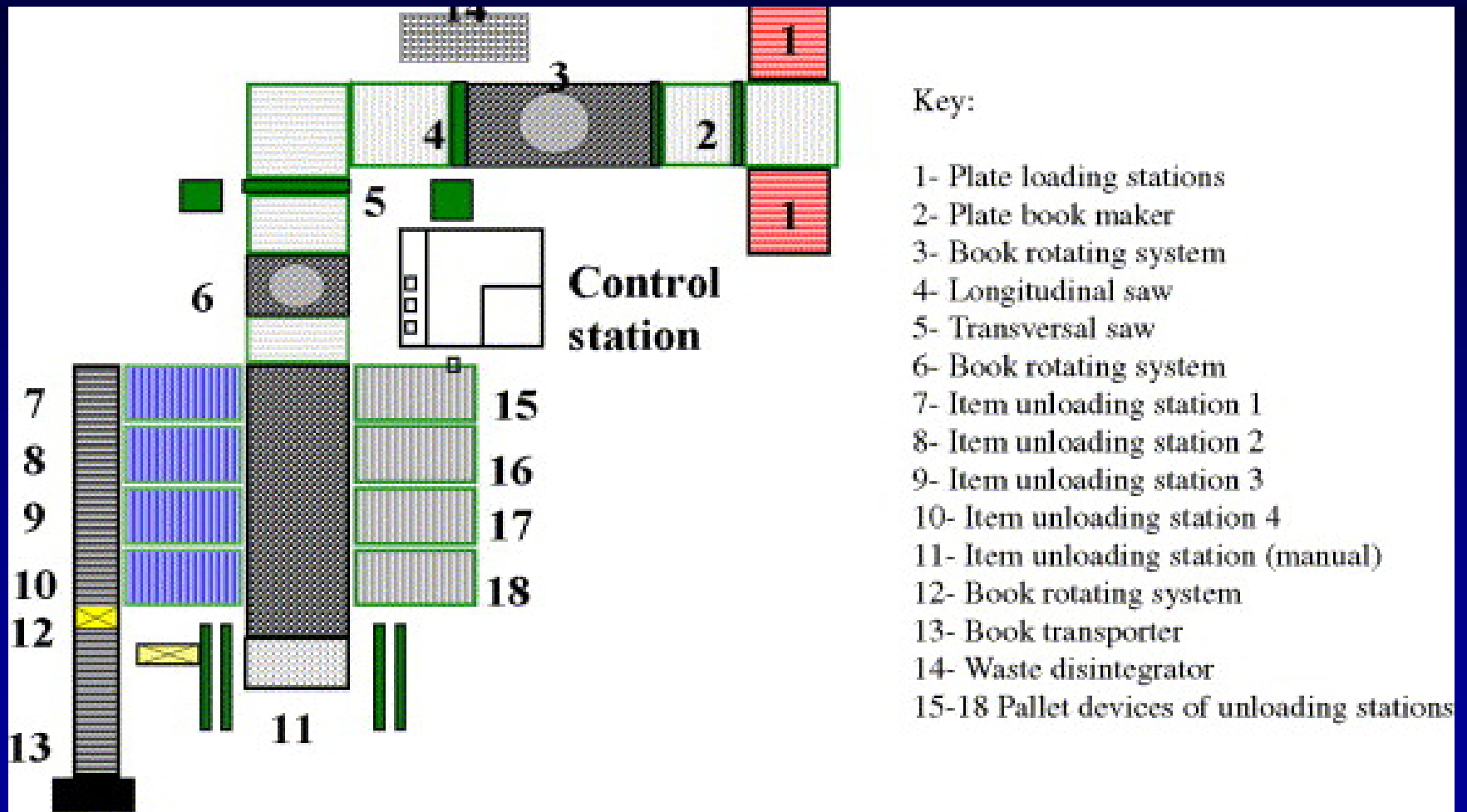
DIPARTIMENTO DI INGEGNERIA INFORMATICA, GESTIONALE E
DELL'AUTOMAZIONE
UNIVERSITA' POLITECNICA DELLE MARCHE
Via Brecce Bianche, Ancona (Italy)

CONTENT OF THE PRESENTATION

Ferdinando Pezzella

1. Panel – sizing center
2. Project summary
3. Project objectives
4. Relevance to the objectives of Co-operative Research
5. Contractor list
6. Potential Impact
7. Workpackage list
8. Workplan – for full duration of the project
9. Optimization software for furniture enterprises: overview
10. Evaluation and dissemination results
11. Experimental results on real world problems
12. Project resources and collaborations

PANEL – SIZING CENTER



Scheme of an angular panel-sizing center (cutting machine)

PROJECT SUMMARY

- Project is focused on **furniture industries** operating on semi-finished components by computer controlled wood-cutting machines and automated material-handling systems to produce finished good types
- The most relevant problem consists in an optimal selection of standard stock sizes and cutting stock sheets into smaller pieces according to specified requirements so that the total trim loss is minimized (**cutting stock problem**)
- The efficiency of the production process also depends on the organization of a good production scheduling and a good cutting pattern sequence in order to minimize set-up costs (**scheduling and pattern sequencing problem**)

PROJECT OBJECTIVES

Reduce the cost of the raw materials

- optimal stock size selection in cases of two-stage cutting processes
- minimization of trim loss through the adoption of optimal sets of cutting patterns
- optimal reuse of material, when applicable

Improve the internal and external logistics

- optimal stock size selection to reduce stock assortment
- work-in-process minimization through optimal sequencing of cutting operations
- optimal two- and three-dimensional pallet/container loading
- minimizing the number of bins used

Facilitate the application of automation systems

- standardization of cutting operations
- specification of a Manufacturing Execution System (MES) and manufacturing control systems based on Advanced Process Control

Improve the internal organization of labour

- improvement of material handling through optimal stock size selection
- reduction of part transfers on the shop floor through optimal pattern sequencing
- reduction of machine set-up times and manual cutting machines

RELEVANCE TO THE OBJECTIVE OF CO-OPERATIVE RESEARCH

- The project aims at developing technologically advanced **software tools** to support a wide set of operations related to the wood-cutting phase in the European furniture industry
- The project develops **advanced optimization methods** to solve complex problems arising in the management and control of manufacturing processes and systems adopted by European SMEs
- A further output is a **prototype of decision support software** able to integrate state-of-the-art optimization features for cutting stock, production scheduling, pattern sequencing and pallet loading problems in automated manufacturing systems

CONTRACTOR LIST

- SMEs :**
1. Mobilpref SpA, Ancona (I) – Furniture semi-finished articles
 2. Softel sas., Terni (I) – Software house and ICT solution development
 3. Benicarlò Moble 2000 s.l., Benicarlò (E) – Furniture production

RTD performers

1. Università Politecnica delle Marche - Dipartimento di Ingegneria Informatica, Gestionale e dell'Automazione, Ancona (I)
2. Università degli Studi dell'Aquila - Dipartimento di Informatica, L'Aquila (I)
3. Universidade do Minho – Departamento de Produção e Sistemas, Braga (P)

OTHER ENTERPRISES - END-USERS

1. COSMOB - Consorzio del Mobile, Pesaro (I)
2. AIDIMA – Asociación de Investigación y Desarrollo en la Industria del Mueble y Afines, Valencia (E)

POTENTIAL IMPACT

- The main innovation of this project is the conception of automated wood-cutting machines with control systems based on advanced **optimization methods**
- The flexible system architecture coupled with the new heuristic optimization methods recently developed in literature is a **substantial step forward** for planning and control of manufacturing systems for the furniture industry
- The optimization problems arising in the furniture industry are **very complex**, and SMEs cannot generally solve them efficiently without external collaboration
- The efficiency of a supply chain involving cutting operations can greatly benefit from **decision support systems**

WORKPACKAGE LIST

WP No	WORKPACKAGE TITLE	Lead contractor
1	PROCESSES ANALYSIS AND TECHNICAL REQUIREMENT DEFINITION	COSMOB
2	OPTIMIZATION MODELS FOR CUTTING, PACKING, SCHEDULING AND INVENTORY CONTROL	UNIVAQ
3	OPTIMIZATION ALGORITHMS FOR CUTTING AND PACKING	UMINHO
4	OPTIMIZATION ALGORITHMS FOR PATTERN SEQUENCING AND PRODUCTION SCHEDULING	UNIVPM
5	SOFTWARE PROTOTYPE DEVELOPMENT FOR SHEET CUTTING AND PROCESS OPTIMIZATION	SOFTTEL
6	SOFTWARE TESTING RESULTS AND COMPARATIVE ANALYSIS WITH THE PREVIOUS PERFORMANCES	SOFTTEL
7	PROJECT MANAGEMENT AND MONITORING	UNIVPM
8	EVALUATION AND DISSEMINATION OF RESULTS	COSMOB

WORKPLAN – for full duration of the project

1ST YEAR

WP7 - PROJECT MANAGEMENT AND MONITORING

WP1 - PROCESS ANALYSIS AND TECHNICAL REQUIREMENT DEFINITION



WP2 - OPTIMIZATION MODELS FOR CUTTING, PACKING, SCHEDULING AND INVENTORY CONTROL

WP3 - OPTIMIZATION ALGORITHMS FOR CUTTING AND PACKING

WP4 - OPTIMIZATION ALGORITHMS FOR PATTERN SEQUENCING AND SCHEDULING



WP5 - SOFTWARE PROTOTYPE DEVELOPMENT FOR SHEET CUTTING AND PROCESS OPTIMIZATION

WP6 - SOFTWARE TESTING RESULTS AND COMPARATIVE ANALYSIS WITH THE PREVIOUS PERFORMANCES



WP8 - EVALUATION AND DISSEMINATION OF RESULTS

2ND YEAR

OPTIMIZATION SOFTWARE FOR FURNITURE ENTERPRISES: OVERVIEW

PROFESSIONAL CUTTING STOCK OPTIMIZATION SOFTWARE (25)

Company Continent	Europe 13	North America 9	Oceania 1	Asia 1	Africa 1
Software Cost	< 500€ 13	> 500€ & < 1000€ 2	> 1000€ 3	n.d. 7	
Trial Version Available	yes 22	no 3			

MOBILPREF : *Optisave* – GIBEN INTERNATIONAL spa (Italy)

BENICARLO' : *Optiplanning* – BIESSE Group spa (Italy)

NOTE: IN GENERAL FEW SOFTWARE RESOLVE ALSO PATTERNS SEQUENCING AND PACKING PROBLEMS AND ARE CNC COMPATIBLE

EVALUATION AND DISSEMINATION RESULTS (SOFTTEL)

Structure of the SCOOP project web site:

www.scoop-project.net

- Designed in order to allow the information exchange among the partners
- Visualization of the research activity in progress of the projects
- Improvement of the management and monitoring of the project
- Dissemination planning including publications in specialized journals and in the conferences acts, minutes of meetings etc..
- The access to confidential information reported in the web site by each partner it will be possible using a password supplied by SOFTTEL
- Reporting and financial project sheet every six month for each partner

EXPERIMENTAL RESULTS ON REAL WORLD PROBLEMS (UNIVPM)

- **Real world instances of Pattern Sequencing Problems**

Panel sizing center in wood-working enterprises

Collected instances from Mobilpref

Collected instances from Benicarlò Moble 2000

- **Computational results and comparative analysis**

List of computational results for each instance of Mobilpref and BM 2000

Comparative analysis with OPTISAVE solutions on Mobilpref instances

Comparative analysis with OPTIPLANNING solutions on BM 2000 instances

Evaluation of efficiency and effectiveness of the developed algorithm

- **Future research**

New formulations in terms of Linear Integer Programming for the MOSP to find better lower bounds of the objective function obtained solving the associated linear relaxations

PROJECT RESOURCES AND COLLABORATIONS

- **UNIVERSITA' POLITECNICA DELLE MARCHE – DIIGA:**

PROF. FERDINANDO PEZZELLA

DR. FABRIZIO MARINELLI (RESEARCHER)

DR. ROBERTO ROSETTI (DOCTORAL GRANT)

DR. BARBARA COCETTA (WP7, WP8 – MANAGEMENT and EVALUATION)

DR. SYLVIA TIETZEN (WP7, WP8 – MANAGEMENT and EVALUATION)

ENG. GIONATA MASSI (WP4, WP5, WP6- OPTIMIZATION SOFTWARE)

ENG. MARCO CIRI (WP4, WP5, WP6- OPTIMIZATION SOFTWARE)

Eng. LUDOVICO CATANI (WP5, WP6- OPTIMIZATION SOFTWARE)

- **EXTERNAL COLLABORATIONS:**

DEPT. OF PURE AND APPLIED MATHEMATICS – Università di Padova

OPERATIONS RESEARCH GROUP – DAUIN (Politecnico di Torino)

INSTITUTE OF SYSTEMS ANALYSIS AND INFORMATICS (CNR – Roma)

BIESSE GROUP SpA (Pesaro - Italy)