

A BIG LEAP FORWARD – THE NEW EUROPEAN COST ACTION E 36 "MODELLING AND SIMULATION IN THE PULP & PAPER INDUSTRY"

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Abstract

The COST programme is one of the oldest EU-funded instruments to support the European scientific community. Hundreds of actions have been launched during the last decades, bringing together thousands of scientists. This year a new action concerning modelling and simulation in the pulp and paper industry has been started with a duration of 4 years. The main objective of the Action is to promote the development and application of modelling and simulation techniques in pulp and paper manufacturing processes. This is intended to eg. reduce emissions and increase the productivity and cost-efficiency of the processes. The main benefit will be a better understanding of the mechanisms of the processes and their control loops. This will help to find solutions for currently pending problems in the paper industry: improving the paper quality, optimising the wet end chemistry, enhancing the runnability and reducing emissions by improving process design, process monitoring and decision support during operation. In the long run this action should also contribute to designing superior or new product properties.

Keywords: COST, Modelling, Simulation, Pulp and Paper, Action E36

Introduction

The pulp and paper industry is currently faced with heavy economic pressure. The shut down of mills and a strong tendency to form even bigger companies clearly reflects the impact of a tight market on the paper industry. Within the mills ever less people are confronted with processes of growing complexity. Sufficient staffs of technologists are missing in many mills.

As a consequence even today trial and error appears to be the most common approach in this traditional industry. Mill personnel are fully occupied with the task of keeping the production up. No time is left for a systematic approach towards an optimised state of the production process. A lot of profit and time is lost this way.

In this context modelling and simulation will be of major importance for the paper industry in the near future. It provides the industry with new answers based on a far better understanding of the process.

This know how is "built into" the process either through an optimised process design or an intelligent process control approach. In addition it can help to identify the causes for operational problems and suggest solutions.

Computational simulation in the pulp and paper industry

Problems concerned

Although the pulp and paper industry has used balancing calculations and process control for a very long time, its scope of modelling and simulation applications is not as comprehensive as that of many other modern industries. This is largely because of the complicated nature of the processes concerned in terms of raw material characteristics, the difficulty of applying real-time control tools to processes that incorporate substantial time delays, and the high degree of

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interactions between the various production processes. As an added difficulty, some key parameters and variables of the industry's raw materials and products cannot be quantified quickly and automatically. Some of these problem fields come along with a need for an improved environmental performance of the mills. Reasons for quite many operational problems are the increasing use of recovered paper and the narrowing of water cycles.

Hope of overcoming these problems arises from developments in a wide variety of fields, including control science and process simulation (including real-time simulation). New techniques, such as multivariate statistics, software sensing algorithms and general stochastic distribution modelling and control, will enhance the controllability and permit a global optimisation of papermaking processes.

Indeed, some of these techniques have already been explored in the pulp and paper industry. Examples are data analysis tools for improved process efficiency, new formation sensors and stochastic distribution control algorithms.

Development of knowledge in pulp and paper science and technology concerning simulation

The number of publications has had a dynamic development in the past 30 years (Fig. 1). This development has accelerated during the late '90s.

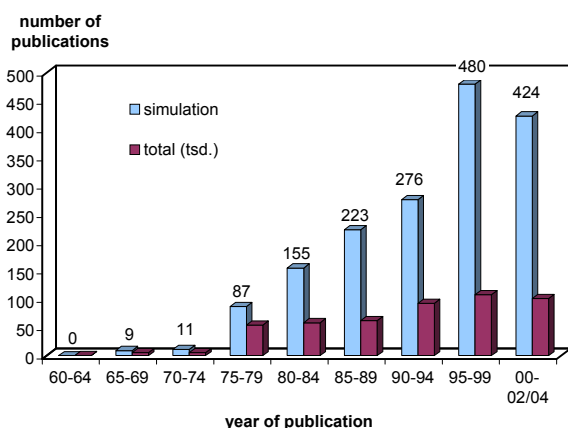


Fig. 1 Development over time of the number of publications in pulp and paper concerning simulation [1]

The most important topics handled are drying or otherwise energy related (Fig. 2). This is quite understandable since the paper industry relies far more on energy than other industries. 4.7% of the Cost is energy compared to 1.2% as an average of

manufacturing [Sweden; 2]. The number of publications concerning coating, sheet formation and grade changes has had an exceptionally high growth during the past four years. This reflects most recent areas of high interest in pulp and paper.

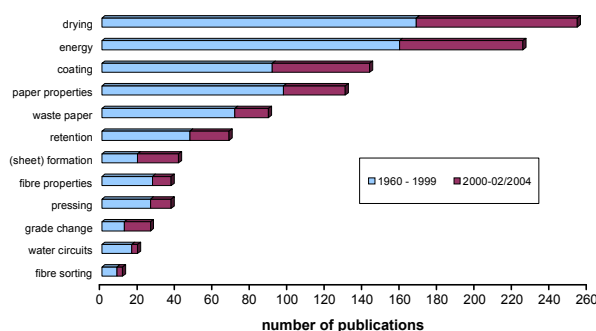


Fig. 2 Thematic distribution of publications in pulp and paper concerning simulation [1]

Evaluation of the market involved

The market for services concerning simulation activities in pulp and paper is relatively small (Tab. 1). This traditional industry is not yet using simulation to a great extent. Still, compared with approx. 2.2% rise in paper and board production between 2002 and 2003 [3] the growth rate of simulation services shows a dynamic development. This mirrors the evolvement of the scientific and technological progress described in the previous chapter.

Tab. 1 Size of market for simulation software and services in 2002 and growth rate of turnover (2002 – 2007) [4]

	2002	Turnover	Growth rate
		mUS\$	%
all industries		338.7	8.5
paper industry		7.7	8.2

It can reasonably be assumed, that – as in other industry sectors [4] – software shipping has a higher share of the turnover compared to services and consultancy.

The COST funding mechanism

COST is one of the oldest funding mechanisms of the European Commission. It has been established in order to promote the exchange of scientific

knowledge within the European Community [5]. As a funding mechanism it is a predecessor of the Networks of Excellence (NoE) promoted within the 6th Framework Programme. COST is currently funded by the European Community within the Framework Programme and managed by the European Science Foundation (ESF) [6].

Objectives of the COST Action E36

The main objective of the Action is to promote the development and application of modelling and simulation techniques in pulp and paper manufacturing processes. This is intended to reduce emissions and increase the productivity and cost-efficiency of processes, for example.

The main benefit will be a better understanding of the mechanisms of the processes and their control loops. This will help to find solutions for currently pending problems in the paper industry: improving the paper quality, optimising the wet end chemistry, enhancing the runnability and reducing emissions by improved process design, process monitoring and decision support during operation. In the long run this Action should also contribute to designing superior or new product properties.

The Action has been started in January 2004 and will last until January 2008. The Action currently has 12 participating countries: Austria, Belgium, Finland, France, Germany, Netherlands, Norway, Slovakia, Slovenia, Spain, Sweden, and United Kingdom. 17 scientists represent their countries in the Management Committee. Within this group 9 professors from 7 universities are present. 8 national research institutes are participating. The work is organised in three working groups consisting of 41 scientists and technologists including 5 participants from industry.

Activities of the Action

As one of the activities to achieve the Actions scientific goals, the partners intend to compile all research projects planned, currently under way or recently finished in order to get a clear picture of the current work focus of research activities. This could also lend itself as a basis for new research and/or project related partnerships on a European level. The scientific programme will also include other activities, aimed at exchanging and disseminating ideas, findings and new knowledge as described in the following.

Work group discussion meetings

The constitutory meetings of the working groups were conducted in March 2004. Next meetings are planned to happen in September. Currently the main focus of activities is to define the priorities for the first half of the action. A more detailed description of the results reached so far is given in the following chapter concerning working group activities.

Organisation of workshops, seminars, conferences and publication of proceedings

A first conference was organised in Munich [7]. Being situated in the beginning of the COST Action E 36, it served as an ideal option to define the state, modelling and simulation in pulp and paper has currently reached. Against the background of what has been presented during the two days the following clusters could be identified:

- spreadsheet based object oriented process models,
- tools for monitoring and evaluation of online data,
- model based process optimisation and
- in smaller number, some approaches to model single process steps as the modelisation of the press- or drying section.

One large trend is to upgrade static simulation tools by integration of dynamic abilities into the simulators used. A big issue still to be solved is to define quality parameters for the validity of both, steady state and dynamic simulation models. In many papers more accurate models of the processes were identified as still missing. Thus, one important task will be to develop proper generic models of key processes that ideally will be available for common use within the industry.

Publication of targeted and periodical reports and the final report

It is planned to publish a survey on the current use of simulation software within 2004. Furthermore the publication of reports on the exchange of know-how contained in models and recommendations on suitable software tools and requirements for further software development is intended. An Action specific web page has already been set up in July 2004 [8]. Information concerning participating partners can be found there.

Working group activities

Working group A

Working group (WG) A will cover all activities concerning the use of modelling and simulation as an R&D tool, for an optimal process design, for use in operator training and trouble shooting.

To achieve this aim, the WG will cover all topics related to the modelling and simulation of the whole pulping and paper production process. This includes chemical reactions in digesters, the complex pulp washing process, the modification of fibre properties in the stock preparation process, the modelling of the complex wet end chemistry and of water loops and energy balances. Special attention will be given to the use of dynamic process simulation, real-time simulation tools and model validation tools.

The thematic focus of the working group is:

- standard model interfaces for model portability
- evaluation, calibration and validation of models
- property modelling
- water system chemistry modelling
- optimisation and simulation
- resource saving
- intelligent models
- grade-change optimisation
- data reconciliation
- diagnostics systems
- state-of-the art and who is who in modelling and simulation

The next meeting will focus on model evaluation, calibration and validation.

Working group B

WG B will concentrate on the use of simulation models during the operation phase. It focuses on model-based monitoring, simulation-based operations decision support and model-based control.

For this purpose, it is intended to look deeply into multivariable process control, fast data acquisition, high-dimensional data analysis and reduction, non-linear system modelling and multivariable system optimisation.

The thematic focus of the working group is:

- understanding the operator behaviour, decision making

- dynamic optimisation, MPDS, algorithms and applications
- combining physical simulators, grey box models and black box modelling
- model based and/or simulation based diagnostics

Next activities are intended to refine the thematic focus. The benefit and infrastructure analysis on application topics is to be explored.

Working group C

WG C intends to bring together software developers and (possible) users in order to reach agreements on the contents, features, relevance and performance of software products. Existing software packages should be evaluated. User needs and the goals of further developments are to be established. Discussions will include the development and use of software packages. In addition WG C will take care of integration aspects (simulation software in mill environments).

WG C is specially intended to take care of the knowledge exchange between the WG's and to foster the development of better simulation tools with a high compatibility across the platforms used. This WG will therefore have a different schedule, organising dedicated workshops to meet with suppliers and developers of software in order to exchange knowledge and enhance software development.

WG C has already started a survey of all partners in the COST Action E36 to gather information on current software use. In addition, all available software evaluations performed by the partners have been collected and will be processed by WG C. The results of this survey on software use will be published as a mini-booklet within 2004. Currently 13 organisations in 8 countries are taking part.

Workshops are planned to cover the topics of software evaluation, mathematical tools for data analysis, neural networks, multivariate analysis, data handling and pre-processing before simulation and on requirement specifications for future simulation tools.

Summary and Outlook

The COST Action E36 is a promising approach to foster the development of modelling and simulation in the pulp and paper industry. The expertise of the European paper industry is gathered in this action. It will contribute heavily to

the acceptance of modelling and simulation approaches in the pulp and paper industry.

During the next years all possible users of modelling and simulation technologies in the pulp and paper industry will have to define their position in terms of staff, software and total involvement.

The most important task for all software and solution developers will be to show the possible economical benefit the pulp and paper industry has by using the tools developed.

A network of excellence has been created and will possibly lead to numerous successful follow up activities as has been proven by other COST Actions.

- [1] Combined search results in literature databases Papertech (www.ptspaper.de) and Pirabase (www.pira.co.uk)
- [2] Bergman MA, Johansson P. *Large investments in the pulp and paper industry: a count data regression analysis*. Forest Economics 2002;8(1): 29-52.
- [3] *Production Statistics 4th Quarter*. Brussels: CEPI, 2004
- [4] *Process Simulation and Optimization*. Dedham: ARC, 2003
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- [5] COST homepage: <http://cost.cordis.lu>
- [6] CORDIS homepage: www.esf.org/
- [7] Kappen J., Bienert Ch. *Simulation and Process Control for the Paper Industry*. Munich: Proceedings PTS MS 441, 2004.
- [8] www.costE36.org