

# LISCOS

## Project Reference

**LISCOS:** Large Scale Integrated Supply Chain Optimisation Software Based upon Branch & Cut and Constraint Programming Methods

**Duration:** 36 months : 2000-2001-2003

## Key words

Supply chain planning, production planning, production scheduling, distribution planning, generic models, SCM model library, new development environment, optimisation interface, mixed integer (linear) programming (MIP), branch & cut (BC), constraint programming (CP), hybrid optimisation methods.

## Objectives

The objective of the project is to develop tools and technologies for large scale integrated Supply Chain Optimisation and Advanced Planning and Scheduling software based upon state-of-the-art software for general Mixed Integer Programming (MIP), Cutting Planes / Branch-and-Cut (BC), and Constraint Programming (CP). We aim to extend and generalise the existing production planning cutting plane software "BC-PROD" in order to encompass the areas of logistics, supply chain management (SCM), integrated supply chain optimisation and the overlapping and interacting production scenarios presented by the Virtual Enterprise. The software should be effective – producing solutions of guaranteed quality rapidly and easy to use in that the user need not be an optimisation specialist, but can contribute his specific industrial expertise. The software is intended to effectively solve large-scale problems covering requirements and constraints in

- production,
- supply,
- stock-keeping,
- logistics,
- distribution of a broad range of industries in the context of
- short-term operational scheduling,

- mid-term tactical planning,
- long-term strategic planning.

The novelty of the approach is the deep integration of two technologies, which already proved their effectiveness for distinct decision levels of SCM:

- mixed integer programming (MIP) incl. branch-and-cut methods (BC) for strategic and tactical planning,
- constraint programming (CP) for short-term operational scheduling.

## Test cases

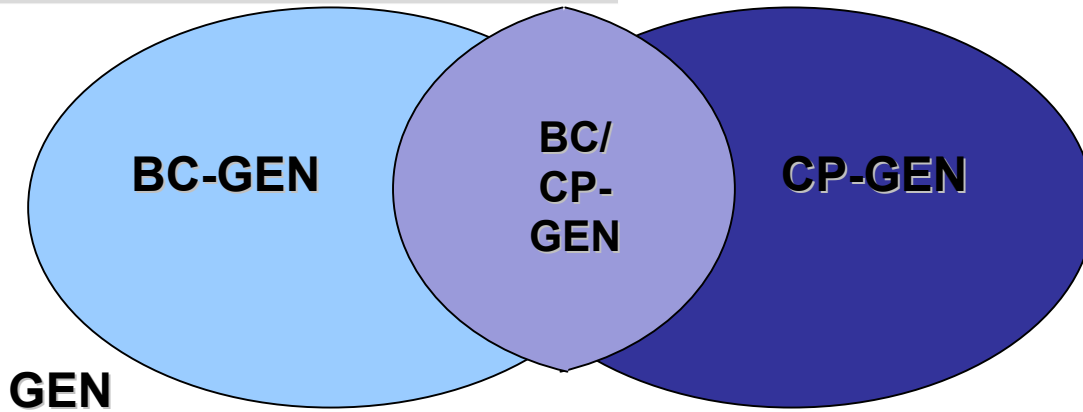
The industrial partners provide test cases that cover a broad domain of supply chain problem structures. Some of these problems are too large in scale for current SCM software capability, while the others cannot be solved satisfactorily with any available commercial or research tools. As a result, industry today can only tackle these problems inefficiently. The overall objective is to be able to get better solutions with less effort for such problems. We define what we mean by "better" solutions in these terms:

*from the application point of view :*

- significant improvement in the quality of management decisions at the strategic, tactical and operational level;
- improvement of competitiveness;
- overall improved human conditions at work;
- reduction of waste and inefficiencies in procurement, production and transportation;

*from the scientific point of view :*

- solutions that are provably optimal (e.g. throughput maximised, make-span minimised, susceptibility to failure minimised etc.);
- more precise solutions obtained with a given amount of computer time;
- larger problems solved to the same degree of accuracy;(more time periods, more machines, finer division of customer grouping etc.);
- a smaller bound of how close a solution is to the optimal one.



**Mathematical Programming models and techniques:** Mathematical Programming models have concentrated on distribution, production and process planning and design including treatment of bottlenecks, capacity and lead-time optimisation. Mixed integer programming (MIP) techniques combined with efficient problem formulations, column generation, cutting planes and heuristics based on the software XPRESS have led to powerful solutions.

**Constraint Programming technology:** Constraint Programming is a recent technology compared to Linear Programming and Mixed Integer Programming. A major contribution to CP was the introduction in 1992 of the concept of "global constraints" in CHIP by COSYTEC. Global constraints combine pre-processing and propagation techniques and are currently one of the best tools for formulating highly combinatorial problems, like scheduling and assignment.

**The combination of the two technologies will lead to the following results:**

- richness of functionality and robustness of modelling language;
- integration of new and existing MIP and CP structures and heuristics;
- robustness of the new solvers;
- effectiveness of the generic supply chain structures;
- solver time improvements versus classical optimisation methods (where available);
- comparison of system's results to current company practice; economic gains achievable by applying the system's results.

**Industrial Partners:**

- BASF AG, Germany
- Procter & Gamble Europe, Belgium
- PSA, Peugeot Citroen Automobiles, France
- BARBOT CA. LDA. (Portugal)

**Software partners:**

- COSYTEC S.A. (France),  
Software: CHIP
- DASH Associates (GB),  
Software: XPRESS-MP

**Academic partners:**

- CORE, University of Louvain-la-Neuve, Belgium
- DEIO, University of Lisbon, Portugal
- LORIA, University of Nancy, France

**For more information**

The consortium is managed by BASF

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