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0 TECHNICAL INFORMATION

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1. RESEARCH

1.0. Objectives/Concept

The objective of this research network is bringing together scientific activities in the field of deterministic scheduling of the teams which have experience of joint research on scheduling models and methods, in particular in the framework of INTAS projects (INTAS 93-257, INTAS 93-257-Ext, INTAS 96-0820) carried out in the years 1995-2000. The partnership of these teams will promote synergy on developing scheduling research to satisfy practical needs of modern manufacturing, resource planning, logistics and supply chains. The regular exchange of information within this network will be maintained by joint meetings both within the scheme of this proposal and at the international conferences and symposia on OR (Operations Research), CO (Combinatorial Optimization), MP (Mathematical Programming), PMS (Project Management and Scheduling), MAPSP (Models and Algorithms for Planning and Scheduling Problems), SCMS (Scheduling in Computers and Manufacturing Systems).

1.1. Overview of Research Activities / Conformance with the Work Programme

Research was carried out on fundamental issues in scheduling theory and on applications in manufacturing. General advances have been obtained on complexity results and the design of solution algorithms in scheduling. Particular emphasis was put on scheduling models combined with a material handling system (forming a robotic cell in which the production rate is to be maximized) and with a logistic system (in order to minimize the cost of delivering goods to the customers). New optimization methods have been developed for the design of manufacturing lines. They can be used in Decision Support Systems and CAD/CAM/CAE tools for the optimal design of complex manufacturing lines.

Main activities were carried out within the subtasks (see below) **1.1** (USouthampton, UGreenwich, UIIP NAS Belarus, BSU Minsk), **1.2** (LLI Grenoble, UMagdeburg, EM StEtienne, UIIP NAS Belarus, BSU Minsk, IM NAS Belarus, Omsk Branch SIM RAS), **1.3** (LLI Grenoble, USouthampton, UGreenwich, UMagdeburg, EM StEtienne, UIIP NAS Belarus, BSU Minsk, IM NAS Belarus, BSUIR, Minsk), **1.4** (LLI Grenoble, USouthampton, UGreenwich, BSUIR, Minsk, Omsk Branch SIM RAS), **2.1** (UMagdeburg, EM StEtienne, BSU Minsk, Omsk Branch SIM RAS), **2.2** (LLI Grenoble, USouthampton, UGreenwich, BSU Minsk, BSUIR Minsk), **3.1** (LLI Grenoble, USouthampton, UGreenwich, UMagdeburg, UIIP NAS Belarus, BSU Minsk, BSUIR Minsk), **3.2** (EM StEtienne, UIIP NAS Belarus, IM NAS Belarus, Omsk Branch SIM RAS), **3.3** (UGreenwich, UIIP NAS Belarus).

1.2 Compliance with the Work Programme

The research has been in accordance with the Work Programme. The duration of the project has been increased to 41 months.

1.3. Results

1.3.1. Scientific Results

- **1. Scheduling for hybrid manufacturing systems**

1.1. Scheduling for perishable product manufacturing. Papers [185, 70] describe models, polynomial time algorithms, NP-hardness proofs and heuristics for scheduling problems with job processing times depending exponentially on their start times. Application areas for the results are perishable product manufacturing and optimal planning of rescue, de-activation or cleaning works in an area contaminated with radioactive or chemical materials.

A comprehensive study on single machine scheduling problems with start-time dependent and position dependent processing times is given in [122]. For various models the conditions are given under which an objective function is priority generating. Polynomial time algorithms for several scheduling problems with positional deteriorations are given in [123].

1.2. Grouping and sequencing operations for repeated jobs in multistage systems. Problems of grouping and sequencing of operations in multistage systems are considered when operations are grouped at two levels. The set of all operations is partitioned into subsets that are executed at a single stage. In turn, the operations of a stage are grouped into blocks that are performed by the corresponding device. Three kinds of such multistage systems are investigated: blocks of the same stage are executed in series, simultaneously or in mixed order. These classes can be modeled as special partition problems. For solving them, exact and heuristic algorithms are developed. The exact algorithms use approaches that are based on graphs [1, 2, 5, 25, 27, 28, 29, 48, 50, 54, 55, 120, 124, 139, 146, 148] and on MIP [28, 37, 38, 40, 50, 84, 111, 118, 141, 162, 148]. The heuristic algorithms use the following: a random assignment of blocks to a current stage [26, 28, 39, 211], depth-first search techniques [6, 28], decomposition of the initial problem into several sub-problems that are then solved by exact algorithms [28, 40, 41, 42, 54, 118, 119, 108, 147]. Experimental software was developed [140, 161] and numerical experiments were carried out. The mixed order of the bloc execution is considered in [10, 67, 81, 87, 104]. Decision support systems for multi-unit transmission systems are described in [167].

Finding the domination number of a graph is one of basic algorithmic graph theory problems occurring in many models in Computer Science and Operations Research. It is shown that this problem can be solved in polynomial time within several hereditary classes of graphs, e.g., the class of P_3-dominable graphs and the class of domination reducible graphs [22, 151].

The problem of approximating the size of a minimum (maximum) induced matching in a given n-vertices graph is considered in [33, 51, 57, 133, 143]. Induced matchings (a set of pairwise non-adjacent edges such that their end-vertices induce a 1-regular graph) are important in connection with applications for grouping operations in manufacturing, secure communication channels and VLSI design problems. It is shown that unless P = NP, there is no polynomial-time constant approximation algorithm for the minimum induced matching problem in bipartite graphs. Some approximation and complexity results are also obtained for the maximum induced matching problem.

An $O(n\log n)$ time algorithm is developed in [127] for a two-stage flow shop problem with jobs forbidden to be processed in the first or last position. A polynomial-time algorithm is proposed for a special case of a three-stage flow-shop problem [203].

1.3. Scheduling with precedence constraints. In [21], an interesting applied problem with precedence constraints is introduced. The objective is to execute the tasks to be scheduled as fast as possible, but at the same time one wants to minimize the utilization of the required machines.

Scheduling with precedence constraints is closely related to the investigation of specific graph properties. Finding a minimum Hamiltonian path in a weighted graph is known to be equivalent to minimizing the makespan in a single machine scheduling problem with setups. Hamiltonian properties of finite induced subgraphs of a graph associated with the two-dimensional triangular grid are considered [7, 36, 52, 121, 144, 145, 155, 164, 165]. It is shown that all connected, locally connected triangular grid graphs on at least three vertices are fully cyclic extendable (with only one exception). Recognition of hamiltonicity for triangular grid graphs, in the general case, is established to be NP-complete, but it is shown that a Hamiltonian cycle in connected, locally connected triangular grid graphs can be found in polynomial time. The Hamiltonian properties are considered in [45, 46, 130, 154] for locally connected graphs with bounded vertex degree. If the maximum vertex degree Δ does not exceed 4, all connected, locally connected graphs are explicitly described; if $\Delta = 5$ and the minimum vertex degree is greater or equal to 3, these graphs are shown to be fully cycle extendable. Recognition of hamiltonicity for locally connected graphs with $\Delta \leq 7$ is shown to be NP-complete.

The Quadratic Assignment Problem (QAP) is used as an adequate mathematical model for a number of problems in scheduling, location theory, statistical data analysis, and parallel or distributed computing. Conditions imposed on the input data of the QAP with bimonotone, additively monotone, and monotone matrices (which permit the inverse orderings of the elements of rows and columns) are derived such that an optimum of this problem is attained on a given permutation [3, 12, 44, 116]. The proposed conditions describe four restricted versions of the QAP, two of which generalize all known well solvable cases of the QAP with monotone Anti-Monge and Toeplitz matrices. Four new classes of matrices, for which effective solvability of the QAP is a priori provided, are described in terms of the specified concept of additive monotony of matrices (the 1- and 2-additive nondecrease and/or nonincrease of elements of their rows and/or columns) [115, 132, 138, 209]. The obtained descriptions expand the existing list of special cases of the problem with a guaranteed optimum on a given permutation.

An application of the single machine scheduling problem with treelike precedence constraints for optimizing the search on graph structures is presented [91]. Combinatorial methods usually applicable for scheduling problems were used for a problem of reconstructing the DNA linear structure in [174].

The results obtained in [122] imply that many single machine scheduling problems with non-constant times are polynomially solvable under series-parallel precedence constraints.

1.4. Scheduling in robotic cells. Some problems involving a robot to move jobs between machines are modeled as coupled-operation scheduling. One such coupled-operation problem involves scheduling jobs, each consisting of two operations with a minimum and maximum time lag between them, on a single machine to minimize the maximum completion time. Construction algorithms and local search (descent and tabu search) algorithms are developed [94]. It has been shown that there is in fact a formal equivalence between the scheduling of coupled tasks and a certain type of one-machine no-wait robotic cells [135]. Further insight is obtained for the cyclic production of a single part in robotic flow shops [85, 89].

The two-machine flow shop and open shop problems with a single interchange transporter have been studied. The best possible heuristic approximation algorithms have been designed, provided that the transporter can take any number of jobs, and no more than two shipments are allowed [73]. Algorithms with improved performance guarantees are developed in [232, 233, 234] for the flow shop and in [128] for the open shop.

For a special case of the Cyclic Job Shop Problem with C_{max} criterion and bounded number H of parts processed within one cycle, a pseudo-polynomial algorithm is proposed, based on dynamic programming [224]. Also for this problem with fixed H a fully polynomial time approximation scheme (FPTAS) is constructed [95, 96, 225, 226] and in the special case of H=2 a polynomial-time exact algorithm is proposed [223]. The cyclic job shop problem with a no-wait constraint is proven to be NP-hard in the strong sense [227]. The Cyclic Job Shop Problem has a significant importance in modern manufacturing systems. Two FPTASs are constructed for the resource constrained project problem with bounded width of the partial order on the set of jobs. The time complexity of the FPTAS for these problems is estimated in two cases: minimization of the makespan and minimization of the average completion time. As a corollary, there is an FPTAS for the job shop scheduling problem with a bounded number of jobs [98, 228]. An exact algorithm combining branch-and-bound and dynamic programming approaches is proposed for the resource constrained project scheduling problem [230]. The resource constrained project scheduling problem with non-renewable resources and a special criterion is shown to be NP-hard [229, 231].

- **2. Coordinating scheduling with logistics**

2.1. Scheduling models and methods for problems of re-inverse logistics. Papers [32, 126, 171, 172] address problems of re-inverse logistics. There, items of the same product are produced in batches. The processing of a batch includes two stages. In the first stage, all items of a batch are manufactured and good quality items go to the inventory to satisfy given demands. In the second stage, defective items of the same batch are reworked. During the waiting for rework, defective items deteriorate. Polynomial time algorithms have been developed to find batch sizes such that all the demands are satisfied and the total setup, rework and inventory holding cost is minimized.

Papers [190, 195] study discrete versions of the Economic Order Quantity problem, in which an inventory holder satisfies a constant rate discrete demand for the same product by sending orders to the producer. The problem is to determine the number of orders and the order sizes such that the demand is satisfied and the total order and inventory cost is minimized. Paper [195] assumes that the inventory costs apply to one order of maximum size, while paper [190] assumes that they apply to all the orders. Polynomial $O(\log^4 n)$ and $O(\log n)$ time algorithms are developed, respectively.

An FPTAS is proposed for the problem of finding a minimum cost delivery plan from a set of providers to a manufacturing unit, given lower and upper bounds on shipment sizes, lower-bounded demand and linear delivery costs [16, 198]. For the case of more general cost functions, another FPTAS (also based on dynamic programming but with different time complexity) is suggested [65]. Hardness of approximation is established for a larger number of manufacturing units [16, 198]. For a generalization of this problem, where a set of admissible intervals for the shipment sizes of each supplier is given, the FPTASs are proposed for linear [200] and concave delivery costs [199]. Several genetic algorithms and an exact Benders decomposition algorithm have been developed for a similar supply management problem with a number of manufacturing units and exact demand constraints. The computer experiments showed good results [15, 88, 101]. For a supply management problem with several manufacturing units and lower-bounded demands, an optimized crossover operator is proposed and a genetic algorithm, based on this operator is developed. The computer experiments showed competitive results in comparison with known genetic algorithms and ILOG CPLEX solver [112, 134]. L-class enumeration algorithms are developed for solving a production planning problem with interval input data [181]. Analysis of stability of some integer programming algorithms under small variations of the goal function coefficients is carried out. These results are applicable to the plant location problem and the supply management problem in an integer programming formulation [219]. A hybrid heuristic algorithm has been developed for scheduling a multi-product chemical production, using MIP-formulation and ILOG CPLEX 9.0 solver in combination with greedy algorithms and local search [207].

2.2. Scheduling with setups and batching. For a problem, where n jobs are to be scheduled in a no-wait flow shop consisting of m batching machines with unbounded capacities, efficient exact and approximate algorithms have been derived to minimize the makespan for fixed m [34, 43]. Two fundamental questions have been addressed: (1) limiting the number of batches in an optimal schedule, independent of the number of tasks to execute; (2) determining the quality of schedules if one allows only a small number of batches. These results are extended in [97] to the case where the no-wait constraint is replaced with the zero-buffer constraint according to which a job completed on an upstream machine may stay on this machine until the downstream machine is ready for its processing. The latter constraint naturally arises in chemical processes where leaving a machine (a chemical tank) for a long time is not allowed because of oxidation and diffusion of a product.

An FPTAS for a capacitated economic lot-sizing problem with the most general cost structure is presented in [180]. A survey of the results on scheduling with setup times and costs is given in [169]. The k-traveling salesman problem, which is to find the cheapest salesman's tour visiting exactly k out of n cities, is considered [49]. Lower bounds for the optimal objective value are constructed based on 2-matching, 1-tree and linear programming relaxations. A new class of facet inequalities is suggested.

Batch scheduling under step deterioration is considered in [80]. In [17, 68, 218], the research on batch processing with task compatibility is continued. These problems connect the theory of scheduling and graph theory and arise in industrial applications. Scheduling problems for jobs that occur in families are frequent in applications. In such cases, the input length of an instance may be much smaller than the actual number of jobs. A framework for the complexity analysis of these so-called high-multiplicity problems is given in [64]. A problem of scheduling jobs on a single machine with family setup times is considered. A setup is necessary when the machine switches from processing jobs in one family to jobs in another family. A genetic algorithm and a tabu search method are developed [14]. A branch and bound algorithm for minimizing the number of late jobs is developed and evaluated using computational tests [66]. In an on-line version of the family scheduling problem, the jobs arrive over time and the goal is to minimize the makespan. A lower bound on the competitive ratio of any on-line algorithm is derived, and for two families an algorithm that achieves this lower bound is provided. As the number of families increases, the lower bound approaches 2, and a simple algorithm with a competitive ratio of 2 is proposed [158].

Many scheduling models do not consider the cost of delivering jobs to customers, assuming implicitly that a separate shipment is made for each job. New models, which allow jobs to be delivered in batches to customers, are developed. Dynamic programming algorithms are described for some problems, while NP-hardness has been established for other problems [69]. The two-machine open shop max-batch problem with at most two jobs in a batch has been studied in [56, 149, 150], a non-trivial linear time scheduling algorithm has been developed for a given batching decision. Contrary to an earlier assumption, the problem with three consistent batches has been shown to be polynomially solvable [184]. An improved 6/5-approximation algorithm for the two-machine open shop scheduling problem with batch setup times has been designed in [58].

A batch processing machine is one that can process several jobs simultaneously. The cutting of sheets of material is modeled as a batch processing machine, where the items to be cut have due dates and the goal is to minimize the maximum lateness. A genetic algorithm is developed and compared with neighborhood search algorithms [82].

- **3. Scheduling in supply chains**

3.1 Scheduling with release dates and deadlines. Simulated annealing and tabu search approaches to a single machine common due date assignment and scheduling problem with jobs available at different times are considered. The objective is to minimize the total weighted sum of earliness, tardiness and due date costs [19, 79, 90].

An $O(n^2)$ algorithm is developed for the problem of minimizing total flow time in a two machine environment with release dates, equal processing times and treelike precedence constraints provided that preemptions are allowed. This algorithm also can be used to solve the related two-machine open shop problem with integer release dates, unit processing times and analogous precedence constraints [74]. $O(n^3)$ algorithms are developed for the preemptive scheduling problem of minimizing total flow time (provided that jobs have release dates and equal processing requirements) [75] and total tardiness on two uniform parallel machines [93, 194]. A survey of the results on scheduling with fixed job processing intervals on parallel machines and possible job rejection is given in [191].

A segment of a supply chain (supplier – manufacturer – customer) has been modeled as a single machine scheduling problem with controllable processing times, machine speeds, release dates and release speeds. The complexity issues of the arising problems have been resolved, several new polynomial-time algorithms have been designed [196]. Several basic problems in supply chain scheduling have been addressed. In [20, 63, 192], the fundamental strategy of just-in-time scheduling in modern manufacturing systems is studied. Basic issues for the material handling (by machines or human operators) are presented in [103, 106]. Finally, genetic algorithms are used to solve distributed FMS scheduling problems with alternate routings [86] and with maintenance [179].

A comparison of different exact and heuristic solution procedures for the 2-machine flow shop problem has been done [59, 60, 175]. Dynamic Programming and other exact approaches for this problem have been given [61, 176]. Complexity of shop scheduling problems with a fixed number of jobs has been investigated [114]. Further results have been obtained on *H*-comparability graphs and irreducible sequences [83]. Intensive implementation work has been done in the area of open shop scheduling problems with different objective criteria, in particular for mean flow time [100, 102, 208]. A two-machine job shop problem with sequence-dependent setup and removal times has been considered in [160]. Different constructive and iterative algorithms for flexible flow shop problems with unrelated parallel machines, release dates, setup times and dual objective criteria have been given in [107]. For the latter problem, also a mixed integer programming formulation has been presented.

For a situation where a set of original jobs has been scheduled on a single machine, but not processed, and a set of new jobs arrives, the decision maker needs to insert the new jobs into the existing schedule. To avoid excessive disruption to the original schedule, specific release dates and deadlines are imposed on the original jobs. The problem of scheduling all jobs to minimize the maximum lateness is shown to be NP-hard. Several approximation algorithms are developed, and their worst-case performance is analyzed. Also a branch and bound algorithm is designed [11].

3.2. Assembly scheduling problems. For the problem of buffer allocation in a production line with unreliable machines we have developed a hybrid algorithm, combining a genetic algorithm and a branch-and-bound method with bounded error. In this model the failure and repair times of machines are supposed to be exponentially distributed, while the processing time of each machine is deterministic. The NP-hardness of a special case of this problem is established and its complexity is studied. The computational experiments show good results [4, 109, 117, 142]. A structure of local optima of the buffers allocation problem are experimentally investigated, it was shown that local optima tend to form clusters in the search space. This result allows to choose the most appropriate local search technique for solving the problem and also may be useful for developing new efficient algorithms [109, 204].

The simple assembly line balancing problem is studied in [35], where necessary and sufficient conditions are proven for optimality of the line balance when processing times of some operations are modified. It is shown how to calculate the maximal value of independent variations of the processing times, which definitely keep the feasibility and optimality of the given line balance.

A problem of optimal lot-sizing and scheduling of manufacturing items at a assembly line is considered. The following factors are taken into account: manufacturing time, set-up time between two lots of different types of items, random machine breakdowns and rejects. The goal is to maximize the probability of a desired output for a given period. A mathematical model of the problem and an optimization approach is proposed [30]. A survey of advanced methods for assembly line balancing and sequencing is presented in [105].

OC-convexity, defined by the intersections of conic semispaces of directional convexity, is investigated. Half-spaces of *OC*-convexity are described, and conditions on separability of *OC*-convex sets are obtained [13]. It is shown that there exists a connected halfspace of ortho-convexity being not simply connected in the three-dimensional space, which disproves the Fink – Wood conjecture [76]. Extreme properties of solutions to optimization problems on *OC*-convex sets are established [202].

3.3 Scheduling with controllable times and assignable due dates. A single machine scheduling problem of minimizing holding costs with no tardy jobs is considered subject to the SLK due date assignment rule. It is shown that the problem of minimizing a non-increasing function of slack and total weighted earliness or total weighted exponential earliness has a polynomial-time solution if precedence constraints are given by a series-parallel graph or by a graph which can be decomposed in such a way that the size of blocks (modules) is limited [8, 9, 24, 31, 47].

Single machine scheduling problems with due dates assigned depending on processing times are analyzed (assignment policies with common slack due dates, total-work-content or processing-plus-wait due dates), concentrated mainly on polynomially solvable problems where objective functions can be maximum tardiness, total weighted earliness-tardiness, or earliness costs with no tardy jobs [18, 23]. An improvement of an algorithm for single machine common due date assignment and scheduling problem with the rate-modifying activity is proposed in [99, 183, 210].

The two-machine flow-shop scheduling problem with random processing times of jobs is considered to find a minimal set of schedules that dominates all feasible schedules [77, 92, 110, 193, 201, 220]. Necessary and sufficient conditions for fixing the order of two jobs for the makespan criterion are obtained. The conditions for existence of a single schedule which is dominant for the makespan are found. The two-stage two-machine job-shop scheduling problem with random processing times of jobs is considered to find a minimal set of schedules that dominates all feasible schedules [193]. Necessary and sufficient conditions for fixing the order of two jobs for the makespan criterion are obtained.

Scheduling problems of minimizing the makespan in a two-machine job-shop with w given intervals of machine non-availability is studied. Sufficient conditions for which Jackson's pair of permutations remains optimal for the two-machine job-shop problem with $w \leq 1$ non-availability intervals are found in [62].

Scheduling problems of minimizing the makespan in a two-machine job-shop with given sequence-dependent setup and removal times are studied. Sufficient conditions for which Jackson's pair of permutations remains optimal for the two-machine job-shop problem are found. The results provide lower and upper bounds for the makespan, which are used in a branch-and-bound algorithm. Computational results show that an exact solution for this problem may be obtained in a suitable time for the number of jobs no more than 280. Heuristic algorithm and worst-case analysis for it have been developed [131, 159, 160, 168].

Several problems with machine maintenance periods of controllable duration have been studied. The length of a maintenance period depends on its start time. A number of exact and approximation algorithms have been designed [71, 72].

Polymatroid methods have been successfully applied to preemptive scheduling problems with controllable processing times, and a number of new polynomial-time algorithms have been described [78].

References
1st year

♦ Joint Publications of INTAS and NIS project teams

▪ International journals

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▪ National journals

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- Summarise the scientific output (number of papers, etc.) in the table below:

	ALL PUBLICATIONS			**ONLY: Jointly by INTAS and NIS Project teams**
Scientific Output	**Published**	**in press/accepted**	**Submitted**	
Paper in an International Journal	44	22	19	33
Paper in a National Journal *)	8 (Russian)	1 (Russian)	4 (Russian)	3 (Russian)
Abstract in proceedings (conferences, workshops)	87 (English) + 6 (French) + 10 (Russian)	2 (English) 3 (Russian)	2 (English)	44 (English) + 3 (Russian) + 3 (French)
Book, Monograph *)	3 (English) + 3 (French) + 2 (Russian)	1 (English)		4 (English) 1 (Russian)
Internal Report **)	17			10
Thesis (MSc, PhD, etc.) *)	3 (French) + 1 (Russian)		1 (Russian)	
Patent				

*) Indicate the language **) Indicate if a report has not been published purely in order to protect intellectual property rights.

1.3.2 Impact and Applications

Results can be used in a computer-aided control of a combined manufacturing and remanufacturing system. Results of [185] can be used in optimal and safe planning of works in areas contaminated with chemical or radioactive materials. Results of [34] can be applied in optimal production planning of chemical, galvanic and pharmaceutical baths. Results [35] have a large area of application for manual assembly systems with stochastic processing times.

Many theoretical results have been obtained on fundamental issues in scheduling theory. These advances of general knowledge in the field concern algorithmic complexity results [23, 63, 64, 71, 114, 127, 184, 191] as well as the design of exact and approximate solution methods [11, 58-60, 65, 66, 170, 175, 177, 179, 192]. Emphasis has been on scheduling models with application-oriented features such as setup times [14, 58, 169], precedence constraints [31, 68, 74, 122], batching (i.e., grouping of jobs) [32, 34, 66, 68, 69, 171, 172], and non-availability periods of machines or operators [34, 71, 73, 113]. These results could be explored and helped to develop software for an industrial partner in the chemical industry. The concepts of setups, precedences, and batching have also been incorporated in the design of very general and complex manufacturing lines [27, 111, 120]. New optimization methods have been developed that help to balance the lines and to reduce the production costs [2, 10, 26, 28, 29, 118, 119]. These methods can be used, in the future, in Decision Support Systems and CAD/CAM/CAE tools for the optimal design of assembly lines.

1.3.3 Summary of results

The INTAS project 03-51-5501, entitled *Scheduling for modern manufacturing, logistics and supply chains*, took place from March 1, 2004, to July 31, 2007. Ten research teams participated in the project, coming from five countries: Belarus (4 teams from Minsk), Russia (Omsk), France (St. Etienne and Grenoble), Germany (Magdeburg), and United Kingdom (Greenwich and Southampton). During this period, 15 meetings were held, often in connection with international conferences. Also three conferences were organized by members of this project and under the given theme: Second International Workshop on *Discrete Optimization Methods in Production and Logistics* - DOM'2004, July 20-27, Omsk-Irkutsk, 2004 (organizer : A. Kolokolov) ; ECCO XVIII, European Chapter on Combinatorial Optimization, Minsk, May 26-28, 2005 (organizers : M. Kovalyov, V.Gordon) ; 12th IFAC Symposium on Information Control Problems in Manufacturing – INCOM 2006 (organizer : A. Dolgui) with the special Track *Scheduling for modern manufacturing, logistics and supply chains*. As a result of this last mentioned conference, a special issue of the journal *Computers and Operations Research* is forthcoming, edited by the members of this project.

Research was carried out on fundamental issues in scheduling theory and on applications in manufacturing. General advances have been obtained on complexity results and the design of solution algorithms in scheduling, in particular for problems with precedence constraints and with grouping of jobs (so-called batching). Many of the models investigated arose from practical situations, for instance in connection with the planning of rescue operations and the cleaning tasks in contaminated areas. Particular emphasis was also put on scheduling models combined with a material handling system (forming a robotic cell in which the production rate is to be maximized) and with a logistic system (in order to minimize the cost of delivering goods to the customers). New optimization methods have been developed for the design of manufacturing lines. These methods allow decreasing the production costs. They can be used in Decision Support Systems and CAD/CAM/CAE tools for the optimal design of complex manufacturing lines.

The intensity of the collaboration between the research groups as well as the output of joint publications have greatly exceeded our hopes at the beginning of the project. In fact, 36 co-authored journal papers and 5 books or chapters in books have been published or are accepted and forthcoming. In addition, 50 joint conference papers have been presented during the time of the project. Several new research directions evolved during the numerous discussions between the participants. For instance, some fundamental aspects in scheduling that can be formulated in terms of graph theory will be addressed. These topics, initiated through this INTAS project, will continue to be studied in the future by this group of researchers.

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1.3.4 Role and Impact of INTAS

Role of INTAS	Definitely yes	rather yes	rather not	definitely not
Would the project have been started without funding by INTAS?			x	
Would the project have been carried out without funding from INTAS?				x

Main achievement of the project	very important	quite important	less important	not important
exciting science	x			
new international contacts	x			
additional prestige for my lab		x		
additional funds for my lab		x		
helping scientists in NIS		x		
other (specify):				

The co-operation among the project teams will certainly continue in the future.

2. MANAGEMENT

2.1. General management

2.1.1. Project management

- Co-ordination meetings, exchange visits of scientists, or major field trips which took place up to now:

Co-ordination meetings:

1) Dagstuhl, Germany, May 30-June 5, 2004. Six teams present (LLI Grenoble, USouthampton, UGreenwich, UMagdeburg, UIIP NAS Belarus, BSU Minsk).
2) Omsk – Irkutsk, Russia, July 18-28, 2004. Four teams present (LLI Grenoble, EM StEtienne, UIIP NAS Belarus, Omsk branch SIM RAS).
3) StEtienne, France, March 1, 2005. Four teams present (LLI Grenoble, EM StEtienne, UIIP NAS Belarus, IM NAS Belarus).
4) Minsk, Belarus, May 24-28, 2005. On the occasion of the ECCO conference. All teams present.
5) Siena, Italy, June 6-10, 2005. On the occasion of the MAPSP workshop. Four teams present (LLI Grenoble, USouthampton, UGreenwich, UIIP NAS Belarus).
6) Honolulu, USA, July 9-16, 2005. On the occasion of IFORS meeting. Four teams present (LLI Grenoble, USouthampton, EM StEtienne, UIIP NAS Belarus).
7) Bremen, Germany, September 5-11, 2005. On the occasion of OR'2005 conference. Four teams present (LLI Grenoble, UIIP NAS Belarus, BSU Minsk, Omsk branch SIM RAS).
8) Greenwich, UK, February 9, 2006. Four teams present (LLI Grenoble, USouthampton, UGreenwich, BSUIR Minsk).
9) StEtienne, France, May 16-20, 2006. On the occasion of 12th IFAC International Symposium. Eight teams present (LLI Grenoble, USouthampton, UGreenwich, EM StEtienne, UMagdeburg, UIIP NAS Belarus, IM NAS Belarus, Omsk branch SIM RAS).
10) Marseille, France, May 28-June 3, 2006. On the occasion of the Workshop on Scheduling Algorithms for New Emerging Applications. Five teams present (USouthampton, UGreenwich, UMagdeburg, UIIP NAS Belarus, BSU Minsk).
11) Reykjavik, Iceland, July 2-7, 2006. On the occasion of the 21st European Conference on Operational Research Five teams present (LLI Grenoble, USouthampton, UGreenwich, UMagdeburg, UIIP NAS Belarus).

12) Grenoble, France, February 11, 2007. Three teams present (LLI Grenoble, UIIP NAS Belarus, BSU Minsk).
13) Limassol, Cyprus, May 23-26, 2007. On the occasion of the International conference ECCO XX. Five teams present (UGreenwich, UMagdeburg, UIIP NAS Belarus, BSU Minsk, BSUIR Minsk).
14) Istanbul, Turkey, June 30-July 6, 2007. On the occasion of the Workshop MAPSP'07. Four teams present (LLI Grenoble, UGreenwich, UMagdeburg, BSU Minsk)
15) Prague,Czech Republic, July 8-12, 2007. On the occasion of the 22nd European Conference on Operational Research. Five teams present (LLI Grenoble, UGreenwich, UMagdeburg, UIIP NAS Belarus, IM NAS Belarus)

Visits:

Name of the person, team.	**Place of travel**	**Dates**	**Purpose**	**Notes**
1. Sotskov Yu., UIIP NAS Belarus	Magdeburg, Germany	March 1 – 6, 2004	Joint work with Prof. F.Werner	
2. Levin G. UIIP NAS Belarus	StEtienne, France	April 9 – 26, 2004	Joint work with Prof. A.Dolgui	
3.Guschinsky N. UIIP NAS Belarus	StEtienne, France	April 9 – 26, 2004	Joint work with Prof. A.Dolgui	
4. Gordon V. UIIP NAS Belarus	Magdeburg, Dagstuhl, Germany	May 26 – June 7, 2004	1st INTAS meeting Joint work with Prof. F.Werner	Expenses are partly covered by Dagstuhl seminar
5. Gordon V. UIIP NAS Belarus	Omsk-Irkutsk, Russia	July 17 – 30, 2004	2nd INTAS meeting, Intern. conference DOM'04	
6. Guschinsky N. UIIP NAS Belarus	Omsk-Irkutsk, Russia	July 17 – 29, 2004	2nd INTAS meeting, Intern. conference DOM'04	Expenses are partly covered by EM StEtienne
7. Guschinsky N. UIIP NAS Belarus	StEtienne, France	June 29 – December 24, 2004	Joint work with Prof. A.Dolgui	Expenses are partly covered by EM StEtienne
8. Gordon V. UIIP NAS Belarus	Magdeburg, Germany	November 27 – December 6, 2004	Joint work with Prof. F.Werner	Expenses are partly covered by Magdeburg University
9. Orlovich Y., IM NAS Belarus	Magdeburg, Germany	November 27 – December 6, 2004	Joint work with Prof. F.Werner	
10. Aneichyk A.S., BSU Minsk	Magdeburg, Germany	May 22 – 28, 2004	Joint work with Prof. F.Werner and Prof. K. Inderfurth	
11. Kovalyov M.Y., BSU Minsk	Magdeburg, Dagstuhl, Germany	May 22 – June 6, 2004	1st INTAS meeting Joint work with Prof. F.Werner and Prof. K. Inderfurth	Expenses are partly covered by Dagstuhl seminar
12. Barketau M.S., BSU Minsk	Omsk-Irkutsk, Russia	July 17 – 23, 2004	2nd INTAS meeting, Intern. Conference DOM'04	
13. Kovalev M.M., BSU Minsk	Magdeburg, Germany	December 9 – 19, 2004	Joint work with Prof. F.Werner and Prof. K. Inderfurth	
14. Lushchakova I. BSUIR Minsk	London, UK	January 30 – February 13, 2005	Joint work with Prof. V.Strusevich	
15. Eremeev A.V. Omsk branch SIM RAS	Irkutsk, Russia	July 24-28, 2004	2nd INTAS meeting, Intern. Conference DOM'04	
16. Kolokolov A.A. Omsk branch SIM RAS	Irkutsk, Russia	July 24 – 28, 2004	2nd INTAS meeting, Intern. Conference DOM'04	
17. Servakh V.V. Omsk branch SIM RAS	Irkutsk, Russia	July 24 – 28, 2004	2nd INTAS meeting, Intern. Conference DOM'04	
18. Borisovsky P.A. Omsk branch SIM RAS	StEtienne, France	November 7 – 15, 2004	Joint work with Prof. A.Dolgui	
19. Sigaev V.S. Omsk branch SIM RAS	StEtienne, France	November 7 – 15, 2004	Joint work with Prof. A.Dolgui	
20. Finke G. LLI Grenoble	Dagstuhl, Germany	May 30 – June 5, 2004	1st INTAS meeting	
21. Finke G. LLI Grenoble	Omsk-Irkutsk, Russia	July 18 – 28, 2004	2nd INTAS meeting, Intern. Conference DOM'04	

22. Lemaire P. LLI Grenoble	Dagstuhl, Germany	May 30 – June 5, 2004	1st INTAS meeting	
23. Strusevich V. UGreenwich	Dagstuhl, Germany	May 30 – June 5, 2004	1st INTAS meeting	
24. Strusevich V. UGreenwich	Minsk, Belarus	July 17 – 30, 2004	Joint work with Dr. I. Lushchakova	
25. Dolgui A, EM StEtienne	Omsk-Irkutsk, Russia	July 18 – 29, 2004	2nd INTAS meeting, Intern. Conference DOM'04	
26. Dolgui A, EM StEtienne	Minsk, Belarus	July 29 – August 10, 2004	Joint work with Prof. Y.Sotskov	
27 Potts C. USouthampton	Dagstuhl, Germany	May 30 – June 5, 2004	1st INTAS meeting	
28 Potts C. USouthampton	Greenwich, UK	May, 2004	Joint work with Prof. V.Strusevich	
29. Werner F. UMagdeburg	Dagstuhl, Germany	May 30 – June 5, 2004	1st INTAS meeting	Expenses are covered by Magdeburg University
30. Gordon V. UIIP NAS Belarus	IM NAS Belarus, Minsk	April 12 – 16, 2004	Joint work with Dr. V.Demidenko	Expenses are covered by UIIP NAS Belarus
31. Demidenko V. IM NAS Belarus	UIIP NAS Belarus, Minsk	April 19 – 23, 2004	Joint work with Prof. V.Gordon	Expenses are covered by IM NAS Belarus
32. Gordon V. UIIP NAS Belarus	IM NAS Belarus, Minsk	January 10 – 12, 2005	Joint work with Dr. Y.Orlovich	Expenses are covered by UIIP NAS Belarus
33. Orlovich Y. IM NAS Belarus	UIIP NAS Belarus, Minsk	January 13, 14, 17 – 21, 2005	Joint work with Prof. V.Gordon	Expenses are covered by IM NAS Belarus
34. Sotskov Yu., UIIP NAS Belarus	Magdeburg, Germany	April 29 – May 5, 2004	Joint work with Prof. F.Werner	
35. Sotskov Yu., UIIP NAS Belarus	Magdeburg, Germany	July 12-28, 2004	Joint work with Prof. F.Werner	
36. Leshchenko N. UIIP NAS Belarus	Magdeburg, Germany	February 23-March 5, 2005	Joint work with Prof. F.Werner	
37. Gordon V. UIIP NAS Belarus	StEtienne, Grenoble, France	February 26-March 14, 2005	3rd INTAS meeting , Joint work with Prof.G.Finke	
38. Orlovich Y. IM NAS Belarus	StEtienne, Grenoble, France	February 26-March 14, 2005	3rd INTAS meeting , Joint work with Prof.G.Finke	
39. Finke G. LLI Grenoble	StEtienne, France	March 1, 2005	3rd INTAS meeting	
40. Finke G. LLI Grenoble	Minsk, Belarus	May 23-28, 2005	4th INTAS meeting, ECCO conference Joint work with Prof.V. Gordon and Dr. Y. Orlovich	
41. Strusevich V. UGreenwich	Minsk, Belarus	May 23-June 6, 2005	4th INTAS meeting, ECCO conference Joint work with I.Lushchakova	
42. Whitehead J. USouthampton	Minsk, Belarus	May 24-28, 2005	4th INTAS meeting, ECCO conference	
43. Potts C. USouthampton	Minsk, Belarus	May 24-28, 2005	4th INTAS meeting, ECCO conference Joint work with Prof.V. Gordon and Dr. Y. Orlovich	
44. Werner F. UMagdeburg	Minsk, Belarus	May 24-28, 2005	4th INTAS meeting, ECCO conference Joint work with Prof.Y. Sotskov, Prof.V. Gordon and Dr. Y. Orlovich	
45. Mörig M. UMagdeburg	Minsk, Belarus	May 24-28, 2005	4th INTAS meeting, ECCO conference	
46. Dolgui A, EM StEtienne	Minsk, Belarus	May 24-June 3, 2005	4th INTAS meeting, ECCO conference Joint work with Prof.	Expenses are covered by EM StEtienne

			G.Levin and Dr.N. Guschinsky	
47. Gordon V. UIIP NAS Belarus	BSU Minsk	May 25-28, 2005	4th INTAS meeting, ECCO conference	
48. Levin G. UIIP NAS Belarus	BSU Minsk	May 25-28, 2005	4th INTAS meeting, ECCO conference	
49. Guschinsky N. UIIP NAS Belarus	BSU Minsk	May 25-28, 2005	4th INTAS meeting, ECCO conference	
50. Kovalyov M.Y., BSU Minsk	UIIP NAS Belarus, Minsk	May 25-28, 2005	4th INTAS meeting, ECCO conference	
51. Kovalev M.M., BSU Minsk	UIIP NAS Belarus, Minsk	May 25-28, 2005	4th INTAS meeting, ECCO conference	
52. Barketau M.S., BSU Minsk	UIIP NAS Belarus, Minsk	May 25-28, 2005	4th INTAS meeting, ECCO conference	
53. Sas A.I., BSU Minsk	UIIP NAS Belarus, Minsk	May 25-28, 2005	4th INTAS meeting, ECCO conference	
54. Kovalev A., BSU Minsk	UIIP NAS Belarus, Minsk	May 25-28, 2005	4th INTAS meeting, ECCO conference	
55. Demidenko V. IM NAS Belarus	BSU, UIIP NAS Minsk	May 25-28, 2005	4th INTAS meeting, ECCO conference	
56. Naidenko V. IM NAS Belarus	BSU, UIIP NAS Minsk	May 25-28, 2005	4th INTAS meeting, ECCO conference	
57. Orlovich Y. IM NAS Belarus	BSU, UIIP NAS Minsk	May 25-28, 2005	4th INTAS meeting, ECCO conference	
58. Gordon V. UIIP NAS Belarus	Siena, Italy	June 6-10, 2005	5th INTAS meeting, MAPSP workshop	Expenses are covered by ISTC
59. Gordon V. UIIP NAS Belarus	Honolulu, Hawaii	July 9-16, 2005	6th INTAS meeting, IFORS meeting	Expenses are covered by ISTC
60. Levin G. UIIP NAS Belarus	Honolulu, Hawaii	July 9-16, 2005	6th INTAS meeting, IFORS meeting	Expenses are covered by ISTC
61. Guschinsky N. UIIP NAS Belarus	StEtienne, France	July 14-30, 2005	Joint work with Prof. A.Dolgui	
62. Tarasevich A. UIIP NAS Belarus	Bremen, Germany	September 5-11, 2005	7th INTAS meeting, OR'2005 conference	
63. Gordon V. UIIP NAS Belarus	Bremen, Germany	September 5-11, 2005	7th INTAS meeting, OR'2005 conference	Expenses are covered by ISTC and OR'2005
64. Gordon V. UIIP NAS Belarus	Magdeburg, Germany	November 25- December 5, 2005	Joint work with Prof. F.Werner	Expenses are partly covered by Magdeburg University
65. Orlovich Y. IM NAS Belarus	Magdeburg, Germany	November 25- December 5, 2005	Joint work with Prof. F.Werner	Expenses are partly covered by Magdeburg University
66. Sotskov Yu., UIIP NAS Belarus	Magdeburg, Germany	November 8-26, 2005	Joint work with Prof. F.Werner	Expenses are partly covered by Magdeburg University
67. Orlovich Y. IM NAS Belarus	UIIP NAS Belarus, Minsk	January 9 – 13, 16 – 18, 2006	Joint work with Prof. V.Gordon	Expenses are covered by IM NAS Belarus
68. Gordon V. UIIP NAS Belarus	IM NAS Belarus, Minsk	February 20 – 24, 2006	Joint work with Dr. Y.Orlovich	Expenses are covered by UIIP NAS Belarus
69. Kovalyov M.Y., BSU Minsk	Magdeburg, Bremen, Germany	September 1-14, 2005	7th INTAS meeting, OR'2005 conference, joint work with Prof. F.Werner and Prof. K. Inderfurth	Expenses are partly covered by OR'05 conference
70. Kovalev M.M., BSU Minsk	Magdeburg, Germany	November 28 – December 7, 2005	Joint work with Prof. F.Werner and Prof. E. Girlich	Expenses are partly covered by Magdeburg University
71. Lushchakova I., BSUIR Minsk	UIIP NAS Belarus, Minsk	May 25-28, 2005	4th INTAS meeting, ECCO conference	Expenses are partly covered by BSUIR
72. Ivashenko V. BSUIR Minsk	UIIP NAS Belarus, Minsk	May 25-28, 2005	4th INTAS meeting, ECCO conference	Expenses are partly covered by BSUIR
73. Lushchakova I., BSUIR Minsk	Greenwich, UK	January 29 – February 12, 2006	8th INTAS meeting, Joint work with Prof. V.Strusevich	
74. Eremeev A.V. Omsk branch SIM	Minsk, Belarus	May 25-28, 2005	4th INTAS meeting, ECCO conference	

RAS				
75. Kolokolov A.A. Omsk branch SIM RAS	Minsk, Belarus	May 24-29, 2005	4th INTAS meeting, ECCO conference	
76. Servakh V.V. Omsk branch SIM RAS	Minsk, Belarus	May 24-29, 2005	4th INTAS meeting, ECCO conference	
77. Kolokolov A.A. Omsk branch SIM RAS	Bremen, Germany	September 5-10, 2005	7th INTAS meeting, OR'2005 conference	
78. Finke G. LLI Grenoble	Magdeburg, Germany	August 17-21, 2005	Joint work with Prof. F.Werner	
79. Strusevich V. UGreenwich	Grenoble, France	March 30-April 2, 2005	Joint work with Prof.G.Finke	
80. Strusevich V. UGreenwich	Siena, Italy	June 5-11, 2005	5th INTAS meeting, MAPSP workshop	
81. Finke G. LLI Grenoble	Siena, Italy	June 5-10, 2005	5th INTAS meeting, MAPSP workshop	
82. Brauner N. LLI Grenoble	Siena, Italy	June 5-10, 2005	5th INTAS meeting, MAPSP workshop	
83. Potts C. USouthampton	Siena, Italy	June 5-11, 2005	5th INTAS meeting, MAPSP workshop	
84. Whitehead J. USouthampton	Siena, Italy	June 5-11, 2005	5th INTAS meeting, MAPSP workshop	
85. Potts C. USouthampton	Honolulu, Hawaii	July 9-16, 2005	6th INTAS meeting, IFORS meeting	
86. Finke G. LLI Grenoble	Honolulu, Hawaii	July 9-16, 2005	6th INTAS meeting, IFORS meeting	
87. Dolgui A, EM StEtienne	Honolulu, Hawaii	July 10-17, 2005	6th INTAS meeting, IFORS meeting	
88. Potts C. USouthampton	Greenwich, UK	February 28, 2005	Joint work with Prof. V.Strusevich	
89. Strusevich V. Ugreenwich	Southampton,UK	June 27, 2005	Joint work with Prof. C.Potts and J.Whitehead	
90. Strusevich V. Ugreenwich	Minsk, Belarus	July 23-August 7, 2005	Joint work with I. Lushchakova	
91. Potts C. Usouthampton	Greenwich, UK	September 21, 2005	Joint work with Prof. V.Strusevich	
92. Whitehead J. Usouthampton	Greenwich, UK	September 21, 2005	Joint work with Prof. V.Strusevich	
93. Potts C. Usouthampton	Greenwich, UK	February 9, 2006	8th INTAS meeting	
94. Finke G. LLI Grenoble	Greenwich, UK	February 9, 2006	8th INTAS meeting	
95. Finke G. LLI Grenoble	Bremen, Germany	September 5-10, 2005	7th INTAS meeting, OR'2005 conference	
96. Guschinskaya O. EM StEtienne	Minsk, Belarus	May 25-June 4, 2005	4th INTAS meeting, ECCO conference, Joint work with Prof. G.Levin	Expenses are covered by EM StEtienne
97. Dolgui A, EM StEtienne	Grenoble, France	January 5, 2006	Joint work with Dr.N.Brauner	Expenses are covered by EM StEtienne
98. Sotskov Yu., UIIP NAS Belarus	Magdeburg, Germany	March 30-April 3, 2005	Joint work with Prof. F.Werner	
99. Leshchenko N., UIIP NAS Belarus	BSU Minsk	May 25-28, 2005	4th INTAS meeting, ECCO conference	
100. Tarasevich A. UIIP NAS Belarus	BSU Minsk	May 25-28, 2005	4th INTAS meeting, ECCO conference	
101.Kovalyov M.Y., BSU Minsk	Poznan, Poland	April 25 – May 5, 2006	Workshop PMS'06	
102.Kovalyov M.Y., BSU Minsk	Marseille, France	May 28 – June 3, 2006	10th INTAS meeting. Workshop on Scheduling Algorithms for New Emerging Applications	Expenses are partly covered by Ecole des Mines de Nancy

103.Kovalyov M.Y., BSU Minsk	St.Etienne, France	July 2–6, 2006	Joint work with Prof. A.Dolgui and his team	Expenses are partly covered by EM StEtienne
104.Kovalyov M.Y., BSU Minsk	Karlsruhe	September 4-10, 2006	Inter. conference SOR'06	
105.Kovalyov M.Y., BSU Minsk	Magdeburg	December 9-25, 2006	Joint work with Prof. F.Werner and Prof. K. Inderfurth	
106. Kovalev A., BSU Minsk	Magdeburg	December 9-25, 2006	Joint work with Prof. F.Werner and Prof. K. Inderfurth	
107. Kovalev M.M. BSU Minsk	Magdeburg	January 27 - February 12, 2007	Joint work with Prof. F.Werner and Prof. K. Inderfurth	
108.Kovalyov M.Y., BSU Minsk	Limassol Cyprus	May 19 -26, 2007	13th INTAS meeting. International conference ECCO XX	Expenses are mainly covered by ISTC
109. Kovalev A., BSU Minsk	Limassol, Cyprus	May 23 -26, 2007	13th INTAS meeting. International conference ECCO XX	Expenses are mainly covered by Poznan University
110.Kovalyov M.Y., BSU Minsk	Istanbul, Turkey	July 2-5, 2007	14th INTAS meeting. Workshop MAPSP'07	
111. Kovalev A., BSU Minsk	Prague Czech Republic	July 7-11, 2007	15th INTAS meeting. 22nd European Conference on Operational Research	Expenses are mainly covered by Poznan University
112. Demidenko V., IM NAS Belarus	StEtienne, France	May 16-June 9, 2006	9th INTAS meeting. 12th IFAC International Symposium, Joint work with Prof. A.Dolgui	
113. . Orlovich Yu., IM NAS Belarus	UIIP NAS Belarus, Minsk	September 25-29, 2006	Joint work with Prof. V.Gordon	Expenses are covered by IM NAS Belarus
114. Orlovich Yu., IM NAS Belarus	Magdeburg, Germany	November 16-27, 2006	Colloquium on Combinatorics, Joint work with Prof. F.Werner	Expenses are partly covered by Magdeburg University
115. Orlovich Yu., IM NAS Belarus	UIIP NAS Belarus, Minsk	December 4-8, 2006	Joint work with Prof. V.Gordon	Expenses are covered by IM NAS Belarus
116. Orlovich Yu., IM NAS Belarus	Grenoble, France	February 10-19, 2007	12th INTAS meeting. Joint work with Prof. G.Finke	Expenses are partly covered by LLI Grenoble (G-SCOP)
117. Orlovich Yu., IM NAS Belarus	Prague, Czech Republic	July 7-13, 2007	15th INTAS meeting. 22nd European Conference on Operational Research	
118. Eremeev A.V. Omsk branch SIM RAS	StEtienne, France	May 16-20, 2006	9th INTAS meeting. 12th IFAC International Symposium	
119.Kolokolov A.A. Omsk branch SIM RAS	StEtienne, France	May 16-20, 2006	9th INTAS meeting. 12th IFAC International Symposium	
120. Lushchakova I., BSUIR Minsk	University of Greenwich, London, UK	December 3 – 13, 2006	Joint work with Prof. V.Strusevich	
121. Lushchakova I., BSUIR Minsk	University of Greenwich, London, UK	January 28 – February 14, 2007	Joint work with Prof. V.Strusevich	
122. Lushchakova I., BSUIR Minsk	Limassol Cyprus	May 19 -26, 2007	13th INTAS meeting. International conference ECCO XX	
123. Guschinsky N. UIIP NAS Belarus	StEtienne, France	May 14-23, 2006	9th INTAS meeting. 12th IFAC International Symposium, Joint work with Prof. A.Dolgui	Expenses are partly covered by the 12th IFAC International Symposium
124. Levin G. UIIP NAS Belarus	St Etienne, France	May 16-26, 2006	9th INTAS meeting. 12th IFAC International Symposium,	Expenses are partly covered by the 12th IFAC International Symposium

			Joint work with Prof. A.Dolgui	
125. Gordon V. UIIP NAS Belarus	StEtienne, Grenoble, France	May 16-27, June 4-6, 2006	9th INTAS meeting. 12th IFAC International Symposium, Joint work with Prof. G.Finke	Expenses are partly covered by LLI Grenoble and by the 12th IFAC International Symposium
126. Gordon V. UIIP NAS Belarus	Marseille, France	May 28 – June 3, 2006	10th INTAS meeting. Workshop on Scheduling Algorithms for New Emerging Applications	Expenses are partly covered by the Organizing Committee of the Workshop
127. Gordon V. UIIP NAS Belarus	Magdeburg, Germany	November 18-27, 2006	Joint work with Prof. F.Werner	Expenses are partly covered by Magdeburg University
128. Guschinsky N. UIIP NAS Belarus	StEtienne, France	September 19-November 11, 2006	Joint work with Prof. A.Dolgui	Expenses are partly covered by EM StEtienne
129. Sotskov Yu., UIIP NAS Belarus	Magdeburg, Germany	December 2-25, 2006	Joint work with Prof. F.Werner	Expenses are partly covered by Magdeburg University
130. Gordon V. UIIP NAS Belarus	University of Greenwich, London, UK	January 14 - February 4, 2007	Joint work with Prof. V.Strusevich	
131. Gordon V. UIIP NAS Belarus	Grenoble, France	February 10-19, 2007	12th INTAS meeting. Joint work with Prof. G.Finke	Expenses are partly covered by LLI Grenoble (G-SCOP)
132. Gordon V. UIIP NAS Belarus	Limassol Cyprus	May 19 -26, 2007	13th INTAS meeting. International conference ECCO XX	Expenses are mainly covered by ISTC
133. Gordon V. UIIP NAS Belarus	Prague, Czech Republic	July 7-12, 2007	15th INTAS meeting. 22nd European Conference on Operational Research	Expenses are partly covered by EUROXXII Organizing Committee and ISTC
134. Levin G. UIIP NAS Belarus	Prague, Czech Republic	July 7-12, 2007	15th INTAS meeting. 22nd European Conference on Operational Research	
135. Sotskov Yu., UIIP NAS Belarus	Magdeburg, Germany	July 14-24, 2007	Joint work with Prof. F.Werner	
136. Rozin B.M., UIIP NAS Belarus	Porto, Portugal	July 21-26, 2007	International .Conference on. Optimization 2007	
137. Guschinsky N. UIIP NAS Belarus	StEtienne, France	July 9-31, 2007	Joint work with Prof. A.Dolgui	
138. Werner F. UMagdeburg	StEtienne, France	May 16-20, 2006	9th INTAS meeting. 12th IFAC International Symposium	
139. Werner F. UMagdeburg	Marseille, France	May 28 – June 4, 2006	10th INTAS meeting. Workshop on Scheduling Algorithms for New Emerging Applications	
140. Werner F. UMagdeburg	Reykjavik, Iceland	July 2-7, 2006	11th INTAS meeting 21st European Conference on Operational Research	
141. Werner F. UMagdeburg	St Etienne, Grenoble, France	March 25 –April 1, 2007	Joint work with Prof. A.Dolgui and Prof. G.Finke	
142. Werner F. UMagdeburg	Limassol Cyprus	May 21 -28 2007	13th INTAS meeting. Inter. conference ECCO'07	
143. Andresen M. UMagdeburg	Istanbul, Turkey	June 30 –July 6, 2007	14th INTAS meeting. Workshop MAPSP'07	Expenses are partly covered by Magdeburg University
144. Werner F. UMagdeburg	Prague, Czech Republic	July 8-12, 2007	15th INTAS meeting. 22nd European Conference on Operational Research	
145. Finke G. LLI Grenoble	St Etienne, France	May 19-20, 2006	9th INTAS meeting. 12th IFAC International Symposium	
146. Finke G. LLI Grenoble	Istanbul, Turkey	June 1- July 7, 2007	14th INTAS meeting. Workshop MAPSP'07	
147. Strusevich V.A.	Southampton,	February 28, 2006	Joint work with Prof. C.N.	

Greenwich	U.K.		Potts and Dr J.D. Whitehead	
148. Strusevich V.A. Greenwich	St.Etienne, France	May 16-20, 2006	9th INTAS meeting. 12th IFAC International Symposium	
149. Strusevich V.A. Greenwich	Marseille, France	May 28 – June 3, 2006	10th INTAS meeting. Workshop on scheduling	Expenses are partly covered by CMS School, University of Greenwich
150. Strusevich V.A. Greenwich	Minsk, Belarus	July 15–August 5, 2006	Joint work with Dr I.N. Lushchakova and Prof. M.Y. Kovalyov	
151. Strusevich V.A. Greenwich	Grenoble, France	September 18-22, 2006	Joint work with Prof. G.Finke and his team	
152. Strusevich V.A. Greenwich	Southampton, U.K.	October 10-11, 2006	Joint work with Prof. C.N. Potts and Dr J.D. Whitehead	
153. Strusevich V.A. Greenwich	Minsk, Belarus	November 15–22, 2006	Joint work with Dr I.N. Lushchakova and Prof. M.Y. Kovalyov	
154. Strusevich V.A. Greenwich	Limassol Cyprus	May 20 -28, 2007	13th INTAS meeting. Inter. conference ECCO'07	
155. Strusevich V.A. Greenwich	Istanbul, Turkey	June 1- July 7, 2007	14th INTAS meeting. Workshop MAPSP'07	
156. Strusevich V.A. Greenwich	Prague, Czech Republic	July 8-12, 2007	15th INTAS meeting. 22nd European Conference on Operational Research	
157. Dolgui A, EM StEtienne	Minsk, Belarus	December 23, 2006 – January 3, 2007	Joint work with Prof. G. Levin and Dr. N. Guschinsky	
158. Dolgui A, EM StEtienne	Minsk, Belarus	May 6, 2007 – May 13, 2007	Joint work with Prof. G. Levin and Dr. N. Guschinsky	
159. Dolgui A, Guschinskaya O., Delorme X., Hnaien F., EM StEtienne	Grenoble, France	May 6, 2007 – May 13, 2007	ROADEF/FRANCORO conference organized by LLI Grenoble	
160. Potts C. USouthampton	Marseille, France	May 29 – June 2, 2006	10th INTAS meeting. Workshop on Scheduling Algorithms for New Emerging Applications	
161. Whitehead J. USouthampton	St.Etienne, France	May 16-20, 2006	9th INTAS meeting. 12th IFAC International Symposium	
162. Brauner N. LLI Grenoble	Prague, Czech Republic	July 8-12, 2007	15th INTAS meeting. 22nd European Conference on Operational Research	

- The meetings and visits are summarised in the table below:

Visits	**Number of scientists (visits)**	**Number of person days**
West ==> East	17	172
East ==> West	67	962
West ==> West	43	230
East ==> East	32	161

2.1.2. <u>Collaboration</u>

- In your opinion, how intense was the collaboration among the different Contractors up to now?

Intensity of Collaboration	**High**	**Rather high**	**rather low**	**low**
West <=> East	+			
West <=> West		+		
East <=> East		+		

- In this project, do you co-operate to a major extent with additional (inter)national organisations and institutions not mentioned in the Co-operation Agreement? If yes, please, specify:
  Cooperation with INRIA-Lorraine, Metz; Ecole des Mines de Nancy (France); RUTCOR, Rutgers University (USA); University of Leeds (UK); Institute of Engineering Cybernetics of Wroclaw University of Technology; Poznan University of Technology (Poland); Department of Logistics of the Hong Kong Polytechnic University (China).

2.1.3. Time schedule

In accordance with the Work Programme, but with an extension of 5 months.

2.1.4. Problems encountered: None

Problems encountered	**Major**	**Minor**	**none**	**Not applicable**
Co-operation of team Members			+	
Transfer of funds			+	
Telecommunication			+	
Transfer of goods				+
Other				

3. FINANCES (in EURO)

3.1 This grant

Contractor		**Cost Category**						**TOTAL (Euro)**
# *)	Name of Contractor *)	Individ. Grants Labour Costs	Overheads	Travel and Subsistence	Consumables	Equipment **)	Other Costs	
1	LLI Grenoble	6720	500	9000				16220
2	USouthampton		500	9000				9500
3	UMagdeburg		500	8613				9113
4	EM StEtienne		500	9000				9500
5	UGreenwich		500	9000				9500
6	UIIP NAS Belarus	6210	-	25500				31710
7	BSU Minsk		-	15000				15000
8	IM NAS Belarus		500	9300				9800
9	BSUIR Minsk		470	5800				6270
10	Omsk branch SIM RAS		500	10500				11000
TOTAL (Euro)		12930	3970	110713				127613

Spending has been in accordance with the Work Programme.

3.2 Other funding

This project did not receive substantial funding from other sources than INTAS.