

# A Graduate Program in Business Informatics: Experiences at the University of Pisa\*

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## Abstract

At the University of Pisa, a graduate program was started in 2002 to prepare professionals with an interdisciplinary skills both in informatics and in business to satisfy the increasing demand by companies to compete using analytics methods. The graduate program focused on Business Intelligence techniques to support decision making. This paper presents the structure of the graduate program, the results achieved in the first six years, and how it has been redesigned to satisfy the requirements of the new ministerial law regarding the curricula of the Italian universities.

## 1 Introduction

In 2002, for the first time in Italy, the University of Pisa set up a graduate program of the Informatics class 23/S<sup>1</sup> to prepare professionals with an interdisciplinary skills both in informatics and in business to satisfy the growing demand for experts in both areas by companies and the civil service. The graduate program was offered jointly by the Faculty of Science and the Faculty of Economics, and was named *Informatica per l'economia e per l'azienda* (for the sake of simplicity *Business Informatics 2002*).

It was widely recognised that the evolution of the relationship between organisations and information technologies would entail a continuous alignment and integration of both worlds where professionals are able to share languages, methods and

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<sup>1</sup>In the Italian university system a graduate program belongs to one of the classes identified by the MIUR (Ministry of Instruction, University, and Research), which have associated a minimum number of credits, for one or more subjects, and which is compulsory at a national level for each study program of a class. See <http://www.miur.it>.

strategic objectives in order to enable organisations to be more flexible, responsive and competitive in increasingly aggressive and global markets.

The graduate program was organized by a joint committee of professors from the Departments of Informatics, Economics, and Business Economics at the University of Pisa, taking into account the following considerations:

- In line with international trends, in Italy there was a decline in the total number of new students who enrolled in traditional undergraduate or graduate informatics programs, in both the Faculty of Science and the Faculty of Engineering. An idea widely shared to tackle this trend was to promote programs in informatics with more emphasis on an interdisciplinary content.
- Surveys of national and international organizations revealed a demand for graduates with skills both in information technology and business economics in order to develop applications to support decision making. This need has been also confirmed by recent studies and surveys (T. H. Davenport e G. C. Harris, *Competing on Analytics: The New Science of Winning*, Harvard Business School Press, Boston 2007; T. Burelli, A. Marzona, M. Pighin, *From Intuition to Knowledge* (in Italian), Aracne, Roma, 2007; *Observatory on Business Intelligence* (in Italian), Report 2007-2008 SDA Bocconi).
- To enable the graduates of the course of study to take the Italian State Examination that gives admittance to the regulated profession of IT Professional Engineer, or to progress to senior management positions, the interdisciplinary graduate program had to award a degree in the Informatics class, unlike similar interdisciplinary study programs offered by other Italian universities. There were, in fact, programs covering both information technology and business, offered by economics faculties or by science faculties, but they were only undergraduate programs, and were not part of the Informatics class.
- Graduates needed to acquire a broad skill in informatics to be able to do a PhD in informatics.
- The advanced subjects of the graduate program had to be supported by close connections with the research activities of the members of the Departments of Informatics, Economics, and Business Economics. In addition, it was a ministerial requirement that each teaching program had to be signed by a minimum number of professors or researchers, called *garanti* (guarantors), who committed themselves to teaching courses on the program.

The study program was thus designed to prepare graduates both to master the information technologies and to understand the needs of organisations with a specific training in Business Intelligence for decision support. This vision was supported by close connections with the research topics carried out by the Departments of Informatics, Economics, and Business Economics in areas such as: datawarehousing, data mining, marketing, business information systems.

In the following sections, we present the structure of the graduate program, followed by the results achieved in the first six years, and finally we will describe how the program has been redesigned to satisfy the requirements of the new ministerial law concerning the curricula of the Italian universities.

## 2 Graduate Program Structure

The graduate program *Business Informatics 2002* was organised with two curricula, for a total of 120 credits<sup>2</sup>, which require a thesis of 18 credits: a curriculum for students with a bachelor's degree in Informatics and another curriculum for students with a bachelor's degree in Economics, or Business Economics, or in Statistics for Business Economics.

The curriculum for students with a bachelor's degree in Informatics was organized as follows:

- Compulsory subjects with 46 credits
  - Microeconomics, 10 credits,
  - Business Economics, 10 credits,
  - Statistics, 5 credits,
  - Business Intelligence, subjects with 21 credits.
- Elective subjects with 25 credits from one of the following areas: Economics, Business Economics, Business Law.
- Elective subjects with 10 credits from any of the following areas: Economics, Business Economics, Business Law.
- Elective subjects with 5 credits from the Management Information Systems area.
- Elective subjects with 10 credits from the informatics area.
- Elective subjects with 6 credits from any area.

The structure of the curriculum for students with a bachelor's degree that was not in informatics depended on the number of credits that the student had in Informatics, Mathematics, and Economics. In general, they were admitted to the graduate program even if they had an insufficient number of credits (*formative debits*), and they had to attend courses from the undergraduate program.

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<sup>2</sup>One credit corresponds to 8 hours of teaching in frontal lessons or 12 hours of teaching in a laboratory, plus individual study by students to reach a total of 25 hours.

The two curricula had the following compulsory Business Intelligence subjects in common for a total of 21 credits:

- Databases for decision support (5 credits). The course includes data-driven decision support systems, a data warehouse design methodology, On-Line Analytical Processing (OLAP) techniques and systems to use data warehouses for business decisions, and the technology of Data Warehouses Management Systems (storage structures, star query optimization techniques, query rewriting to use materialized views).
- Enterprise Information Systems (5 credits). The course covers the principles, methods and techniques to make rational decisions using corporate information assets. It introduces the theory of decisions, according to the classical approach of the criterion of maximization of expected value. Methods of forecasting and optimization are then introduced, such as Bayesian methods and dynamic programming. Lastly, typical examples of these principles and methods in the economic-business area are presented.
- Data Mining (5 credits). The course introduces the basic steps of knowledge discovery in databases, the main techniques of data mining and their algorithmic aspects. Methodological issues are discussed in depth by presenting case studies in market basket analysis, customer segmentation, fraud detection and web mining. In addition, privacy concerns in data analysis are presented, given that they pose ethical and legal obstacles to the practical application of data mining.
- Laboratory of Business Intelligence (6 credits). The course presents technologies and systems for data access, datawarehousing implementation, Online Analytical Processing (OLAP) analysis, and knowledge discovery from data. The focus is on the tools and on applications for real-world problems, such as marketing and customer relationship management. Students learn how to critically analyse commercial software applications, and how to separate the purely technological aspects from the functional requirements of a Business Intelligence project.

Although doing a thesis with an internship was not compulsory, it was typically associated with an internship of three to four months in public or private companies. Agreements were set up with more than 30 companies, mostly located in Milan and Rome, so not just in the Pisa area. The companies were not only software houses, but also companies in the area of consulting, auditing, fashion, mobile telephony, manufacturing, retail, and supermarket chains.

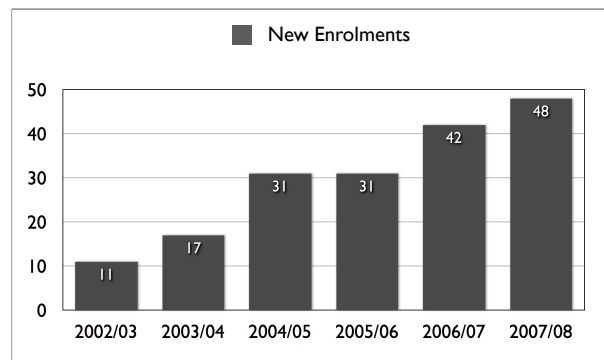


Figure 1: New enrolments by year

### 3 Notable Accomplishments

The graduate program has achieved the following main results in its first six years:

- *Accreditation.* A Quality Assurance (QA) system was designed in accordance with the CRUI (Conference of Italian University Rectors) guidelines, which in turn, were based on the ISO 9001 norms. The QA system describes the roles, responsibilities, resources, structures and registrations in didactic, technical and administrative processes. An annual self-evaluation audit was conducted in the period 2003-2007. External audits were also performed by a CRUI committee made up of one academic member and one industrial member.
- *Awards.* The graduate program was funded by the regional administration in Tuscany (European Social Fund, ESF) for the academic years 2003/04 and 2004/05 for Experts in Business Intelligence. Nineteen students completed all the required activities within the scheduled time, including extra curricular activities. In addition, the graduate program was one of nine programs at the University of Pisa funded in 2007 by the regional administration in Tuscany to support students whose thesis involved an internship in organisations in regions different from Tuscany.
- *Attractiveness of the graduate program.* The graduate program was well received by students; there were 180 new enrolments in the first six years, a figure which is constantly increasing, as shown in Figure 1.
- *Type of enrolments.* 31% of the 180 total enrolments in the first six years were from 16 other Italian universities (i.e. not Pisa) (Figure 2). There were 11 new enrolments with an Economics degree, 9 with a degree in Economics and Informatics, and 1 with a degree in Statistics (Figure 3).
- *Withdrawals.* The graduate program has had a total of 23 withdrawals so far (13%).

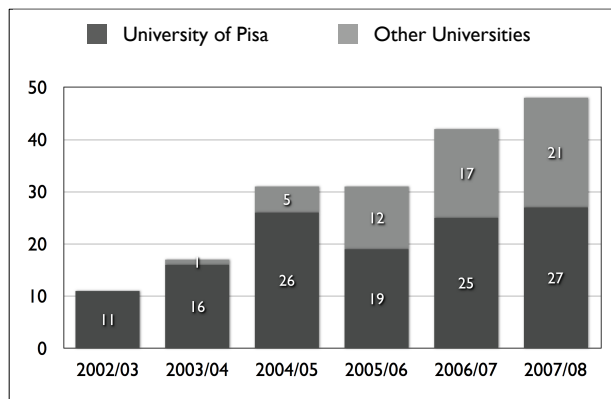


Figure 2: New enrolments by year from Italian universities different from that of Pisa

- *Level of satisfaction of students.* The graduate program has encouraged feedback from students through the distribution of the subject evaluation questionnaires at the end of each semester, which were then used for the annual report that the program coordinator submitted to the Faculty Dean and to the Evaluation Unit of the University. The evaluations were expressed by a numerical value from 1 (very negative) to 4 (very positive). For each course that students attended in a semester, they were asked to assess:
  - adequacy of prior knowledge of the prerequisites of the course;
  - match between official program and actual contents of the course;
  - usefulness of the didactic material (books, slides, lecture notes);
  - clarity and effectiveness of the teacher;
  - capacity of the teacher to stimulate active participation and interest;
  - workload in relation to the number of course credits;
  - clarity of information on the on-going and final marks;
  - presence and timekeeping of the teacher;
  - interest value of course contents;
  - overall evaluation of the course.

Summaries of the statistics were published on the graduate program web site at the end of each semester. The overall average scores were always greater than 3.

- *Years of study to graduate.* In the first six years the graduate program had 47 graduates: 25 completed the course within the official allocated time, 19 had fallen behind schedule and required one extra year, and 3 required two extra years (Figure 4).

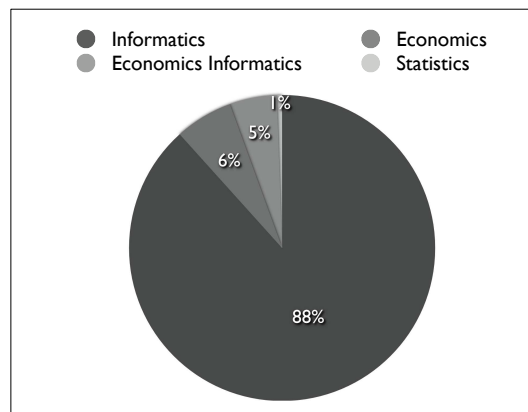


Figure 3: Total enrolments by undergraduate degrees

- *Level of satisfaction of graduates.* The graduate program led to the signing of internship agreements between the Department of Informatics and public or private companies, during which students carry out theses on projects of their interest, providing they fit in with the educational objectives. This opportunity was much appreciated by graduates because it gave them the opportunity to see how they got on in the world of work and apply the knowledge gained. In addition it provided access to stable employment in their field of interest, often in the same organizations that hosted the participants. As reported in the *Self Evaluation Report 2006*, according to a survey of graduates on the match between the job and the training received during the course on a scale of three (total-partial-none), 65% of graduates reported a total match, 22% a partial match and 13% no match. In the latter case, these graduates were employed in commercial or software development activities. Note, however, students were always positive about the quality of the training received in terms of introducing them into the world of work.
- *Employment trends of graduates.* 33 out of 47 graduates carried out their thesis in external organizations. The views of the tutor in evaluating the graduating have expressed keen interest in the original training and full satisfaction with the activities carried out by them, who have always been offered to stay in the organization. On average, students found a job within one month of graduating. All positions were in line with the Business Intelligence training provided by the graduate program. The low average time to find a job confirmed that the graduate program prepared graduates with interdisciplinary expertise who are highly sought after by the job market.

Clearly, the organization of the program had to be done on an inter-faculty basis. In fact, the *didactic coordinator* turned out to be an invaluable resource for the success of the various initiatives. The didactic coordinator, was part of the technical-

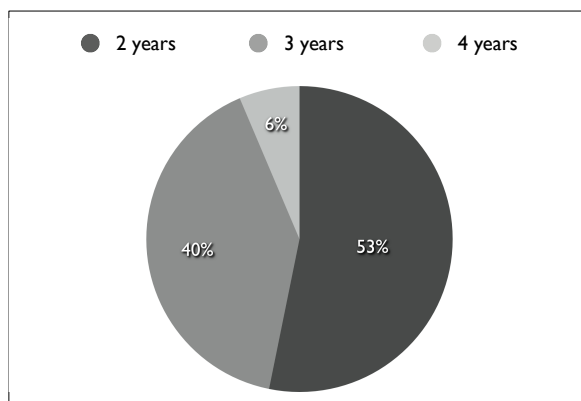


Figure 4: Number of years to complete the graduate program

administrative staff of the graduate program, and had the following tasks: support for students; dissemination of information on various aspects of logistics and bureaucracy; career advice and monitoring; coordination of internships; contact point for public and private companies; and many others.

#### 4 A New Version of the Graduate Program

In the 2008 the graduate program *Business Informatics 2002* was revised to meet the new requirements established by the Italian Ministry of Education, University and Research with the Ministerial Decree DM 270/04: *Linee guida per la progettazione dei nuovi ordinamenti didattici dei corsi di laurea e di laurea magistrale*.

In the redesign of the graduate program, it was decided to define it not only as inter-faculties but also as inter-classes, both because it could satisfy the constraints of the two classes (LM-18 Informatics) and (LM-91 Techniques and Methods for the Information Society), and to deal with the growing demand for the admission of students with a bachelor's degree other than Informatics. With the previous regulation this was not possible or could only be done with a curriculum that included a number credits greater than the standard value of 120. Admission with an insufficient number of credits is now forbidden under the new ministerial rules.

The new graduate program has been renamed *Informatica per l'Economia e per l'Azienda (Business Informatics)* (for simplicity *Business Informatics 2009*), and it has been organised with two curricula, for a total of 120 credits, based on the interests and needs of stakeholders, i.e. students, employers, and academic institutions:

- *Business Informatics* for students with a bachelor degree in Informatics or Engineering Informatics;
- *Business and Informatics* for students with a bachelor's degree that does not provide enough background in informatics.



The curricula is organized as follows:

- Subjects with 48 credits from the Informatics area.
- Subjects with 48 credits from the following areas: Business Economics, Business Law, Economics, Operation research, and Statistics.
- Elective subjects with 9 credits, from a list defined every year by the Graduate Program Council.
- A thesis with 15 credits.

The two curricula have at least 48 credits on Informatics in common, with 36 in the following compulsory subjects in the field of the fundamentals of Business Intelligence:

- Decision Support Information Systems
  - Module 1: Decision Support Data Bases (6 credits)
  - Module 2: Data-driven Decision Methods (6 credits)
- Data Mining
  - Module 1: Data Mining: Foundations (6 credits)
  - Module 2: Data Mining: Advanced topics and applications (6 credits)
- Business Performance Analysis
  - Module 1: Business Process Modelling (6 credits)
  - Module 2: Business Intelligence Laboratory (6 credits)

### **The Changes in *Business Informatics 2009***

Based on the experiences with *Business Informatics 2002*, faculty resources and skills, and the evolution of technology and business needs, the main changes in the design of the new graduate program *Business Informatics 2009* were:

- Revision of course contents and credits so that graduates have the following interdisciplinary expertise to master the information technology and to understand the needs of organizations in order to exploit new opportunities offered by information technology:
  - Information and communication technology supporting business and operational goals (operational information systems), decision making (decision support information systems), and business services on the Web.
  - The fundamentals of economics and management science.

- Enterprise organizational models, typical functions, primary and support activities.
- The role of management planning and controlling systems.
- The Business Intelligence methods and tools to design, plan, implement and manage applications to provide managers with information synthesis in order to achieve more effective tactics and strategies to increase their competitive edge.
- Methods and tools for analyzing business processes and the redesign of such processes, where necessary using the technology of Web services.

In addition, *Business Informatics 2009* graduates will have the cultural, scientific and methodological skills necessary to access to advanced levels of university education, particularly the PhD in Informatics at the University of Pisa.

- Design of two alternative curricula to enable students with different bachelor's degrees to continue their studies in order to acquire expertise in informatics and business.
- Reduction in the number of exams, by providing at most two modules per subject, with at least 3 credits and coherent contents, and under the responsibility of one professor.
- Review and increase in the content and number of credits of the compulsory subjects in the area of the Business Intelligence.
- Addition of two new core Informatics courses (Business Process Modelling, Data Mining: Advanced topics and applications) to take into account the changes in the IT area, the new business needs, and the development of research in innovative applications in the departments involved with the graduate program.
- Altogether the tenured professors from the departments involved with the graduate program have to teach subjects for at least 60 credits, primarily in compulsory subjects. This is a ministerial requirement strengthening the obligations of the *garanti* of *Business Informatics 2002*.

## 5 Conclusions

We have presented the rationale and objectives of an interdisciplinary graduate program in Business Informatics at the University of Pisa, the structure of the program, the results achieved in the first six years, and how it has been redesigned to satisfy the requirements of the new ministerial law regarding the curricula of Italian universities.

On the basis of our experience we believe that the idea of an interdisciplinary graduate program to prepare professionals with both the theoretical foundation and practical knowledge in informatics with a business perspective, and specific skills in Business Intelligence techniques to develop decision support systems, is highly recommended for the following reasons:

- The graduate program attracts new students that make up for the decline of enrolments in Informatics.
- The graduate program attracts highly motivated students who are looking for an opportunity to achieve further experience after their bachelor's degree which gave them a basic knowledge in a specific cultural area.
- Graduates are highly sought after in the job market and they have the opportunity to choose from among several job offers within a few weeks after graduating.

There is a need for an appropriate (and resource-consuming) coordination of the management of the graduate program. In addition to the organisational or administrative issues, special attention was paid to:

- The design of the syllabuses. Due to both resource constraints and lack of skills, the ideal situation where the contents of all the interdisciplinary courses are specifically designed to satisfy the objectives of the graduate program proved to be a little unrealistic, given that lack of funding, resources and time meant that ad hoc courses could not always be prepared.
- The workload of supervising the thesis. Due to the high number of enrolled students compared to the number of researchers working in informatics and business topics, students may have problems in starting their thesis work with an academic supervisor. Internships have been very effective in mitigating this problem as students have been able to do their thesis within a company.

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