Most organizations today face a significant data explosion problem. Automated data collection tools and mature database technology have led to vast amounts of data being stored in enterprise resource planning systems, databases, data warehouses and other information repositories. Firms are drowning in data but starving for knowledge! As the information infrastructure continues to mature, organizations have a continuous opportunity to make themselves dramatically more intelligent through “knowledge intensive” decision support methods.

Compared to a decade ago, a substantially broader array of techniques lies at our disposal. Collectively, this array of techniques offers the decision-maker an extensive set of tools, capable of addressing increasingly more difficult problems than were ever possible to embark upon. Clearly, the continuous developments in computer technology have extended the application of O.R. techniques, but these developments have also encountered an interesting side effect. Application areas, previously considered separate and distinct, have merged with operations research. As if on cue, the term “business intelli-
Business Intelligence

HOWARD DRESNER, former chief strategy officer at Hyperion, is widely considered to be the “father” of business intelligence since he used the term in 1989 and described the area as the “concepts and methods to improve business decision-making by using fact-based support systems” [4]. However, with the exponentially increasing interest in and growth of the business intelligence field, it turns out that Hans Peter Luhn was apparently the first to coin the term “business intelligence” in a 1958 paper, “A Business Intelligence System,” published in the IBM Journal [7]. Luhn defined business intelligence as “the ability to apprehend the interrelationships of presented facts in such a way as to guide action towards a desired goal.” Nonetheless, it was not until the late 1990s that the term business intelligence fell into widespread use.

Dresner, whose focus on BI hasn’t waned, told ZDNet Australia in 2006 that “business intelligence needs to move beyond IT in order to be truly effective” [6]. He then defined BI as “an umbrella term to describe how end users access and analyze structured content or data.” BI is now defined as a “broad category of applications and technologies for gathering, storing, analyzing, and providing access to data to help enterprise users make better business decisions. BI applications include the activities of decision support systems, query and reporting, online analytical processing (OLAP), statistical analysis, forecasting and data mining” [11].

This expansion of the application of BI has also resurrected an even older term: business analytics (BA). The term business analytics dates back to Fredrick Taylor’s time management exercises in the late 19th century, as well as the beginnings of the field of operations research/management science (OR/MS). Today, Beller and Barnett define business analytics as “the skills, technologies, applications and practices for continuous iterative exploration and investigation of past business performance to gain insight and drive business planning” [2]. In Davenport’s and Harris’s 2007 book “Competing on Analytics,” [3], they describe business analytics as “the extensive use of data, statistical and quantitative analysis, explanatory and predictive models, and fact-based management to drive decisions and actions.”

Davenport views BA as a subset of business intelligence and BI as a set of technologies and processes that “includes both data access and reporting, and analytics.” Business analytics “is the science of analysis – the processes by which we interpret data, draw conclusions and make decisions. Business analytics goes well beyond simply presenting data, numbers and statistics. The essence of analytics lies in the application of logic and mental processes to find meaning in data. Business analytics is surely the next major evolutionary step in the continuously changing field of business intelligence (BI)” [10].

Extensive computer technology improvements in techniques, skills, technologies and definitions have broadened the term BI since first being coined several decades ago. Dependent on individual training and background, the definition of BI may include, but not be limited to:

- an information technology viewpoint conducting queries that “slice and dice” the data and producing reports and dashboards, possibly using an OLAP tool;
- a statistics viewpoint employing data mining tools to analyze and explore the deluge of data and uncover unforeseen relationships, and;
- an operations research/management science (OR/MS) viewpoint developing models that impact the organization’s strategy, planning and operations.

Despite a fairly inclusive definition of BI, Dresner asserts that the definition of BI has also been “perverted over time by vendors trying to find new ways to market their products” [6].

Business Intelligence Framework

FIGURE 1 PRESENTS a cohesive vision of business intelligence as a melding of technologies, models, techniques and practices. The three circles of the Venn diagram each represent areas of study and application that had previously been considered quite distinct: 1. information systems and technology, 2. statistics, and 3. OR/MS. It serves to encapsulate the broadening definition of BI. With this new vision, we may now characterize BI from each of three viewpoints as: business information intelligence (BII), business statistical intelligence (BSI) and business modeling intelligence (BMI). Each of the viewpoints has particular business aspects, and academically speaking, courses that are independent of the other viewpoints. Conversely, each viewpoint can work together or utilize techniques/skills from one or possibly two of the other disciplines. For example, data mining, which requires a high level of statistical knowledge as well as the availability of necessary data, may

Organizations, both corporate and academic, have been rushing to the table with their own business intelligence groups and programs.
require significant IT skills and/or knowledge. Further, if data mining analysis demands a systematic process of analysis, modeling skills may be required.

Business analytics (BA), within our framework, is classified as a combination of business statistics intelligence (BSI) and business modeling intelligence (BMI): \( BA = BSI + BMI \). BI is the union of the areas of BA, BI and business information intelligence (BII): \( BI = BII + BA \) or more specifically \( BII + (BSI + BMI) \). As evidenced in the data-mining example, black and white distinctions between disciplines can quickly become gray.

**Industry**

The first and most obvious home of business intelligence within an organization is the area of information technology (IT). IT departments will typically have four major functional areas: hardware maintenance, network maintenance, technical support/help desk and database administration. The area of database administration, with all of its analysts and administrators, populates the BII circle of Figure 1. This department is responsible for the management, maintenance and proliferation of data and data warehouses throughout most organizations. The department is additionally responsible for a significant amount of data analysis using business analytics techniques, including analyses supporting the accounting and finance departments. A strong IT department is a critical foundation for the successful implementation of any component of BI. Without a high-quality IT component, the depth and breadth of BI functions are limited.

Operations, though not immediately thought of in terms of business intelligence, is actually an incredibly large and important facet of BI. The lower circle and upper right-hand circle of Figure 1, BMI and BSI, both have strong correspondence to this area. For purposes of this research, the functional area of operations will be broken down into supply chain management/planning, quality management (including six sigma), process control engineering, industrial and system engineering, operations analysis and shop floor or service floor management.

Supply chain management and planning has become critical to the success of businesses in recent decades. No matter the type of company, supply chain strategy must integrate fully into overall corporate strategy in order to achieve complete success. Understanding the needs of the supply chain is only the first step. Massive amounts of data are processed and built into mathematical and simulation models in efforts to continually improve the efficiency and strategic fit of manufacturing, service and distribution operations.

Quality management and statistical analysis often overlap in companies. Their goal is to understand the consistency and efficacy of products, whether manufactured or service products. These professionals again work with massive amounts of data and distill them down into meaningful information through analytical methods.

In the remaining areas of operations, engineers, analysts and management are all faced with business intelligence challenges every day. They also have a significant overlap with the areas already discussed, and they exploit analytical techniques to effect continuous improvement in the design and management of operations.

Marketing, sales, product development and human resources extensively use statistical analysis and forecasting to support decisions within their areas. Market research, sales forecasting and workforce forecasting are among the most important types of analyses performed in these areas – analyses that are all pillars of business intelligence.

We can easily comprehend that executives and managers must find increasingly creative solutions to complex challenges. Data has become the third most important asset a company can have. The need for better and faster decision-making is stronger than ever. Being able to use massive amounts of data is a necessary competitive advantage. The BI capabilities presented above, that are so pervasive in industry, provide this competitive advantage. In many industries they not only provide a competitive advantage but must also be applied in order to survive. It is therefore critical that companies identify and exploit all business intelligence functions, no matter when they exist.

It is critical that business begin to fully recognize the depth and breadth of the business intelligence functions within their organizations. Without this recognition and a movement
toward the culture of BI, companies will lose any competitive foothold they have to those companies that have embraced and duly benefited from the area of business intelligence.

**Education**

UNIVERSITY LEVEL COURSES and curriculum in business intelligence/business analytics (BI/BA) may appear in Business, Arts and Sciences or Engineering schools, in mathematics, computer science or statistics departments, and in undergraduate or graduate programs. Nonetheless, a BI/BA program, whether a course, a concentration or a major, should aim to achieve one of three levels of competency: fundamental, basic specialized or advanced specialized.

**Fundamental Level:** The minimum/core fundamental learning objectives of all programs containing the BI/BA competency should be:

- problem-solving skills,
- communication skills,
- a fundamental understanding of business, and
- introduction to BI areas of study.

Problem-solving, or modeling, is the process of structuring and analyzing problems to develop some quantitative abstraction of the problem that will lead to a rational course of action. Students need to learn where and when to use the tools and techniques we teach them, and more so, how to go about solving a real problem [8], [5]. We cover a certain chapter(s) that encompasses a particular technique and then give homework or test the students on that technique, and our students do fairly well. However, at the end of the semester, during a comprehensive final exam, most students have difficulty deciding which technique to use and when to use it. As an analogy, we teach our students how to use the hammer, drill, saw and so on, but they don’t know anything about how to be a carpenter. Given their tools, a stack of lumber and other materials, they have no idea how to start to build a house.

We need our students to learn the craft of problem-solving/modeling skills so that they can become the master carpenters of BI. The skills of analyzing problem situations and building models are already fundamental skills to most scientists and engineers. However, these problem-solving skills are severely lacking and must also become fundamental skills for other disciplines, such as business managers, educators, and healthcare providers. The statistics and OR/MS courses for most of these students are viewed just as other mathematics course, not as they should be – as courses providing them with important decision-making tools. These skills are essential to the BI worker. Students with these core fundamental learning objectives would become managers or neophyte BI analysts.

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The communication of the analytical results to the decision-makers is a critical step of whether or not the results will be implemented. As F. Bradshaw notes, “Most managers would rather live with a problem they can’t solve than use a solution they don’t understand” [9]. The mathematical or statistical jargon related to analyses and models must be stripped away and the nature of the solution technique must be communicated to management in non-technical and business perspective terms. As early as 1961, Wynne said that the challenge faced by OR/MS specialists “consists of stripping the research argument of its mathematical complexities and irrelevancies while retaining the rigorous logic for the executive’s understanding” [12]. This step not only requires good communication skills, but also an understanding of business. Most business programs provide their students with a reputable fundamental understanding of business, as well as numerous opportunities to improve their communication skills. On the other hand, most non-business programs do not emphasize these communication and business skills.

The last fundamental objective that should be found in all curriculums containing BI/BA is a basic introduction to the three BI areas of study. These courses would provide an introduction to the three disciplines of information technology, statistics, OR/MS and an understanding of their relationship to the overall BI framework.

Basic Specialized Level: The next level of BI/BA competency is the basic specialized level. This level requires further development beyond the basic fundamental BI skills covered by introductory course in one, two or all three discipline areas of the BI framework. In the IT discipline, for example, these specialized skills could encompass courses in database, programming and/or enterprise data. In the statistics discipline, these skills could be covered in multivariate and/or data mining classes. In the OR/MS discipline, it could include courses in supply chain, simulation and/or linear programming. Students with these skills could be junior to senior BI analysts.

Advanced Specialized Level: The highest level of BI/BA competency is the advanced specialized level. This level of achievement is obtained by a doctoral program or an advanced master’s level graduate program. The focuses should be on the theory, concepts and applications of one of the three BI/BA disciplines. Students achieving this level of skills could be senior BI analysts, researchers or professors.

Conclusions

Despite the appearance of BI in both academia and industry, until now the field has lacked a clear definition. Not all aspects of BI will be exploited in every situation, but it is still important to know what the future holds. Within this

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structure, BI was broken down into three significant areas: business information intelligence (BII), business statistical intelligence (BSI) and business modeling intelligence (BMI). Specialists exist in all of these areas, but the importance of the intersection and unions of these areas needs to be emphasized. True intelligence results from the melding of all of these technologies and tools.

This article outlines descriptive taxonomies of academic programs and corporate groups as a means of fashioning both. Academic programs should constantly evolve to meet the ever-growing need for qualified professionals in the field of BI. Companies must adapt their cultures to manage and explore the vast amounts of available data, the third most valuable asset a company has. The taxonomies also provide a sound standard for evaluation of new hires for companies. By understanding the complete role of business intelligence, managers may more effectively address the nature of their BI needs and choose qualified applicants to hire.

Over the years, OR/MS has had many identities including decision sciences (DS) and operations management (OM). Business intelligence is not OR/MS, nevertheless, it can be viewed as just the latest “repackaging” of operations research. All curriculums that encompass BI/BA as proficiency, whether from one course to a minor or major, must include the four fundamental BI/BA skills. If not, the future of OR/MS and the BI/BA component will never fully achieve its overall potential impact. Even with OR/MS’ past successes, as Ackoff predicted in 1987, OR/MS could again face serious problems [1].

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