

**BI Norwegian School of Management – Thesis**

Master of Science in Innovation and Entrepreneurship

GRA 19002

**Convergence, Complementarity or Disruption:  
Enterprise Search and Business Intelligence**

**By**

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Hand-in date:

01.09.2009

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This thesis is a part of the MSc programme at BI Norwegian School of Management. The school takes no responsibility for the methods used, results found and conclusions drawn.

## **Acknowledgments**

I would like to thank my supervisor, Dr. Espen Andersen, for his support and guidance throughout the project. I am also grateful to all participants in this research for their contribution and time. Finally, I thank my family for their understanding, encouragement and patience.

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## **Abstract**

Business intelligence has been used in companies for decades, enabling management to make decisions and to increase their competitiveness in the market. Search technology has enabled users to access all types of information from anywhere at anytime. In today's world, where the amount of information is ever growing, professionals see the potential of these two technologies. In what direction is the relationship between enterprise search and business intelligence evolving: towards complementarity, convergence or disruption? Throughout the research for this paper, there were 35 professionals interviewed who are industry analysts, technologists, marketing specialists, entrepreneurs, scientists, managers and consultants. Although complementarity has appeared to be the most natural answer, there are some indications of convergence in enterprise search solutions. Finally, enterprise search has the potential to disrupt the business intelligence vendors, but some of the obstacles could be: change in power structure, customers' unawareness, cultural differences, price, complexity, easiness of use and ability to manipulate the accessed information.

## **Introduction**

Large companies have relied on business intelligence solutions for decision making for several decades. On the other hand, enterprise search is relatively new technology that has become increasingly important with the growing number of documents, files, blogs, emails and other types of unstructured content. Due to their individual power, professionals in both industries have started an ongoing discussion on future of these two technologies and their interaction.

Looking at the potential relationships between business intelligence and enterprise search, there are three different perspectives that have been surfacing in literature. While complementarity and convergence have been predominant in discussion, disruption has been mostly ignored.

This paper looks into these two technologies, their capabilities, developments and uses in the market in order to determine how they interact and their potential future relationship. While convergence and complementarity represent harmonious solutions where both technologies coexist, disruption could be perceived as an aggressive view, which leads to win-loose situation. Does enterprise search have a disruptive potential that could lead to eventual replacing of traditional BI solutions?

## **Research Methodology**

### ***Research Question***

How is the current relationship between enterprise search and business intelligence and how could it potentially evolve: complementarity, convergence or disruption?

### ***Method Used***

This paper looks at existing and potential relationships between two technologies, enterprise search and business intelligence. Exploratory case study is the method that was used in this research in order to get an overview of these two technologies and their mutual interaction, as well as to gain insight into the current state of industries.

The case study method is used in social science research, when there is a need to understand “complex social phenomena.” (Yin 2009) The method enables researchers to “retain the holistic and meaningful characteristics of real-life events”. (Yin 2009) Some of the events include small group behavior, organizational and managerial processes and the maturation of industries. (Yin 2009)

Yin (2009) lists out three conditions needed to determine what research method to use. The first condition is “the type of research question”. In this research the question is “how is the relationship between enterprise search and business intelligence?” Therefore, “how” is the type of research question.

The second condition is about whether the researcher has control over “behavioral events”. Due to the nature of this research, there was no intention to manipulate or control behavioral events, such as interviews. Focus on contemporary vs. historic events is the third condition in choosing the method. This research has been focused on the current state of technologies and industries. The case study method fits these three conditions; therefore it has been selected for this research.



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Yin (2009) distinguishes three different types of case studies: exploratory, explanatory and descriptive. This study explores current technological solutions, industries, their existing and potential relationships, thus exploratory case study is an appropriate method for this research.

For this paper, three sources of evidence were used: documentation, interviews and direct observations.

### ***Collecting Data***

Throughout the research 35 professionals were interviewed. They are classified into four groups: business intelligence providers, enterprise search vendors, customers and industry analysts. These were *in-depth interviews*, where professionals were asked to describe technologies and customers, as well as their opinions regarding the relationship between enterprise search and business intelligence. There were instances where interviewees would recommend other professionals that would be beneficial to interview.

### ***BI vendors***

The intention was to interview all major business intelligence solutions providers. Professionals from all but one major vendor agreed to be interviewed. Unfortunately, relevant contacts at SAP did not have time to participate in the research, despite numerous attempts. In addition, professionals who were not directly connected to the above vendors, but having competence and experience with implementation of BI solutions were included in the research.

COMPANY	# of interviewees
Oracle	3
SAS	1
IBM	1
Microsoft	2
StatSoft	1
Teradata	1
Accenture	2
Deloitte	1
Commitment AS	1

**Table 1. Overview of companies and number of interviewed professionals**

#### *Enterprise search vendors*

Professionals from a number of search vendors differing in their market significance, size and technological approach were interviewed as part of this research. Unlike BI vendors, most of the leading enterprise search companies do not have offices in Norway. Being a Norwegian company, FAST is an exception, therefore it is the most represented enterprise search company in this study. T-rank, Comperio and IntelliSearch are also Norwegian companies providing solutions within the search technology market.

Company	# of Interviewees
FAST (a Microsoft subsidiary)	6
Endeca	1
Google	1
Comperio	1
IntelliSearch	1
T-rank	1

**Table 2. Enterprise search companies and number of professionals interviewed**

#### *Customers*

Obtaining an interview with enterprise search customers proved to be difficult. Instead four FAST's project managers were interviewed on behalf of their

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customers. The use of BI and enterprise search has been researched in five companies. They included product and service based industries such as manufacturing, telecommunications, food, consulting and oil.

COMPANY	# of interviewees
Statoil	2
Telenor	2
Mills	1
Storebrand	1
Deloitte	1

**Table 3. Customers and number of persons interviewed**

#### *Analysts*

There were four industry analysts with expertise in enterprise search, business intelligence and text analytics who were interviewed, two of them by email.

#### *Discussion on validity*

This research, being an exploratory case study, carries some standard threats to validity.

The initial plan was to gain an overview of the largest vendors of both technologies in the market, as well as their customers. Although finding customers who use business intelligence solutions was not difficult, finding customers of more complex enterprise search engines was a challenge. FAST's project managers were willing to be interviewed instead of their customers. This has led to an uneven representation of interviewees from different companies and, consequently, potential bias. Since FAST's headquarters is in Norway and their presence here is proportionally greater than the large BI vendors and other big search companies, FAST (now Microsoft) is overrepresented relative to other companies.

Other challenge was in finding equally competent professionals within the companies and industries. Since the research question has included a discussion on the future relationship of these two technologies, it was possible to notice a large variance in the interviewees' understanding of markets and their ability to

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think like visionaries. There has been also a difference in the way that marketing people approached the topic compared to technology background and worked on implementation of existing solutions. Marketing people have had a tendency to focus on promotion of their solutions, while those who have worked on implementation were often more focused on current capability of technology rather than potential. Therefore, the study could be biased due to the quality of answers and ability of professionals to understand both technologies.

Furthermore, in some cases, it has been difficult to distinguish whether the interviewees have expressed their opinion because of loyalty to their company, or whether it is their personal view.

As an attempt to decrease these potential biases, industry analysts from relevant industries were also interviewed. Due to their experiences, they have a more neutral perspective of the industries. Another attempt to increase validity was to conduct a relatively large number of interviews conducted throughout the research.

## Theoretical background

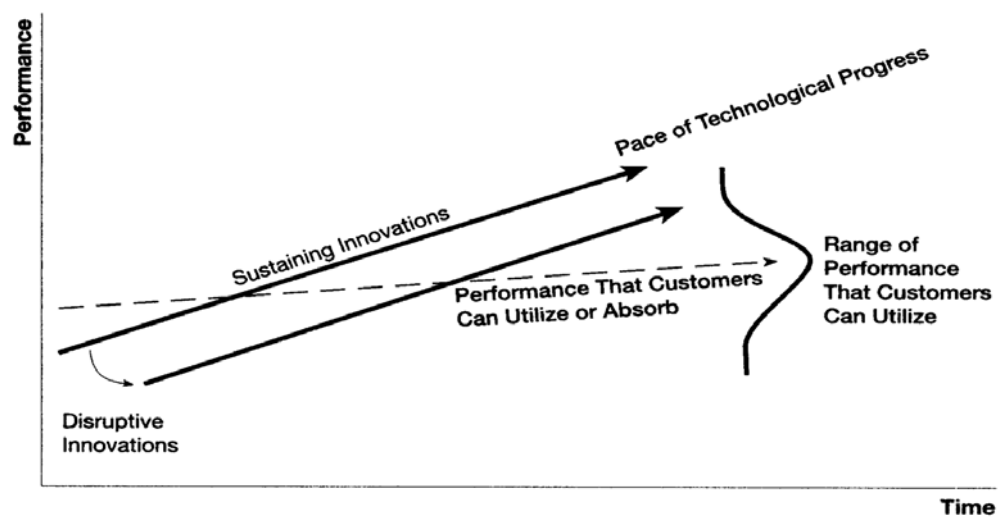
### *Introduction*

Predicting the outcomes of competition has always been a challenge. Even though large established companies in the market have an advantage due to human and financial resources, they have not always come out as winners. Christensen, a researcher at Harvard Business School, presents a new model to determine whether an established company (an incumbent) or newcomer to the market is likely to win.

This paper attempts to look at enterprise search technology as a newcomer to the market and to determine whether it has potential to disrupt established BI vendors. Christensen's disruptive innovation theory is applied to determine this potential.

### *Disruptive Innovation Model*

Christensen identifies three critical elements of disruption as part of the *Disruptive Innovation Model*. The first critical element is customers' ability to use constant improvements in products. While the high-end customers always demand the latest and greatest, there are customers who would be happy with significantly less. There maybe a product or service that is "good enough" for their needs. The dotted line in Figure 1. shows customers and their ability to use improvements. (Christensen and Raynor 2003)



**Figure 1. Disruptive Innovation Model (Christensen and Raynor 2003)**

The second element focuses on the innovating companies' constant improvement of their products. As solid lines in Figure 1. show, the rate of improvement almost always outpaces the customers' ability to utilize such an improvement. Yet, companies aim at constant improvements of their products so they can gain higher profits by selling them to "not-yet-satisfied" in the higher end of the market. (Christensen and Raynor 2003)

The third element is about distinguishing two types of innovations, sustaining and disruptive. According to Christensen's definition, sustaining innovation focuses on demanding customers, who need constant improvements in the performance. The established competitors are dominating the sustaining technology market. On the other hand, disruptive innovations are focusing on bringing new technology to the market. Disruptive technologies are not as good as those products that are already on the market, but their benefits are often simplicity, convenience, and lower cost. These products are appealing to less demanding customers or new ones, who are not using existing products in the market. (Christensen and Raynor 2003)

Once the disruptive innovation is successful in the low-end or new market, it continues to improve to the point where it reaches demanding customers. It is at this point that incumbents become directly affected. Christensen explains that this is possible due to "asymmetric motivation." Established companies in the market are motivated to constantly improve their products, while they are not motivated to fight newcomers in the lower-end of the market. (Christensen and Raynor 2003)

Christensen defines two types of disruptive innovations, low-end disruption and new-market disruption. (Christensen and Raynor 2003)

### ***Low-End Disruption***

Low-end disruptions attack the low end of the established market. These disruptions usually take away customers due to their low-cost products. These products have poorer quality than the incumbents' products. Due to established

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companies' focus on high-end, they do not perceive them as a threat. (Christensen and Raynor 2003)

### ***New-Market Disruption***

New-market disruptions with their more affordable and easier to use technologies create a market for new customers. These customers have previously not considered buying existing products due to their complexity and price. Therefore, new-market disruptions are fighting “nonconsumption”, and not incumbents directly. This is why established companies in the market do not perceive them as a threat. Eventually they gain customers from an incumbent's low-end market. (Christensen and Raynor 2003)

### ***Three Litmus Tests***

Three litmus tests are used to determine whether an idea has a disruptive potential. (Christensen and Raynor 2003):

1. Either one or generally both of these questions need to provide an affirmative answer in order to pass new-market disruption test:
  - a. Is there a large group of people that traditionally has struggled with money, equipment or skill to do this thing for themselves, and hence have not had it, or needed to pay for experts to do it for them?
  - b. Do customers need to go to “an inconvenient, centralized location” to use the product or service?
2. Both of these two questions need to be answered affirmatively to pass the low-end disruption test:
  - a. Are there customers at the low-end of the market who would be happy with less performance than usually offered in the market, although “good enough”, if the price was lower?
  - b. Is it possible to create a business model that enables earning profits, while selling products at lower price?
3. The last litmus test is for both of these two disruption types.

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- a. “Is the innovation disruptive to all of the significant incumbent firms in the industry?” It needs to be disruptive to all players, in order to prevent becoming a sustaining innovation to incumbents.

### ***Summary***

Christensen presents two types of innovations, sustaining and disruptive. While sustaining innovations focus on improving existing products and satisfying the most demanding customers, disruptive innovations disrupt and redefine the market with the introduction of new products. These products are inferior to the existing ones in the market, but they are “good enough” for customers at the lower-end of the market, or for those who previously did not use existing products. Benefits of disruptive innovations include lower cost, simplicity and convenience.



## What is Business Intelligence?

### *Introduction*

Business intelligence (BI) is a buzzword that rings with the sense of importance and urgency, as well as ambiguity. The meaning of the word “intelligence” ranges from “understanding”, “quickness of understanding”, “wisdom” to “collection of information” according to the Oxford Dictionary. Companies need this wisdom and understanding of their surrounding to stay competitive. Since intelligence comes from information, numeric and textual, software solutions have become a necessity for providing business intelligence in direct or indirect ways.

During the 1950s Hans Peter Luhn, an employee at IBM, published a paper in which he coined the term *business intelligence*. (Vesset 2008) Industry analyst, Seth Grimes (2009), stresses that business intelligence at that time was defined as analysis of information in textual sources. Yet, in practice, business intelligence has taken a different path.

According to Davenport and Harris (2007), in the late 1960's, professionals in some fields have started using computer systems for data analysis and to support decision-making. These applications were called decision support systems (DSS), and were used for “analytical, repetitive and somewhat narrow activities”, such as “production planning, investment portfolio, and transportation routing”. (Davenport and Harris 2007:11) Peter Keen and Charles Stabell claimed that the DSS concept stems from studies of organizational decision making at Carnegie Mellon University and technical work done at the Massachusetts Institute of Technology (MIT) during the 1960's. Another theory is that DSS came from the military applications during World War II. (Davenport and Harris 2007:12)

During the 1970's, the SAS Institute and SPSS made statistical analysis more available for researchers and other professionals by introducing packaged analytical applications. Analytical technology was used in decision making and performance monitoring through utilization its ad hoc queries. Enterprise resource planning (ERP), point-of-sale (POS) and later Internet transactions were

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producing large amounts of data, which were managed by online analytical processing (OLAP) and data warehousing. (Davenport and Harris 2007:12)

Today, business intelligence is defined as

*collection, management, and reporting of decision-oriented data as well as the analytical techniques and computing approaches that are performed on the data.* (Davenport and Harris 2007:12)

### ***How businesses view “business intelligence”?***

During the research, interviewees defined business intelligence in various ways, focusing on the value of BI solutions as well as technological implementations. Their opinions have differed due to their personal backgrounds, experiences and companies where they work. An executive, who works exclusively with statistical analysis tools has stressed that BI without data mining is not BI. Reporting or only presenting results has not been considered valuable enough to classify as business intelligence, since it does not provide deeper answers. Sources that work in companies with focus on analytics have expressed similar opinions.

Another term that has been encountered during this research is “competitive intelligence” as a synonym for business intelligence, where it is defined as learning about the competitors and their potential moves in a way that prevents surprises to top management. Within literature there are terms such as strategic, operational and competitive intelligence which all referring to knowledge that a company needs to have when making decisions.

According to a manager from a BI vendor, traditionally, business intelligence stored data and produced reports, while the current focus is on the automation of decision making in some circumstances. For example, in a retail company, there is a system that detects changes in a trend based on customers’ behavior. So, customers’ increased interest in a product, triggers the system to automatically adjust supply. The automation of decision-making significantly shortens the time that management would traditionally use to take an action. Another executive from a large BI company, points out that there has been a shift from looking at what has happened to looking ahead. Furthermore, he mentions optimization,

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forecasting and predictive analytics as important new methods that BI vendors provide.

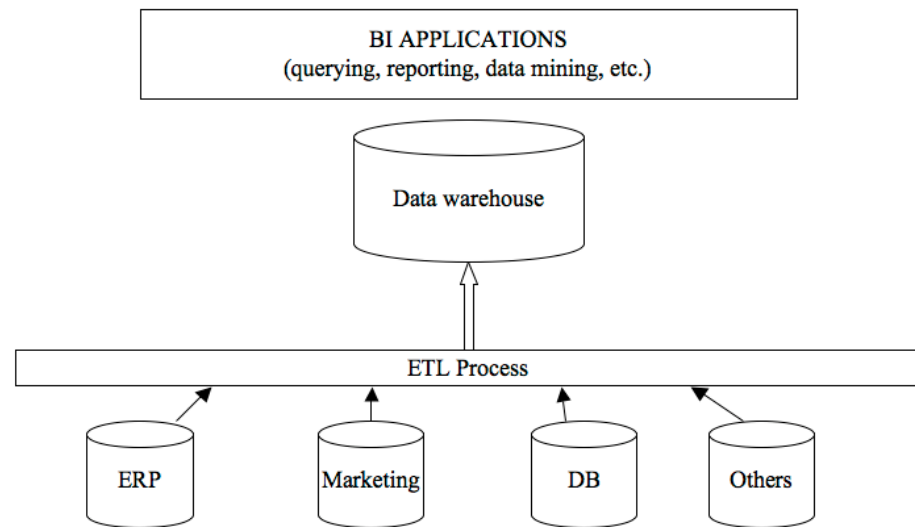
Interviewees have often expressed their own version of a definition of business intelligence, based on solutions they are familiar with and the companies where they work. One large company focuses on business processes and decision making support when discussing business intelligence. Another interviewee from a large software company points out the importance of “logic put into actions.” According to this person, it is not only about reporting and analysis, but the to be able to use the logic from analysis in production. Learning from previous experiences is another aspect that business intelligence should include in order to offer better decision-support.

According to a consultant from a large international company, in addition to structured data, business intelligence needs to include unstructured content such as information from documents, emails, etc. Further he states, if someone wants to know *why* something is happening, it is important to include unstructured data as well in the analysis.

While some professionals express their definition of business intelligence through technological lenses, other focus on the goal of these applications. For example, for an analyst within large corporation, business intelligence is a competitive intelligence where the focus is on determining what customers are doing, and what will be competitors’ future moves. It is also about “getting the right information to the right people at the right time” for another IT manager within a large organization.

### ***Technological implementation***

Traditionally, business intelligence software solutions consist of data storage, often in a form of a data warehouse or data mart, where data is stored after going through “extract, transform and load” (ETL) processes. On top of this structure there are different applications that enable data mining, reporting or more specific functionalities. BI solutions increasingly include text analytics for the purpose of transforming unstructured data to structured. Figure 1. Shows the traditional business intelligence infrastructure



**Figure 2. Business Intelligence Solution**

## **Business Intelligence Industry**

### ***Introduction***

In recent decades, the need for BI technology has been growing. Management has realized that large amounts of data are assets that analytics can convert to competitive advantage. Therefore companies have been investing significant amount of money into their BI solutions and their maintenance. Traditionally, IT departments have been responsible for these systems that were created for highly competent users.

Since data is stored in relational databases, or data warehouses, there is a complex process of cleaning and preparing data in order to be stored adequately in the system. Due to highly structured data, information accessed from the BI system is deterministic. In order to get answers from the system, problem needs to be defined in advance. The process makes the BI solutions rigid, but reliable regarding the data quality.

According to Reynolds (2009), analyst at IDC, the central IT department makes decisions regarding the BI solutions. This could be a potential problem that is reflected in discrepancy between business needs and technological solutions. An IT consultant from an international company has pointed out that BI solutions have been technology driven instead of business driven. Another source, an executive in a software company, has emphasized that there is a gap in understanding between business and technology professionals that creates misunderstandings and underuse of the BI solutions.

The BI solutions tend to demand highly advanced analytical users. These power users, who are capable of extracting and analyzing data from the systems, are middlemen between the technology and the end-users. It is often a process where end-users request reports, without having a direct access to the technology. Traditionally, it could take up to few months before end users would receive reports from IT departments.

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*Industry overview*

The worldwide BI industry has been steadily growing, and it is expected to be a \$7 billion market in 2011. (Sommer et al. 2007) A recent Gartner report points out that the BI platform market will grow in the next three years, despite the economic crisis. Companies will look for a way to increase efficiency and diminish waste through increased use of business intelligence and analytics. (Kelly 2009) The report also emphasizes that “BI comes under increased scrutiny, and its value as a decision-making tool in the toughest economic conditions is put to the test.” (Kelly 2009)

During the past five to six years the industry has consolidated with formation of full-service BI companies from the various part of functionality such as ETL. (Reynolds 2009) During past two to three years the picture has changed where big players such as SAP, IBM, Oracle, Microsoft and SAS have gained additional competence through acquisitions. SAP has bought Business Objects in 2007 for its business intelligence capabilities. Business Objects contribution with superior reporting and ad hoc query capabilities has led SAP to become one of the leaders in the market. (Kelly 2009) According to Gartner, IBM’s acquisition of Cognos has brought “Web services based SOA with shared metadata across the platform enabling ease of transfer from report to query to analysis.” (Kelly 2009) Oracle has acquired Hyperion, another competitor to Cognos, in order to improve its competence base in the market. (Austen 2007) Microsoft has acquired DataAllegro, for its large-volume data warehousing appliances as well as FAST Search that has developed the enterprise search solution. (Fontana 2008) Similarly to its competitors, SAS has acquired Teragram in order to increase its capabilities within text mining (Hostmann, et al. 2009), while most recently, IBM has acquired SPSS in order to improve its business analytics. (Dicolo 2009)

Due to consolidations, the market looks closed for newcomers and smaller vendors. But, McDonough (2009), industry analyst at IDC, points out that market is not only consolidated but also fragmented. The report by Gartner also stresses openings for niche players within the BI market that drives innovation, since these large companies focus on adapting and joining technologies of their acquisitions. Hostmann et al. (2009) at Gartner, mention in-memory BI, search, open source,

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Software as a service (SaaS) and service-oriented architecture (SOA) as technologies that could address new demands in the market.

According to Gartner report (2009) there is still a demand for independent BI platforms. Large BI vendors have been struggling with integrating products after acquisitions, which have led to stagnation in innovation. It opens an opportunity for independent players and their platforms. (Hostmann et al. 2009) Microsoft's BI portfolio, Web 2.0 techniques, software as a service (SaaS) and open source solutions are less expensive than integrated solutions by large vendors. Therefore, for certain business cases independent platforms could provide less expensive solutions than the large BI vendors. (Hostmann et al. 2009)

The report also mentions an opening for solutions that deal with "workgroup BI" and points out an opening in the market for disruptive technologies such as in-memory analytics. (Hostmann et al. 2009) While previously customers have been focusing on the vendor's size as the sign of capability to implement solutions, deciding factor in the future could be the return on investment from implemented solutions. The focus will be on business intelligence's capability to bring the value in decision-making process and justify the total cost of ownership. (Hostmann et al. 2009)

Gartner estimates the growth to be 7% for stand-alone BI platforms and 7.9% for stand-alone and embedded functionalities due to recession, consolidation and commoditization. Since companies will need strategic change and business transformation, it might push CIOs to make investments. The amount of information generated by an enterprise is growing, and management sees it increasingly as an asset for better decision-making. The Gartner report mentions a requirement by customers for making these technologies easier to build and use, where search, visualization, in-memory analytics, SaaS and SOA will play an important role. It is not only large companies that see potential from implementing BI solutions but also midsize and smaller companies. Besides companies, internal departments run their own projects that rely on technology such as in-memory BI, search and visualization. (Hostmann et al. 2009)

A leader in a large consultancy company observed that most of the BI market is commoditized with the exception of analytics. According to the same source, SAS Institute's CEO Jim Goodnight has made investments in analytics rather than in other areas that could be beneficial. More recent IBM acquisition of SPSS could confirm that business analytics is a hot area in the BI market.

### ***Players in the Market***

According to the leader in a large consulting company, IBM, Oracle, Microsoft and SAP are four main players in the BI market, while Gartner report also adds Information Builders, MicroStrategy and SAS Institute to their leader's quadrant. Gartner distinguishes the BI vendors according to their ability to execute and completeness of vision. This paper looks at four major players, IBM, Oracle, Microsoft and SAP due to their presence in the market and richness of their solutions. Another two vendors presented in the paper are SAS as a leader in analytics, and Teradata due to its advanced approach to data storage in data warehouses.

#### ***SAP***

According to the latest Gartner report, SAP is one of the leading companies within the BI market due to its acquisition of Business Objects. According to the company's web page SAP BusinessObjects business intelligence solutions enable advanced analytics, dashboards and visualization, information infrastructure, query, reporting, analysis, search and navigation. (SAP 2009) Prior to acquisition of Business Objects, SAP's main BI product was SAP NetWeaver BI that was integrated with Business Objects solution.

According to a consultant in a large business consulting company, due to the acquisition of Business Objects, SAP is changing their reporting portfolio. Business Objects are bringing advantages to the existing solutions such as use of semantic layer between the data model and reporting layer. It will enable the end user to have better understanding of data model that is based on their business needs. According to the same source, earlier SAP solutions included data warehouse and portal on the top, where portals included collaboration rooms with notes and comments.



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Gartner report points out that SAP Business Objects is considered to be one of the standards in organizations more than any other vendor. While its customers for its reporting and ad hoc capabilities have praised SAP Business Objects, NetWeaver BI's strength lies in its OLAP capabilities. SAP Business Objects provide onDemand BI, advanced capabilities in text analytics, search coupled with BI, *metadata*, data lineage and impact analysis, and data quality. (Hostmann et al. 2009)

### *IBM*

IBM is a market leader according to the newest Gartner report on business intelligence platforms. Its business intelligence application is IBM Cognos 8 that provides various business intelligence capabilities based on “a single service-oriented architecture (SOA).” Due to its architecture it is a modular deployment, which enables customers to implement what they need the most, and later expand their systems. (IBM 2009)

According to Gartner report, IBM Cognos 8 is better integrated than its competitors, and it is efficient in transfer “from report to query to analysis”. Similarly to SAP, many organizations consider IBM Cognos BI as a standard solution within companies. In the research done by Gartner, the IBM Cognos 8 got the highest score for its platform. Strengths were in infrastructure, metadata management, workflow and collaboration, reporting, ad hoc query, Microsoft Office Integration, advanced visualization and scorecarding. (Hostmann et al. 2009)

As already mentioned, IBM has acquired SPSS, in order to improve its business analytical capabilities. It is expected that IBM will become a challenger to SAS Institute, which has been a leader within business analytics. According to Ashford (2009) the acquisition will increase competition with SAP and Oracle that have built their predictive modeling strategies based on their partnership with SPSS. It seems that IBM is further cementing its position as a market leader.

### *Microsoft*

Unlike its competitors who have been focusing on adding analytics and other business intelligence functionalities, Microsoft has decided to focus its business

intelligence offerings on end-user experience, storage and platform. Although BI analysts hardly ever mention MS Excel as a BI tool, Cindi Howson (2008) points out that it is unofficially the leading BI tool in the market.

It seems that Microsoft is continuing with the strategy of delivering BI products to large masses through SharePoint application. According to Kurt DelBene, Microsoft Senior Vice President of the Office Business Platform Group, by merging the scorecard, the dashboard and analytical capabilities from Office PerformancePoint Server into Microsoft Office SharePoint Server, they will attempt to bring pervasive business intelligence at a low cost through every day tools. (Microsoft 2009) According to a manager from Microsoft, SharePoint will enable seamless integration in the organization. According to the same source, a usual problem with business intelligence is that it requires change of culture within organization, while SharePoint will adapt to the culture.

Although PerformancePoint is Microsoft's primary BI software product, there are further improvements with regard to bringing business intelligence to the masses. Microsoft has announced a new SQL server Kilimanjaro that will provide the basis for the first Microsoft data warehouse appliance. In order for a wider use of BI tools, Microsoft is introducing Gemini project that allows users to "build their own report by pulling large amounts of data from corporate databases – including those from competitors such as Oracle and Teradata" as well as the public Internet. Data is presented in an Excel Spreadsheet that is shared with other employees through the SharePoint. (Weier 2008)

According to the analysts, Microsoft has joined the market later compared to its competitors. Its approach is on the cheaper solutions that are attractive to new comers in the market, as well as to those who want to keep the cost down. Another benefit is the approach that relies on Excel, SQL Server and SharePoint Server that are constantly used by its customers. Another advantage is in its development tools that have been rated the best in the market by the customers. On the other hand, some deficiencies are that product vision is limited to reporting, Excel analyst-driven BI and some strategic BI, while it is lacking operational BI vision that Oracle and SAP emphasize. (Hostmann et al. 2009)

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*Oracle*

In recent years, Oracle has acquired numerous companies that have enabled its strong position. According to a manager from Oracle, the company has about 3000 products. One of the important acquisitions for its business intelligence competence has been Hyperion, former competitor of Cognos. (Austen 2007) According to another manager from Oracle, there is a division between already existing products in Oracle and Enterprise Performance Management (EPM), inheritance from Hyperion. EPM solutions deal mostly with financial data. Since Oracle has numerous products, there are other solutions such as SOA that has been used as part of BI solutions. Senior Principal Consultant at Oracle explains the use of SOA in implementing business processes. The important aspect is event handling that enables proactive approach in real-time. Business Activity Monitoring (BAM) enables analysis of those events with regard to Key Performance Indicators (KPI). While Oracle and some analysts consider event handling part of the business intelligence solution, traditional BI does not cover it.

Gartner's analysts' point that Oracle's vision of BI platform is as an enabler for enterprise performance management. There are also improvements in the integration of security and administration capabilities. On the other hand, due to numerous acquisitions, Oracle has been focused on integration of products, while not keeping pace with its competitors regarding search, visualization and in-memory processing. (Hostmann et al. 2009)

While Oracle has been increasingly acquiring companies, it will be interesting to see how integration of all these applications will occur. As mentioned by Hostmann, there is no focus on innovation.

*SAS Institute*

SAS Institute is a privately held company and one of the pioneers within analytics. Although it provides packaged software, some competitors regard it as a company that delivers only solutions, not technology. SAS has acquired Teragram in order to increase its capabilities within text mining. (Hostmann et al. 2009) According to an executive, the focus areas for SAS solutions are statistical analysis, predictive modeling, forecasting and optimization where business can get a look ahead, rather than in the mirror.

As mentioned earlier, SAS's CEO Jim Goodnight has invested in analytics, although some other areas could have been improved. According to Gartner report, SAS in contrast to its competitors focuses on forecasting, predictive modeling and optimization. It is a sole player in the market where there is extensively a need for predictive modeling or data mining. SAS has made investments in data discovery and visualization and in-memory analytics offering. Acquisition of Teragram will enable SAS to add enterprise and mobile search to its business intelligence. Some weaknesses that analysts consider are that SAS has been delivering solutions for power users. (Hostmann et al. 2009) Due to a new trend in the BI market, which focuses on user friendliness aspect, it could be a problem for SAS and their reputation about power users.

### *Teradata*

Although Teradata is not among the leaders according to Gartner report, according to its own web page, it has been present in the market for 25 years specializing in data warehouse implementations. Teradata offers solutions called Active Enterprise Intelligence that is based on Active Data Warehousing. According to a Business Consulting Manager, Active Enterprise Intelligence consists of Strategic intelligence and Operational Intelligence. New approach to business intelligence differs from traditional one since it moves to active data warehousing. Once a change in trend is spotted, information is sent to operational part that automatically makes decision. It decreases the latency from the time that information is received until action is taken. Therefore, new solution "pushes" insight to the front line and creates the appropriate automatic action.

### *Summary*

Traditionally, business intelligence consists of data sources, ETL process that enables cleaning and transformation of data, data warehouses and BI applications on top that enable data mining, analysis, visualization, reporting, querying and other functionalities. The BI vendors focus on different aspects of BI infrastructure in order to distinguish themselves in the market. The market has been consolidating, but there is still opening for new companies. Since large vendors are occupied with acquisitions and mutual adaptation of technology and culture, smaller vendors are leading in innovation and niche markets.

## **What is Enterprise Search?**

### ***Introduction***

Enterprise search allows users to search through documents, files, emails, and other data sources within an organization. It differs from the web search in that enterprise search includes also data from content management systems, collaboration platforms, and repositories as well as general files within an organization.

According to an executive from a search company, search has a long history that dates from UNIX systems where the command “grep” was used to search through documents. Although there was a division of data and information retrieval in the 1970’s, where data retrieval eventually grew into the BI industry, information retrieval took a longer time to develop. Verity, which was established in 1988, was the first commercially available enterprise search package. During that period, personal computers were not widely spread in organizations, so major users of Verity’s technology were IT staff or corporate librarians who would access information on behalf of the people in the company. The second significant player in the market was Autonomy, started in 1995, and for a long time, these two players were without challengers in the international market.

According to another source, during the 1980’s, Schibsted in Norway worked on “search in free text” (SIFT) in their research and development department. Implementation of this technology is still in use today.

Once personal computers (PCs) became cheaper and networks more widespread, the need for search became more acute. According to an executive in a search company, an advantage of search is that it does not require training to learn how to use the technology. Therefore, everyone can use it within an organization. It contrasts to business intelligence, where systems have been traditionally designed for those who have high analytical capability, and those who need information are not those who are accessing it. Enterprise search enables end-users direct access to information.

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*How is enterprise search used?*

There are uses of enterprise search that are obvious, such as retrieval of documents across an organization. Since large amounts of data and documents are constantly accumulated, it is a justified benefit. Companies often use search in their intranet applications that become an internal “knowledge management system.” It allows them to make documents such as “how-to” procedures, templates and general information more accessible for every user within the company. Whether intranet with a search engine can be called Knowledge Management is another discussion. IBM has created a Knowledge Management System based on search technology called Connections that enables creating collaboration groups based on their tagged information. According to a manager from IBM, the application enables finding immediately the right competence in the companies’ offices across the world. For large international companies, such as IBM, the ability to dig in into the company’s hidden resources is highly valuable. Consulting international companies have struggled to keep organizations informed due to large number of employees and increased amounts of information. Search technology in Connections has been useful to solve this problem and to connect people based on their company profiles.

Another major application of enterprise search is within eDiscovery. In litigation cases in the United States, companies need to present all electronically stored information within 99 days. In case they fail to do so, management might face criminal charges. Enterprise search enables management to find information quickly requested by authorities. (Harney 2009)

For research intensive industries, such as life sciences and pharmaceuticals, search technology enables searching and mining through large amounts of documents and research papers. Companies use enterprise search to dive “deep” into knowledge necessary for their future products and innovation in general. Search technology is used in other industries that rely on research. According to a chief scientist at a large Norwegian company, advanced search is necessary for innovation, since it enables finding relevant information for specific needs. It also enables “digging” into patent offices, technology and research publications that might provide answers to scientists’ questions.

Although enterprise search has existed for two decades, according to several interviewees, customers still struggle to understand its benefits. Either it has been used in a simple way, or not at all. One IT manager in a large Norwegian firm explained that top management did not want to invest money in enterprise search, but their attitude has been slowly changing in recent years. Another IT manager explained that there is a need to learn other tools before getting into enterprise search and gaining intelligence from it.

While there are companies that are hesitant to invest in search technology, others are using it without giving much thought to the technology. After talking to them, it was obvious that their entire work was supported by search. Receiving constant updates about changes in the market, patent office registrations, registration of new companies, competitors' web pages and new articles on specific area of interest are examples of search technology being used to provide information necessary for the work of entire departments, especially those focused on innovation and new product development. It seems that these routines are seamlessly incorporated in those organization. Perhaps, this tendency to use it without being explicitly aware of technology is a compliment to search, as it does not require special training or preparation.

Major benefits of search in general are its user-interface that enables non-skilled users to benefit from the technology. Almost everyone has some experience with search in the form of web search, provided by Google, Yahoo and other engines. It enables the use of natural language or at least something close to natural language (compared to for example SQL), which overcomes one of the major challenges related to technology. Therefore, everyone within an organization can use it, which creates egalitarian access to information that can lead to discomfort in relationships within an organization.

According to a regional leader for a search company, use of search and democratization of information makes mediocre management feel obsolete. According to the same source, it is also a fear that implementation of search could solve the problems that traditional business intelligence does, making large investments in those technologies unnecessary. It can make management not only obsolete, but also incompetent in their decision-making. Therefore, potential

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obstacle and slow awareness of benefits of search could potentially stem from fear of a change in power structure within organizations.

### ***Technical implementation***

There are over 30 vendors of enterprise search in the market. (Owens 2008) Most of these vendors have their own architecture and implementation of information retrieval. In addition they differ in the way they index, analyze, clean, slice and dice information.

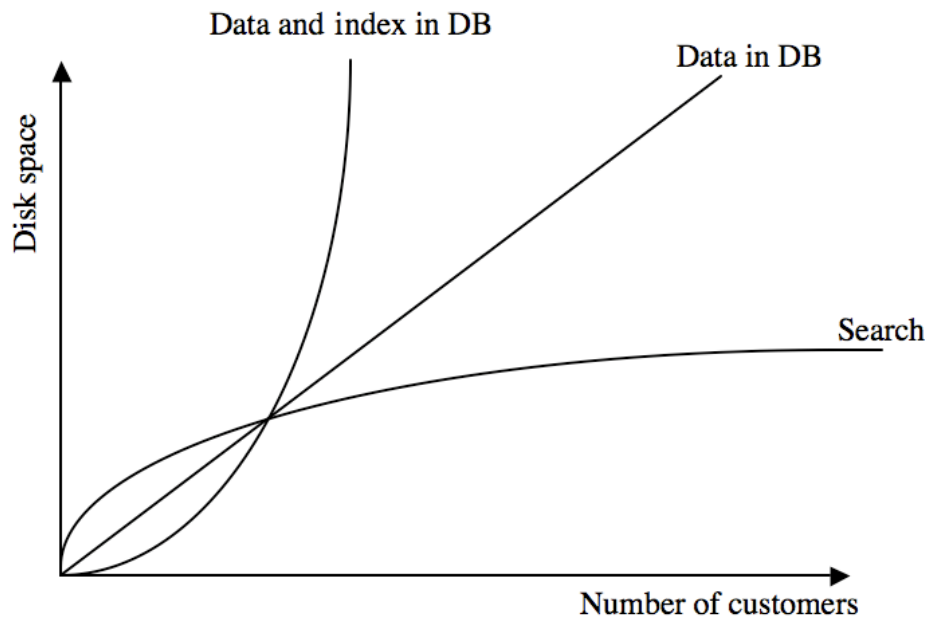
According to Moulton, an industry analyst, a general infrastructure of enterprise search consists of several parts. The first part, it is the actual content with metadata specifying a minimum of two to three properties: who created it, what application was used to create it, and where it is stored. The second part of the architecture consists of repositories, where the content is stored in repositories. These repositories may be in a form of file shares, relational databases, content management and collaboration platforms; or proprietary storage from specialized applications (for example e-mail). The third part, which is not always present is organization and categorization of the content provided by specialized applications. Then there is a search engine, which makes the content available to the end-user. The effectiveness of a search engine depends greatly on technology ranging from simple indexing to use of sophisticated connectors providing connection to all instances of the content. Finally, some implementations include business intelligence functions, such as reporting and analysis. (Moulton 2009)

According to an executive from a search company, Endeca's technology is a hybrid between traditional business intelligence and enterprise search. It takes in structured and unstructured data and converts it to Endeca's own structure, where every document has its own record with its own fields declaring their content. According to Reynolds, Endeca's search engine is therefore highly structured, which is closer to BI architecture. An index is used as a hypercube where metadata is stored in vectors to the documents. (Reynolds 2009) Another search company has developed an intelligent method where all content is represented in a mathematical way utilizing advanced vector technology to describe the content in each document. According to an executive in a smaller search company, some engines rely on linguistics while others prefer to be language independent.



Autonomy has a unique approach to search where it does not use key words, but uses pattern recognition algorithms based on work by Thomas Baynes. (Palmer 2007)

According to an executive from a search company, index structure in search engines is based on a tree structure where anything that is necessary can be indexed. While relational databases require pre-thought structure, indexing can be done ad hoc. Another difference between these two technologies is the growth of complexity when adding new information. Each new line within relational database requires not only storage space for the data, but also additional space for indexing this information. At the same time, search technology requires only space for indexing. Figure 3. shows the difference in data growth between these two technologies. (an executive from a search company)



**Figure 3. Growth of data in relational databases vs. search technology**

Therefore search technology implementations can differ, but they distinguish themselves from relational database in a way that information is being stored. The search technology does not require predefined rules, and it is useful for highly dynamic environments and large amounts of information.

## **Enterprise Search Industry**

Compared to the BI market, which is a mature market, enterprise search is maturing. It has been consolidating due to few significant acquisitions, such as Microsoft's acquisition of FAST and Autonomy's acquisition of Interwoven, which is a content management provider. Analysts expect further development in this direction. There are also initial signs of commoditization of the market as well with the introduction of free enterprise search applications.

As mentioned earlier, the industry has become increasingly important as a consequence of digital age that enables large amounts of documents, and files to be created and shared. Bloen (2007) emphasizes a change in the market during the past few years concerning the perception of enterprise search tools where a shift towards consumer search experience has been heightened. Vizard (2007) similarly points that customers have realized their need for enterprise search since companies have built hundreds of intranets and they struggle to access information with regard to processes. Therefore, the enterprise search technology is on the top of CIOs lists.

Forrester's analyst Leslie Owens (2008) looks at trends for enterprise search on two levels, macro and micro. The first one seems to be favorable where search becomes necessary in order to build relationship to the customers. Its importance is highlighted in eCommerce and online directory sites. Employees are increasingly using social media, wikis, blogs, forums emails, workspaces and others, so all digital information becomes difficult to manage and navigate. Since new regulations in the US demand that company needs to be able to produce "digital communications and records in timely manner", search becomes highly important technology within companies. Enterprise search does not provide only faster information, but it is also a way of managing increasingly growing unstructured data within an organization. (Owens 2008)

On a micro level, according to Owens, there is an uphill battle. While the enterprise search market has consolidated with text analytics, some major BI companies have acquired text analytics vendors. On the other hand, large vendors such as IBM and Microsoft have released IBM OmniFind Yahoo! Edition and

Microsoft's Search Server Express 2008 respectively. It is their attempt to fight competition with Enterprise Google that has been growing profits from enterprise search. All these changes might lead to decrease in prices for commodity search tools. (Owens 2008)

Gartner (2008) estimates that the enterprise search market will exceed \$1.2 billion in total software revenue by 2010. Enterprise search products are expanding to include information access capabilities such as taxonomy, classification and content analysis. (Gartner 2008) According to Tom Eid, research vice president at Gartner (2008) the search technology is maturing but at the same time it has a limited value. Its real value is in establishing effective taxonomies, indexing and classifying content in order to reach meaningful results. The same source points out that the enterprise search market is shifting from high-growth to consolidation phase. There is a similar trend as in the BI market of mergers and acquisitions with the example of Microsoft's already mentioned acquisition of Fast Search and Transfer. The activity of mergers and acquisitions (M&A) is expected to continue by large vendors such as Microsoft, SAP, IBM and Oracle, as well as some other enterprise search vendors. Gartner's analyst, Tom Eid believes that due to the variety of customer needs within search and access information, the market will continue to develop. (Gartner 2008)

According to Forrester Research the search market consists of four segments: information access platforms, embedded platform search, search solutions and commodity search point products. It looks closer at all segments through four criteria such as products, segment characteristics, competitive approach and additional considerations. (Owens 2008)

	<b>Products</b>	<b>Segment Characteristics</b>	<b>Competitive Approach</b>	<b>Additional Consideration</b>
<b>Information Access Platforms</b>	<ul style="list-style-type: none"> <li>• Autonomy IDOL</li> <li>• Endeca IAP</li> <li>• FAST ESP</li> <li>• IBM OmniFind Analytics Edition</li> <li>• Vivisimo Velocity Search Platform</li> </ul>	<ul style="list-style-type: none"> <li>• Search, navigate, and visualize both data and content</li> <li>• Transform data</li> <li>• Analyze text for entities and patterns</li> <li>• Connect to heterogeneous sources</li> <li>• Scale to massive volumes</li> <li>• Customize data ingestion and front-end search</li> </ul>	<ul style="list-style-type: none"> <li>• Sell to the strategic buyers (CIOs and architects) seeking a broad platform on which custom applications are built</li> <li>• Search value proposition: alleviate risk (a single missed fact may have enormous impact)</li> </ul>	A community of partners to build on and extend these search platforms is critical to their long-term viability.
<b>Embedded platform search</b>	<ul style="list-style-type: none"> <li>• Google Search Appliance</li> <li>• InQuira Intelligent Search</li> <li>• Microsoft Office SharePoint Server 2007</li> <li>• IBM OmniFind Enterprise Edition</li> <li>• Oracle Secure Enterprise Search</li> </ul>	<ul style="list-style-type: none"> <li>• Search as one part of broader information management stack, such as portal, content, and collaboration</li> <li>• Search deep into the context of business applications and data</li> <li>• Expose business functionality directly through the search interface</li> <li>• Federate and/or index external information sources</li> <li>• Integrate natively across platform components</li> </ul>	<ul style="list-style-type: none"> <li>• Sell to varied roles: business executives, IT directors concerned about out-of-the-box functionality</li> <li>• Search value proposition: deliver information in context</li> </ul>	Infrastructure vendors benefit from lower perceived integration costs when the search solution is part of a larger suite of tools from the same vendor. Google Search Appliance is pressuring platform providers with its emerging definition of a hybrid platform that encompasses the desktop and cloud-based services like Google Apps.
<b>Search solutions</b>	<ul style="list-style-type: none"> <li>• Coveo G2B</li> <li>• IBM OmniFind Discovery Edition</li> <li>• Microsoft Search Server</li> <li>• Recommind MindServer</li> </ul>	<ul style="list-style-type: none"> <li>• Address specific market needs, such as searching email archives and file systems</li> <li>• Build a complex solution in stages, create collections and design interfaces at the department level and expand as appropriate</li> <li>• Deliver search functionality on approved devices, such as mobile phones</li> <li>• Federate to other search sources with limited emphasis on direct connectivity</li> </ul>	<ul style="list-style-type: none"> <li>• Sell to business units</li> <li>• Search value proposition: boost knowledge worker productivity with a role-based approach to search</li> </ul>	A departmental approach to search has its pros and cons. It allows for quick and customized deployment but can be difficult to trace. Forrester routinely talks to customers who have more than five search engines in place as a consequence of an ad hoc solution approach.
<b>Commodity search point products</b>	<ul style="list-style-type: none"> <li>• Microsoft Search Server Express</li> <li>• IBM OmniFind Yahoo! Edition</li> <li>• Google Mini</li> </ul>	<ul style="list-style-type: none"> <li>• Get up and running in days</li> <li>• Search files and Web pages</li> <li>• Connect to a limited set of supported repositories</li> <li>• Scale to a vendor-imposed or server-hardware-imposed limit</li> <li>• Live with limited feature set and vendor support</li> </ul>	<ul style="list-style-type: none"> <li>• Available for free download</li> <li>• Search value proposition: simple and free enterprise search empower employees — try, then buy</li> </ul>	These tools are useful for addressing immediate pains, departmental needs, and for scoping an enterprise search project.

**Table 4. Forrester Search Market Segments (Owens 2008)**

While there is a discrepancy between analysts, vendors and customers and their terms used for enterprise search and information access platform, this paper chooses to focus on enterprise search that includes all of these mentioned categories. Forrester's report shows the broadness of the market. There are still many smaller innovative players within niche markets. Companies that are considered leaders by Gartner seem to cover structured, unstructured and semi-structured data. Search applications are moving from "plain" finding information to more analytical areas with capabilities to create reports. Companies at the high end of the market provide not only search, but also applications based on search technology. Feldman from IDC points that Autonomy "builds search based applications to answer market demands for better information-centric software." (Stamper 2008) Endeca and FAST have been offering BI solutions based on their technologies.

### ***Players in the market***

According to Gartner's Magic Quadrant, there are six companies in the leaders quadrants and those are Autonomy, Microsoft, Endeca, IBM, Vivismo and ZyLAB. On the other hand, Forrester research classifies Autonomy, Endeca, FAST and Vivismo as leaders in the market, while IBM and Oracle to have the capability, but they lack the focus on enterprise search. Google Search Appliance as the lone appliance is considered "a Leader with the bright future." (Owens 2008)

### ***Autonomy***

Autonomy's IDOL solution is the most complete product with the best core technology architecture, but it is also costly and complex solution. (Owens 2008) Its strength is in a content analysis, and as well as searching through non-textual multimedia such as video and deep user profiling. (Andrews and Knowx 2008) Autonomy has been also focusing on eDiscovery solutions that enable finding all information necessary for a litigation.

### ***Microsoft (FAST)***

Due to Microsoft's acquisition of FAST, it seems to be that analysts are not sure what this will mean for the technology. According to Gartner report, the acquisition has brought two vendors together to compete with Autonomy. Its strength lies in various connectors that enable getting information from a number

of sources. It is also about the ability to process non-textual data, such as video. The technology enables multiple profiles for individual users. According to Owens (2008) FAST will build a new product, next-generation platform NextG, which will emphasize on content analysis.

### *Endeca*

Although Endeca is an information access platform company, its approach to search is based on a new technology that can handle structured and unstructured type of information. According to Atkin (2009) Endeca has been the most innovative company in the recent period. While FAST was acquired, and Autonomy has been focusing on acquiring others, Endeca has been focusing on R&D and innovation. (Atkin 2009) It is a privately held company, with a smaller customer base than Autonomy and FAST. Their technology is built to be able to support searching through relational databases and data warehouses, as well as other types of information such as XML, RSS and documents. (Owens 2008) While FAST and Autonomy have been focusing on the ability to search through massive amounts of unstructured data, Endeca looks into the problems of searching through structured and unstructured data. (Owens 2008) It implies that Endeca's strategy from the beginning has been to handle both types of data, not only unstructured as it is usually the case with search technology. According to Gartner report, Endeca has also capabilities in action-oriented content analytics that analyzes user behavior and includes textual analytics. (Andrews and Knox 2008)

### *Google*

Although Google has been used as a synonym for "search", its products have not been highly visible in the enterprise search market. The Google's enterprise search engine is Google Search Appliance. Despite having simpler technology than market leaders, it has been used by most of Forbes 500 companies according to a Google executive. It is appreciated for its simplicity and low price, although it does not focus on analysis of user behavior and it lacks deeper customization. (Andrews and Knox 2008) Its main focus has been on the ability to find information and making it useful quickly.

*IBM*

IBM has a wide range of products, from a free search version called OmniFind Yahoo! Edition to more sophisticated products such as OmniFind Analytics Edition and OmniFind Discovery. Owens (2008) calls it “the sleeping giant of search”, but also points in her report that IBM does not have a focus within enterprise search. IBM’s strength lies in content analytics and non-textual multimedia. IBM has been also focusing on capabilities regarding social networks. (Owens 2008)

*Vivismo*

According to Owens (2008) it is one of the leaders within the enterprise search market, although it lacks deep semantic features. Its strengths are in federated search, social networking features, user interface flexibility and rich API. (Owens 2008)

*Summary*

Search technology has been traditionally enabling access to unstructured data. Since companies have been storing large amounts of data in a form of files, emails, blogs, documents, and other unstructured content, search has become increasingly important in organizations. Contrary to business intelligence, enterprise search allows a direct access to information by end users, without previous training. Another difference between these two technologies is their way of storing data. While search uses indexing without predefining questions, business intelligence requires pre-thought ideas of what users might need from the system. Due to its structure, enterprise search has been faster in accessing data than BI solutions. Enterprise search has been used in different settings: pharmaceutical industry, life science industries, competitive intelligence, market analysis, eDiscovery, etc.

## What is Text Analytics?

### *Introduction*

Text analytics is a set of methods that enable searching in natural language and analysis of text documents that can lead to discovery. It determines entities, facts, relationships and rules otherwise hidden in the text. It is used in business intelligence solutions and enterprise search, although being applied differently.

According to Seth Grimes (2009), the text analytics “describes software and transformational steps that discover business value in “unstructured” text. The aim is to improve automated text processing.” Techniques range from retrieving information to “text-fueled investigative analysis.” Therefore, it could be seen as a subset of business intelligence, and on the other hand, text analytics’ capabilities would be essential for creating Semantic Web. Text analytics software technologies such as text mining, related visualization and analytical tools “enable machine treatment of text that replicates, automates, and extends human capabilities.” (Grimes 2007)

Initially methods for text analytics included only statistical approaches, but the number of techniques has been extending. Grimes (2009) explains following methods as part of text analytics:

- Statistical approaches have been used to find the word frequency and determine the significance. Different approaches are used for search-engine optimization and for retrieval of documents.
- Vector space methods present documents for classification, retrieval and other tasks.
- Linguistic approaches have been introduced since statistical ones had hard time understanding human language. They are used to analyze parts of the speech or phrase by determining the subject-verb-object parts, as well as other elements
- Natural Language Processing consists of number of steps that include part-of-speech analysis, tokenization – identifies elements within the text, stemming – identifies variations of a word based on grammatical changes, lemmatization, entity recognition and tagging.



### *Text mining vs. text analytics*

According to an executive in a search company, there are two technological approaches to text analytics, where one is closer to structured way of thinking, while the other is about finding proximity in meaning between terms. In some instances, the first one is called text mining, while the other text analytics. Text analytics and text mining seem to be two approaches that some interviewees seem as distinguished technologies, while Grimes in his email to the author on July 30, 2009 claims that there is no significant difference.

Table 5. shows how Russom (2007) sees text analytics and text mining and their differences.

Text Mining and Text Analytics Compared and Contrasted		
	Text Mining	Text Analytics
<b>Approach</b>	Both employ natural language processing (NLP) algorithms to parse text and record entities found there.	
<b>When to use</b>	When you don't know what's in the text or what you need to extract from it.	When you know what's in the text and what you need to extract from it.
<b>Types of sources</b>	With either, text can be anywhere accessible, including various types of files, repositories, databases, or content management systems.	
<b>Quantity of sources</b>	Most configurations operate on large numbers of documents, possibly across many repositories, to understand what topics these documents mention.	Most configurations operate on one or a small number of unstructured data sources, the content of which you understand well.
<b>Output</b>	A taxonomy of entities (with links to their sources). The taxonomy is analytic in nature, since it has classified the content it parsed and even organized the taxonomy by how found entities relate.	A stream of records, each describing an entity instance. These records usually go into a database table or file, less often into a search index.
<b>Use of output</b>	The taxonomy may double as a navigation medium through which users access source documents.	The resulting database or index is itself not analytic per se, but it's used as a source for standard reports or statistical analysis.
<b>Applications</b>	Classifying content in large bodies of documents (possibly in content management systems or portals) in media (especially publishing), research (especially pharma), federal intelligence agencies, etc.	Risk analysis, fraud detection, call center analysis, product service reports, regulatory reporting, customer base segmentation, other customer analytics, etc.
<b>Synonyms</b>	Content classification, topic clustering, taxonomy generation	Entity extraction, concept extraction, concept search

**Table 5. Text analytics vs. text mining (Russom 2007)**

### *Text analytics in enterprise search vs. business intelligence*

Business intelligence solutions and enterprise search use text analytics in different ways. Also in his email to the author, Grimes states that “text analytics that backs up search is meant to support information retrieval: indexing, summarizing, and ranking documents in response to a search query.” He further explains that it enables indexing based on semantics, where topics are indexed based on relationships and themes. Text analytics enables natural language processing,

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which is important for search technology. On the other hand, text analytics in business intelligence is used for information extraction into structured databases and further analysis in a sense of data mining.

During past few years, enterprise search and BI vendors have been adding text analytics applications to their solutions, through collaboration or acquisitions.

***Where are text analytics applications used?***

The idea of text analytics used in business intelligence setting has been present since 1950s when Luhn described it in his paper while working at IBM. Despite his intentions for text analytics to become business intelligence in itself, it is a new IT discipline. (Grimes 2007) First users of text analytics were investigators who looked for terrorists by observing patterns and associations, while bioscientists used it in order to gain better understanding of proteins. (Grimes 2007) The application of text analytics has been used in diverse industries. Some examples are in vehicle safety, manufacturing/warranty analysis, reputation management, stopping money laundering, clinical applications, early insurance risk management, experimental hedge funds and employees' dissatisfaction. (Monash 2009) Therefore, the use of text analytics has been increasing significantly.

According to Harney (2009) sentiment analysis is another important field for text analytics. According to an interviewee, during US presidential elections, FAST's technology has been used for analysis of articles on each candidate. Scholars have been doing the same independently, and their results were close. Grimes mentions that technology provides the ability to go through different articles and get detailed reports on a specific topic by each politician. (Harney 2009) Sentiment analysis enables companies to receive an indirect feedback by its customers. The ability to gain an insight into how customers feel and what they think about a product, service or a brand name is highly valuable for any company. Social networking and forums are a rich source of information that can be analyzed.

According to Harney (2009) e-Discovery is another field where text analytics is used. It enables fast retrieval of information from archives. Previously, lawyers did the manual process of retrieving information that took a lot of time and

resources. Harney further mentions another application of text analytics, which is “*executive search*”. It enables looking through blogs, emails, forums and other sources to find information about potential executives. Sentiment analysis enables scoring of individual executives, helping to find the most suitable candidate.

### ***Text analytics market***

Text analytics market is in comparison with business intelligence and enterprise search market new and relatively immature. According to Reynolds (2009), it consists mainly from small companies, about forty, while IBM is large player in the market.

The biggest vendor is IBM who has tried to establish a standard within the industry called Unstructured Information Management Architecture (UIMA). Later, this platform has been released to the open source software, and currently it is in Apache Software Foundation. According to the IBM’s web page, “it is an open, industrial- strength, scalable and extensible platform for creating, integrating and deploying unstructured information management solutions from combination of semantic analysis and search components.” (IBM UIMA 2009) According to the same source, its goal is for academia and industry to develop technologies that are critical for discovering the vital knowledge present in growing information.

Russom (2007) names pure-play text-analytics vendors, Attensity and ClearForest as leaders in independent software vendors who focus exclusively on text analytics. Attensity Text Analytics extracts facts and then creates output in XML or a structured relational data format that can be fused with structured data for analysis. Attensity has partnerships with Business Objects, Cognos, and IBM, while Teradata resells Attensity in their application. (Russom 2007)

The ClearForest solution consists of tagging and extraction engine. It has rules-based semantic tagger that identifies and categorizes entities and keyword relationships and marks them for extraction. Partners are Business Objects, Cognos, Endeca, IBM, Information Builders and etc. (Russom 2007)

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Another player in the market that has specialized in publishing industry is Nstein. According to Grimes (2007) it is “backed by powerful linguistic technology that enables intelligence and lucrative content linking and purposing.” Publishers increase their digital revenues and decrease operational cost. Newssift.com is an example where Nstein’s technology has been used for text analytics

Lexalytics is a company specializing in text and sentiment analytics. Products that Lexalytics offers are entity extraction, entity relationship, document summarization, sentiment and tone extraction between others. (Lexalytics 2009) Their partners are Endeca and FAST, both enterprise search companies.

### ***Summary***

Text analytics is used in both technologies, enterprise search and business intelligence. It uses a set of techniques and methods that enable discovery from textual data. Business intelligence solutions are using text analytics for transforming data from unstructured to structured form in order to provide further analysis. Text analytics enable natural language querying in enterprise search solutions and retrieval of information. The use of text analytics is increasing in many different fields. Providers of text analytics software collaborate with both the enterprise search companies and business intelligence vendors.

## **What is the relationship between enterprise search and business intelligence?**

Although enterprise search and business intelligence are based on different algorithms, they both provide access to information that is highly valuable for companies. Traditionally, business intelligence has been focusing on numbers often extracted from transactional databases, providing analysis and reports. On the other side, search in general started as an application that helps find information based on a keyword search. With growing number of files, emails, blogs, forums and many other types of information, the need for managing unstructured content has become increasingly important.

How relationship between these two technologies develops will depend on customers, their needs and awareness, as well as vendors of these two technologies. Discussions in literature on these two technologies often point out the benefits and power of these two technologies combined. Thus, complementarity has been one of the important perspectives on the future of enterprise search and business intelligence. Another perspective is the convergence, where one technology starts performing similar functionalities as the other one. The third perspective on the future relationship, which is the potential of enterprise search to disrupt business intelligence vendors, has been less discussed as an option.

During interviews for this paper, professionals have discussed these three perspectives on the future of enterprise search and business intelligence. Their opinions and ideas have been widely influenced by their exposures and understanding of these technologies. It was also possible to observe that professionals have been influenced by companies' vision where they currently work.

### ***Complementarity of enterprise search and business intelligence***

It is undeniable that these two technologies have been complementary from their beginnings. Business intelligence has been dealing with the world of numbers and structured data, and enterprise search was handling unstructured content, mostly text. With the increasing amount of unstructured content, and traditionally

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important business intelligence solutions, companies need both of these technologies to enable them with full insight regarding their organization and its environment.

Campbell (2009) at Teradata Magazine points out how these two technologies are complementary, and together they enable an insightful discovery system. Combination of these tools offer analysis of topics of interest, measuring sentiment and tracking trends. Campbell uses a dramatic analogy to enterprise search and BI by comparing them to hydrogen and oxygen: the combination of these two creates H<sub>2</sub>O, another potent connection.

According to Whiting (2006), “the most likely scenario is that search and business intelligence will become increasingly complementary.” IT staff and business analysts would manage BI tools and create reports and data sets that end users will access through search. Therefore search would be used in order to make business intelligence “a little smarter.” Whiting also mentions that business intelligence vendors have tied their products to enterprise search, where Cognos, SAS and SPSS link their products to IBM’s OmniFind in order to examine unstructured information in documents.

During the research, various professionals have expressed different opinions on the topic. An executive in a smaller analytical company stresses that enterprise search and business intelligence have different technological approaches, and they address different needs. Another manager from a large consulting company stresses that these two technologies are complementary, and joined together in a common platform would make a powerful tool. While business intelligence has powerful analytical tools that are used on structured data, search can contribute with ad-hoc demands. A combination of these two capabilities can lead to understanding of both ambiguous and deterministic information.

According to a manager from a search company, enterprise search and business intelligence are counterparts, where search is not good at numbers, and business intelligence is not good with text. For example, while enterprise search is effective in analysis of newspaper articles about the US elections, business intelligence can provide analysis on numeric data such as exit poll statistics. The relationship

between these two technologies is analogous to a math and an English professor. Each one is an expert in its own field, but incompetent in the other. Another manager from a software company views these two technologies as complementary and individually valuable. Two analysts that have been interviewed, Brian McDonough, a BI industry analyst at IDC, and Lynda Moulton, another industry analyst from the Gilbane Group, see these two technologies as complementary.

Reynolds (2009) points out that there were expectations that BI vendors would acquire search technology, where they would build a Unified Access Layer (UAL). UAL is an IDC's term for a platform that would be on top of all different data types, structured, unstructured and rich data.

### *Are these technologies converging?*

Another perspective on the relationship of business intelligence and enterprise search is convergence, where these two technologies add each other's functionalities in order to provide an insight from both structured and unstructured content.

The benefits of search user interface are often considered important for business intelligence in order to make their solutions user friendly. One of the major challenges of complex business intelligence solutions is that they require power users who are competent enough to use these applications, but adding search would empower less competent users. Davor Sutija at FAST points out that the driving force for combining business intelligence and search is "pervasive business intelligence." He stresses that "the convergence of search and business intelligence is not only about searching for reports that BI platforms are able to produce", but "there is a more fundamental convergence going on in the ability to mine unstructured information by doing extraction and categorization." (Rapoza 2007)

Robb (2007) writes that knowledge workers increasingly need both structured and unstructured data since information lies everywhere. He suggest that convergence of search and business intelligence would be simple by providing access to both types of data on the generic web as well as Deep Web through a common

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interface. An example that he points out is looking for information regarding decreased sales for a product. First, the search would enable querying in customer relationship management (CRM) databases to find out who stopped ordering that product, but also checking emails whether those customers complained or not. That information could be stored in someone's notes, in CRM or some email.

According to Gonsalves (2008), who writes based on Forrester Research report, the boundary between business intelligence and search technology is becoming blurry. In corporations today, neither technology by itself can bring a full view of the organization. What he calls the "ongoing convergence" would, according to Forrester help bring artificial boundaries down between structured data and unstructured content. This new combination will not only affect user interface for discovery, analysis and reporting, but also it will help learn what we do not know. Forrester calls the combination between enterprise search and business intelligence – Unified Information Access.

Advantage of the convergence of these two technologies is discovery of things "you didn't know you didn't know". Gonsalves mentions Endeca, Polestar from Business Objects (now SAP), Information Builders' Magnify and FAST (a Microsoft subsidiary) as search solutions that provide categorization of data based on a query, and further provide information drilling through graphic user interfaces. The users' ability to access information, without having a fully formed question, which has been the oldest BI problem, is what Forrester calls magic. The information obtained from search is stored in a structured form in relational databases for further analysis. (Gonsalves 2008)

McKnight (2006) points out that BI vendors are incorporating some enterprise search principles, but it is not sure whether it is only influence or convergence. On the other hand, Beal (2007) writes that BI vendors are trying to fill "a need by acquiring and developing search technology." Business Objects (now SAP) acquired Inxight, a text analytics company, in order to provide a single point of access for text and data, where Inxight will provide a visual front end. (Beal 2007)



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*Where is convergence happening?*

In order to look at these two markets and determine where convergence is happening, it is important to have an understanding of what *technology convergence* means. According to wikipedia and recommended by Moulton, technological convergence is “the tendency for different technological systems to evolve towards performing similar tasks.” (Wikipedia 2009)

Interestingly, convergence has not been a popular vision of the future between enterprise search and business intelligence. Throughout the research for this paper, there were only two people who pointed specifically to convergence. Reynolds (2009) explains that there were expectations for the BI vendors to acquire search technology companies, but on the contrary, enterprise search has started adopting and adding functionalities of business intelligence solutions. An executive in a search company has been describing Endeca’s solution that includes structured and unstructured worlds in convergence.

*Convergence within the enterprise search market*

While enterprise search has traditionally and initially dealt exclusively with unstructured data, the need to provide full insight for companies has led vendors to include access to structured data as well. Companies need to access information not only from emails, blogs, and documents, but also databases. Search companies such as Autonomy, Endeca and FAST are some companies that have these capabilities to search in structured and unstructured worlds.

According to an executive at Endeca, they had a clear vision from the beginning that their solution would access structured and unstructured data. Technologically, Endeca’s solution is closer to databases; hence it is a hybrid between these two technologies. Endeca offers a BI application that is based on search technology, but also offers analytics and reporting.

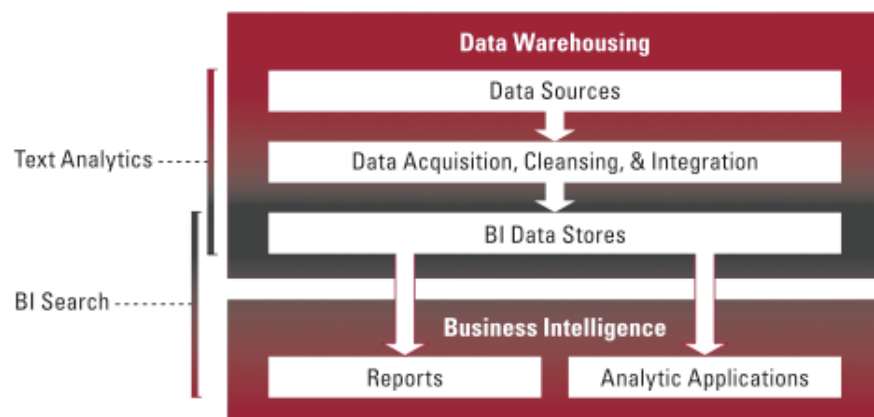
Besides Endeca, FAST’s search engine also has capabilities to access structured data and unstructured content. A few years ago, FAST bought Radar that has traditional BI tools and added them to their search foundation. This, according to an executive, enabled FAST’s application to create reports of the same quality as BI vendors. A new version of FAST’s Enterprise Search Platform (ESP) will

include the capability of using queries on structured data. One of the products is Content Integration Studio, which has similar capabilities as ETL process in BI solutions. It uses linguistics in order to integrate data. These are all applications similar or equal to BI functionalities, which makes FAST's engine able to deal with both worlds.

It appears that enterprise search companies are eager to integrate BI functionalities to add value to their technology. FAST and Endeca are examples of enterprise search vendors that have introduced solutions that are marketed as BI solutions. According to Reynolds, these two companies are pioneers in this field.

#### *Business intelligence adding enterprise search functionalities*

Phillip Russom, a researcher at The Data Warehousing Institute (TDWI) has created a report for technical executives presenting options available for integrating unstructured data into data warehouses, BI databases and tools. He distinguishes two technologies, text analytics and search, and discusses how companies can utilize them in order to deal with the ever-increasing amount of unstructured data. Russom stresses that text analytics and search will not replace any existing technologies within traditional business intelligence and data warehouse stack but rather add new technologies that can handle unstructured data, which implies that companies need to have already implemented BI solutions.



**Figure 4. Layers of the DW/BI technology stack affected by BI search and text analytics – Russom (2007)**

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The Figure 4 shows where Russom sees these two technologies within the BI infrastructure.

Russom defines BI search as the ability to search for the right report within a BI solution or across multiple BI platforms. Furthermore, he opens a possibility to search for documents outside BI solutions. Some search solutions provide users with ad hoc query capability due to indexing of metadata and metrics. All applications of search in a BI context, Russom calls BI search. Compared to his definition of enterprise search, BI search can fit into any scenario, but it has special requirements such as interfacing with BI platforms, indexing report metadata and text.

In his study, Russom has based his results on 370 Internet respondents who are business sponsors/users, corporate IT professionals and consultants. His research, among other findings, shows that respondents view search as beneficial for self-service for report consumers and information discovery. Other advantages of search are the ability to create ad hoc queries, and enabling easy adaptation for new business intelligence users. Their concerns are related to search's ability to report, its complexity and price. Russom concludes that adding search technology to the existing BI stack is important. He believes that most of BI will be operated through the search box, where search might deliver reports, fetch data and paste found items into new reports.

In addition to BI search Russom looks also at text analytics and its possible contribution to the BI stack. He defines text analytics as a software tool, which parses text and extracts facts (addresses, parts, complaints) about key entities (customers, products, accounts). Recognizing these facts and entities requires understanding natural language processing. Facts and entities extracted via text analytics may be stored in a file, database, or search tool's index. Therefore, text analytics imposes structure on information found in unstructured data sources and semi-structured ones. It enables transformation of unstructured data into some kind of structure. Russom attempts to predict that text analytics will become an increasingly important technology that will allow the unstructured world to enter BI and present the whole truth.

According to Evelson (2009) BI vendors are aware of their inability to deal with real-time updates of data. For example, requirements for capital calculation in financial services often require daily updates. Traditional data models and BI tools are unable to do that. SAP has been promoting its engine Explorer, previously known as Polestar. Its structure is similar to Endeca and FAST's engines, which enable users to find out answers to "previously unplanned questions". IBM uses Cognos GoSearch for the same purpose. All these products help the post-discovery process as Evelson calls it, that relational databases due to its rigidity cannot provide.

The major BI vendors realize potential of search and text analytics. They are increasingly including these technologies in their portfolio of products, but it is hard to determine how these two distinct algorithms would work together in a converged product. As Moulton (2009) points out it is a "commercial blending or integration of two types of product sets into packaged solutions that can be acquired together", which is not really a convergence.

#### ***Unified Access Platform vs. Unified Access Layer***

While Reynolds brings UAL as an IDC coined term to discussion, Gonsalves introduces UAP as a Forrester term. These two concepts have different approaches to bringing structured and unstructured data together. While Reynolds talks about a new platform that enables access to all types of data, Forrester (Gonsalves 2008) sees a possibility in converging of enterprise search and business intelligence that would enable benefits from both technologies.

In her email to the author on August 14, 2009, Moulton points out that

*UAP means whatever a vendor wants it to mean. In some cases it will be an integration of two products to form one, in another case it will mean the development of totally new functions in an existing product. Buyers will be left to figure out the true differences.*

#### ***Summary***

Ongoing discussion regarding search technology and business intelligence seems to have an agreement on complementarity of these two technologies, although path in how to achieve a unified insight could be different from vendor to vendor.

Since enterprise search and business intelligence have two distinct algorithms, there is a challenge in determining how these two technologies could converge. That being said, enterprise search vendors have acquired BI tools that they are able to add on top of search technology, providing basic business intelligence capabilities. As mentioned, two enterprise search vendors are offering products within the BI market. Therefore, convergence seems to have happened to some extent within the enterprise search market.

On the other hand, situation among BI vendors is more complex. There are indications that companies are aware of search and text analytics capabilities, since large vendors are acquiring companies with these technologies. The large vendors offer packages of technologies in order to satisfy their customers' needs for dealing with unstructured data, but it is hard to see it as a unified product. It remains to be seen how these large vendors will integrate all text analytics and search technology and whether that could lead to convergence.

## **Can search disrupt the business intelligence market?**

On the contrary to convergence and complementarity, the potential of search technology to disrupt BI vendors has not been widely discussed.

According to Christensen's disruptive innovation theory, there are two types of disruption, the one that attacks at the low end, and another one that creates new markets. Low-end disruption technologies have poorer quality than established technologies, but they are considered to be "good enough" for customers at the lower end of the market. Benefits of low-end disruptive technologies are price and simplicity. On the other hand, new-market disruption creates new market for those who did not have human or financial resources to participate in the original market, and they also address needs that have not been previously covered.

Therefore, could search technology attack the BI market at the lower-end, where enterprise search can be "good enough" to serve as a BI solution? Are there new customers, who have not been considering BI solutions before, but enterprise search provides them with more affordable and simpler solution instead?

So what is the situation today? While there are interviewees who do not see enterprise search potential to disrupt BI vendors, there are those who eagerly wait to see the disruption. Though they have different opinions how and where, as well as why it has not yet happened.

### ***Is search capable of disrupting the BI vendors or creating a new market?***

There are enterprise search solutions in the market that offer more than retrieval of information. They are used to provide business intelligence for users, often in dynamic environments. Search has been praised for its fast access to information as well.

An executive in a large software company claims that large amounts of data and need for classification are conditions for enterprise search applications to be used as a substitute for BI solutions. Since most of enterprise search solutions provide high level of text analytics, it enables dicing and slicing of information that leads to knowledge valuable for businesses. For example, such use of technology has been seen in a large institute in the US, where there was a need for an easy

retrieval of information regarding grants and scholarships with detailed information. There was also a need for serious stratification of information. Enterprise search provided solution that enabled users to find about different grants and all other specific requirements.

Another example, according to a search company executive, is an application of enterprise search that has been used instead of business intelligence for archiving information for long periods of time. In a large retail company, it was used to consolidate multiple databases in order to have a full overview of data. The solution enabled calculations needed for tax authorities. Although it was based on the search technology, data was structured, with future customer's plans for integrating unstructured data for broader view of the organization.

According to a manager in a search company, enterprise search has been used in banks to enable end users to look at their retirement plans. Due to dynamic changes in price, enterprise search provided a solution with alerts for customers and ad-hoc analysis. This solution is based on search technology, but yet accessing structured data. According to Reynolds (2009) Endeca has provided a solution for Putnam Investments that enables continuous updates where the application looks at the information and constantly pulls that from database to search index. The benefit of this solution is that sales managers are able to browse through information without help of the analyst.

Another interesting application that is based on Endeca's solution together with Nstein and Lexalytics is newssift.com – *Intelligent Business Search*, a page done for Financial Times. It provides options such as using “a single search term”, or selecting a topic in categories such as “Explore the Newssift of the Day”, “Insight from Newssift” and “Most popular Newssift Searches.” If the search bar is used, it is possible to enter a word, which provides a number of categories, sentiment analysis, and text analysis of information on a given topic, while providing access to articles on the topic.

According to an executive from Endeca, they have been providing business intelligence solutions to a wide range of industries, such as retail, manufacturing, intelligence and public services. An interesting application is within

manufacturing, where Endeca's application enables designers to get updated information on materials they are selecting. It enables access to data on quality directly from the field and reaction to certain conditions from the current use of a specific material. While previous selection of material was done based on established criteria, ability to include most current information enables higher security in choosing materials. The benefit of Endeca's solutions lies in its ability to access structured and unstructured data, enabling explorative insights.

IBM has published a page NFLMedia.com that provides all historic information as well as real-time statistics leading up to and during the Super Bowl. The portal has access to numerous National Football League (NFL) databases and other sources, structured and unstructured, that is retrieved by enterprise search capabilities. It is an opportunity for sport reporters as well as football enthusiasts to have access to data and other interesting facts. (Kelly 2008)

Currently there are enterprise search solutions that provide basis for decision making for companies within finances, pharmaceuticals, media, manufacturing and other industries. According to a manager from an analytical company, increasing focus on the environment and sustainability could be new industries where search technology might provide solutions instead of traditional BI. Carbon and ecological footprint for the environmental web are some possibilities for enterprise search to be disruptive.

Due to the exploratory capabilities of enterprise search, and search technology in general, it appears that there is an entirely new market for this technology. It is market research and competitive intelligence that use search technology for discovery. Invention Machine from Boston has developed a solution called Goldfire that is promoted as an innovation tool. According to the company's web page it is used to "accelerate their productivity, maximize their creativity, problem solving skills, and drive their company's innovation potential." (InventionMachine 2009) The basis of this application is search technology that indexes various sources of information such as data from patent office and various scientific publications. There is a built-in set of sources that come with the purchasing application, but there is also a possibility for companies to connect to their own internal sources. Analytical capabilities within the search enable users



to mine for answers related to their field, as well as being updated on new articles and developments in sciences and technology. The Goldfire application provides also market analysis. On top of search is a set of innovation processing tools that lead companies through their innovation processes. Companies within aerospace and defense, automotive, consumer, energy&environment, life sciences and technology are customers of this solution.

Within innovation departments of large companies, employees use search technology in order to explore markets, capabilities, forums, blogs and other types of content that help them get ideas for new products and services. These processes are not formalized, or a part of specific application, but they do occur in the market. One of the interviewed scientists at large Norwegian company has stressed that advanced search technology is highly useful in projects based on open innovation. The ability to find, sort and analyze large amounts of information saves time and creates opportunities for scientists in dynamic environments.

***Why enterprise search is not good enough to disrupt BI vendors?***

Besides positive developments within the enterprise search market, some professionals have expressed their concerns and disagreement with the idea of search disrupting the BI vendors. Several professionals have pointed out that BI offers quality data, which one can trust. Companies that need data warehouses and traditional systems for the auditing purposes do not feel comfortable relying on search technology. Another source, who is an executive at a search company states that enterprise search has not developed in a way to handle auditing that traditionally BI supports. Therefore, he does not think that enterprise search can eventually replace current BI solutions. The question of trusting data in enterprise search has been one of the most significant concerns and sources of skepticism for enterprise search to be used as BI.

Another concern has been related to the ability to provide different access levels within an organization. A consultant in an international company has pointed out that customers are often very concerned with protecting certain data from everyone in an organization. There is a lot of technology and time being used in order to prevent employees from accessing all documents. His concern was that

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enterprise search would not be able to provide this security. According to the executive in a large search company, this should not be considered a problem. There is a possibility in the enterprise search applications to have authorizations at different levels.

***Is enterprise search a sustaining innovation?***

The effects of potential convergence can lead to new conditions and circumstances for disruption. Since enterprise search vendors have tendency to convergence through adding BI functionalities, such as accessing structured data, reporting and analysis, possibility for enterprise search to disrupt BI vendors has increased. On the other hand, BI vendors have been buying search and text analytics companies, and there has been discussion on adding those capabilities to their existing solutions. This would mean that incumbent companies are using search technology in order to sustain their position, or what Christensen calls sustaining innovation.

According to Henry Morris, an analyst at IDC, incorporating search in BI is a “good defensive strategy” against being disrupted by search vendors, such as FAST and Endeca. (Beal 2007) SAP has been offering a guided search engine – Explorer that uses similar index to Endeca and FAST in order to enable BI users to discover answers to “previously unplanned questions.” Another example is IBM and its new acquisition of Exeros that enables IBM of post-discovery capabilities. (Evelson 2009)

While BI companies are adding search engines, these two technologies have two distinctive algorithms, so what customers get is a packaged set of products rather than a converged solution. Although, as Moulton points out, how successful these integrations are depends on how well these technologies will work together. It is certain that adding additional technology could increase cost and complexity to already expensive and complex existing solutions. Therefore, enterprise search appears to have a disruptive potential rather than sustaining to established vendors.

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*Is disruption possible?*

It seems that enterprise search fulfills disruptive requirements, which is also visible in the number of examples where enterprise search is used as a BI tool. Enterprise search does not require a central IT department to enable end users to get reports and extract data. It also enables new customers whose needs were not covered by existing BI vendors, due to price, complexity, but in some cases functionality as well. BI solutions have been traditionally enabling quantitative analysis, while search enables mostly qualitative and simple quantitative analysis. Therefore, it is weaker technology regarding data mining and heavy analytics, but it is still “good enough” as it was possible to see in examples. Search is a disruptive technology, which does not attempt to serve high-end customers in the BI market. Due to its limited data mining capabilities, it cannot satisfy highly demanding customers, but it is “good enough” for the low-end market. It also enables post-discovery and advanced text analytics that provide new insights into companies that lead to new customers and markets.

Another benefit of enterprise search over business intelligence is price, since traditional BI implementations have required large amounts of money initially, as well as having costly maintenance. Since the BI market has been consolidating and commoditizing, with focus on heavy analytics, the low-end market has appeared to be vulnerable to disruption. Solutions based on search technology have been simpler to implement, since there is no need for all types of cleaning and structuring data before use. Recently, enterprise search has integrated capabilities that enable access to structured data, analytics and reporting. Potentially, customers who could not afford BI solutions due to its price and complexity, have possibility to use enterprise search instead.

Therefore, enterprise search has potential to disrupt BI vendors, as low-end and new market disruption, as many interviewees have indicated. The burning question becomes, why it is not happening on a larger scale? There are companies that are using solutions based on search technology, but it is not so common.

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***What are the obstacles to disruption?***

There are possible challenges that need to be considered and overcome if enterprise search vendors hope to push disruption further. This paper addresses some potential problems that enterprise search faces.

*Is there a fear of change in power structure within an organization?*

The idea that everyone in an organization has an access to all documents, files, reports etc. might create discomfort for upper management. Certain information is highly guarded treasure, such as salary levels in the US. Access is a power that top management holds, and is not willing to let go. One could imagine all other types of information that management would not want their employees to see. Another example would be, files on decisions, where capable and competent employees might spot incompetence in top management. This change might lead to social changes within a company, loss of respect for managements' capabilities and loss of motivation. Transparency is especially dangerous for incompetent leaders.

An executive at a search company believes that management fears that enterprise search might overtake some problem solving from the BI solutions, which would emphasize that companies have spent large amounts of money for systems that could have been avoided. According to the same source, management has a fear of being obsolete. A consultant who expressed his concerns with the authorization and security in the enterprise search solution confirms the fear of enterprise search that might enable everyone to see everything. Companies have been investing money in security solutions, why would they let it go now?

Interestingly, enterprise search solutions have the capability of restricting access for given users. In reality, this should not present a problem for companies, although the idea of democratization of information seems to be uncomfortable enough for management.

*Is search so easy to use?*

One of the benefits of enterprise search is the ability to use keywords that are close to natural language in order to retrieve information. It enables easy access to information, especially compared to traditional BI applications that require specific competence. Thus everyone can access information, but taking it a step

further requires a capability for abstract thinking and understanding, which is not common among end users. Therefore, Moulton (2009) has expressed her opinion based on experience that although disruption might have been possible for decades now, an average user is not able to make a leap from accessing information to actually manipulating it successfully and efficiently. According to the same source, disruption may occur if enterprise search vendors make it easier for users to grasp content. Since enterprise search solutions have been adding reporting and analytics tools, it might help in overcoming some of these challenges.

### *Difference in culture*

Culture is a term, which has been often mentioned during interviews, especially by professionals who work with search technology. Although it has been mentioned, culture's meaning was not fully explored. It was often used to describe that BI solutions require power users and assumed that everyone can use search technology. It goes back to the power structure problem.

While BI implementations have been conceived from the central IT departments for the entire organization, Gartner mentions that search is used in department-based projects. It does not require a centralized approach. Previously, with the BI implementations, IT departments have been responsible for creating reports, while an enterprise search solution might leave this task to end-users. The change in technology might require new procedures within an organization.

### *Is using search as natural as one might believe?*

Search companies might take the idea of searching for granted. It is possible that there are differences between people and their backgrounds such as age and technology exposure to their way of using search. As expressed by a professional from a search company, there is a discrepancy between the generations and their level of comfort with using search. Although, this research has not surveyed end users and their way of thinking, the insight seems to be valid. For technology people searching ("Googling") might seem to be the most natural way of finding information and learning, while for those that are not so familiar with technology, the idea of entering keywords in a search engine does not come so naturally.

On the other hand, there are those professionals who are using search technology on an every day basis, but they are not “bragging” about it, since it is the most natural process for them. It happens to be seemingly integrated in their way of life. For example, using search technology for learning about customers and competitors. There are services that provide alerts once there is a change in a competitor’s webpage, or articles that might be important for a specific company. These services are based on search technology, but they are not presented in the same way as BI solutions are.

Therefore, search technology in general faces two extremes, from assuming that searching is the most natural thing to do, to actually being so easy that it is not given credit for the value it provides. Education of users might be an answer how enterprise search vendors could address part of the problem.

#### *Customers’ awareness of search technology*

While talking to IT managers in different industries, there was an impression that enterprise search is a simple solution that enables only finding documents. This unawareness might stem from their experience with traditional search technology, as an executive would call it. He points out that there is a “*critical distinction*” between search technology and human searching activity. While, the human activity of searching has been “*much richer than traditional search imagined*”, today’s technology is trying to move away from that tradition and broaden its palette of techniques that are used, such as finding, analyzing and understanding information.

Therefore, customers’ unawareness of search technology capabilities could be another challenge for enterprise search to disrupt BI vendors.

#### *Search in disguise*

In cases where search applications seem to be more noticeable, such as solutions that provide market research, or competitive intelligence, search technology is wrapped up and introduced to the market through its value, rather than technology.

Another example where search is in “disguise” is in applications that some companies deliver for media. According to a consultant in a search company, users often click on a link offered by an application that looks into the similarities to the current article, but only 2% search for an article in a search box offered on the pages.

Introducing search through value rather than technology might be a way of attracting users.

#### *High price and complexity of implementation*

Disruptive innovations are often worse in quality, but they offer benefits such as lower cost, simplicity and convenience. There are enterprise search solutions that have capabilities to be used as business intelligence solutions, but according to several interviewees, these solutions can be costly with complex implementations.

Once these solutions become significantly cheaper and simpler to implement, they might become increasingly present in the BI market.

#### *Summary*

Throughout the research, a number of professionals have argued that enterprise search has potential to disrupt the BI vendors. Search technology has been viewed as simple to implement due to its algorithm of indexing, which does not require cleaning and transforming of data; and predefining any future questions. Due to the simplicity of architecture and low maintenance cost, it is expected that search would be a cheaper solution as well.

There are examples where enterprise search has provided BI solutions based on structured and unstructured data, as well as reporting and analysis. Although data mining capabilities are limited, these solutions have seemed to be “good enough” in some cases. Since BI solutions have been traditionally very costly, cheaper versions of enterprise search open possibilities for previously non-existing customers to enter the market. In addition, certain functionalities such as ad hoc analysis and post-discovery enable analysis that traditional business intelligence has not been able to provide due to its reliance on relational databases.

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If BI vendors attempt to treat search technology as an add-on to their existing application, it will increase cost and complexity of already heavily complex solutions. Therefore, search technology has disruptive potential rather than sustaining for BI vendors. It remains to be seen how BI vendors will attempt to treat these two technologies, and whether they can provide an integrated solution that is a converged application.

Therefore, it seems that search technology has an open possibility to disrupt BI vendors, but it is not happening to a higher degree. There are some challenges that enterprise search companies could address if they want to shape their products as disruptive innovations, but not all of them. The problem of change in power structure due to democratization of information is a difficult one to solve. Companies that rely on open structure, and open innovation systems, seem to be more willing to use enterprise search as a BI tool.

Another challenge that is difficult to address is difference in culture in organizations due to the technology they use. Traditional BI has been centralized, with power users who are creating reports for end users. On the other hand, enterprise search has not been equally centralized, and end users access their information and reports directly. This new approach might be problematic for some organizations. Enterprise search applications could be more appreciated in knowledge industries, which do not rely on the same power structure, and where most of end users are more competent than in simpler industries.

Introducing search through value rather than technology can be another possibility for search companies that might enable better acceptance of search technology in the market. It could also be beneficial for enterprise search vendors to increase the market awareness about its capabilities. Finally, enterprise search solutions with BI functionalities are relatively expensive and require complex implementations. Possibly, enterprise search vendors would be able to deliver new solutions that include BI functionalities, but they are cheaper and simpler than solutions offered today. It would be a solution to another obstacle to disruption.



## Conclusion

Business intelligence and enterprise search are powerful technologies that enable organizations to access information, even knowledge in some instances. Traditionally business intelligence has been dealing with quantitative approach, analyzing data and creating reports based on structured data. On the other side, enterprise search, which is a younger technology, has focused on retrieval of information, but lately on analytics and reporting as well. What these two technologies have in common is their use of text analytics, although in different ways. Search uses it for ETL-like process, while BI for transforming unstructured to structured data.

There has been ongoing discussion between vendors, customers and analysts regarding enterprise search and business intelligence, especially focusing on their mutual relationship. Complementarity has been the most obvious aspect throughout the literature, but also in interviews due to its ability to enable full view of an organization and outside environment, based on structured and unstructured data. Since vendors have understood the potential of these two technologies, there have been certain attempts of convergence on both sides. Enterprise search vendors have been adding BI functionalities, in order to participate in the BI market. Therefore, they have been converging. On the other hand, it is hard to tell whether BI vendors are planning to integrate text analytics and search into one product, or whether they are going to sell it as a package of solutions. At this point, BI solutions are not converging, but it remains to be seen what happens in the future.

Finally, enterprise search seems to have a potential to be a disruptive technology within the BI market. Although search fits into Christensen's description of disruptive innovation, the question remains why it is not happening. There are potential problems that prevent search technology from fulfilling its capacity. Search vendors could benefit from looking into the effects of change in power structure due to democratization of information in companies. It is also the cultural question, where previously solutions were run from central IT points for power users, and search does not require centralization nor higher competence.

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On the other hand, it is important not to take users' capabilities for granted. It is not equally easy for everyone to understand the concept of search technology, as well as to apply abstract thinking in order to make conclusions from given information. High-end enterprise search solutions enable reporting and analysis, but these applications are expensive and complex, compared to simpler solutions. So, search technology has capability to disrupt BI vendors, but it either requires cheaper and simpler solutions that have reporting and analytical capabilities, or finding the right environment where users are capable of digesting accessed information. Therefore, search companies could benefit from educating the public on the advantages of enterprise search and its capabilities. Focusing on the value that search technology brings, rather than the technology itself, could be a way of addressing the problem.

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**Attachment – Preliminary Thesis**