

Hologic

Class Report

Introduction to Management of Technology

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Table of Contents

II. INTRODUCTION	3
(i) <i>Hologic</i>	3
(ii) <i>Digital Mammography Market</i>	3
(iii) <i>Market strategy for Hologic digital mammography products</i>	4
(iv) <i>Future Growing</i>	5
(v) <i>Tomosynthesis</i>	6
(vi) <i>Sales Analysis</i>	6
III. Class Concept: Product Management	7
(i) <i>Defining Product Management</i>	8
(ii) <i>Product Management in Hologic</i>	8
IV. Profiting from Innovation	14
(i) <i>Appropriability Regime</i>	14
(ii) <i>Complementary Assets</i>	15
(iii) <i>Outsourcing</i>	16
V. Hologic's ultrasound products as a disruptive technology	17
(i) <i>What is a Disruptive Technology?</i>	17
(ii) <i>Hologic's ultrasound breast imaging devices</i>	18
(iii) <i>Are Hologic's ultrasound products a disruptive technology?</i>	18
(iv) <i>How does Hologic's ultrasound product compare to Ecton's?</i>	20
(v) <i>Conclusion</i>	20
VI. Team Structure	21
(i) <i>Defining team structures</i>	21
(ii) <i>Organization in Hologic</i>	22
(iii) <i>Classifying Hologic's Team Structure</i>	23
VII. Conclusion	24

II. INTRODUCTION

(i) Hologic

Hologic manufactures medical equipment focusing on women's health. Its core business units are focused on mammography and bone densitometry. However, Hologic also develops, manufactures, and supplies other x-ray based products such as direct-to-digital radiography detectors, breast biopsy systems, and mini C-arm x-ray imaging products.¹

Hologic is a relatively small company compared with large competitors like General Electric (GE) and Siemens. Medical equipment represents a small fraction of the revenue for these competitors, and mammography an even smaller fraction. For Hologic, medical equipment specializing in women's health represents 90% of revenue, half of which is mammography. By remaining focused in a market with large competitors, Hologic has become a leader in this specialized market.

(ii) Digital Mammography Market

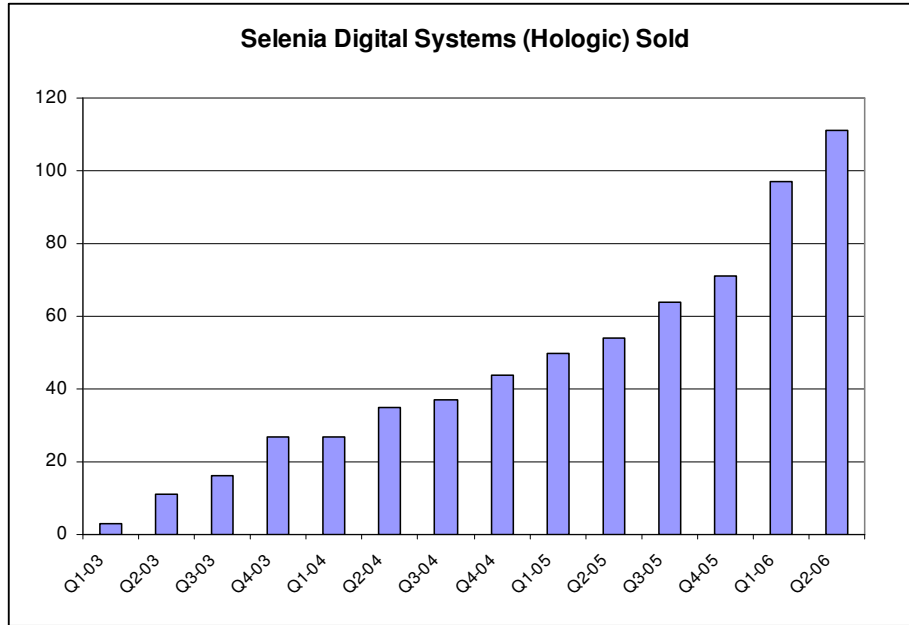
One of the recent innovations in the mammography market is the digital detector, which allows customers to obtain digital mammograms without first exposing and then later scanning film. This technology, recently approved by the FDA, is part of a growing market that experts expect to continue over the next few years.² In this market, GE and Hologic have established a base of customers that they are moving aggressively to retain. Siemens, the last to enter the market, has been slow to respond.

GE started first in this market and initially positioned itself as a leader. Being one of the largest companies on the planet, GE has the resources to advance the technology and control the market. However, as a large slow company, GE has been unable to follow Hologic's fast pace and focus. Meanwhile, Siemens has entered the market but continues to lag. According to a Hologic's executive³, Siemens' has a culture of careful behavior, which may limit their ability to compete with a fast and aggressive player.

¹ Hologic, *Annual Report* (2005): 4

² Hologic – Initiating Coverage. US Equity Research. JP Morgan, December 22, 2004.

³ Interview with Nikolaos Gkanatsios, Ph.D, Director, Product Management, Breast Imaging Technologies (April 13th 2006)



4

(iii)Market strategy for Hologic digital mammography products

Relying on a superior image quality, Hologic first approached leading health institutions to introduce its products and build its brand. At the same time, Hologic changed from a dealer sales model to an aggressive internal sales force that effectively took market share from competitors. By constantly listening to customer’s requests and implementing those requests in the subsequent releases, Hologic created both a better product and a loyal customer base. GE has been ineffective in competing against this strategy. Hologic’s comprehensive product line of imaging systems contributes to its distribution strategy and sales effort.

Hologic’s product managers and sales force are in constant contact with their customers, looking forward to find what they need and what they think about their current products.⁵ Regular interaction between the product manager and the sales force assures a proper flow of information from the company to the market and from the market to the company. To add to the information that Hologic gains from its sales channels, many of Hologic’s executives (including the product manager for Breast Imaging Technologies and the VP of Product Management) have a clinical background and understand the needs of their customers. This deep understanding of the market gives Hologic a competitive advantage. In addition, direct and daily contact between

⁴ Source: Hologic.com (presentation for investor meeting).

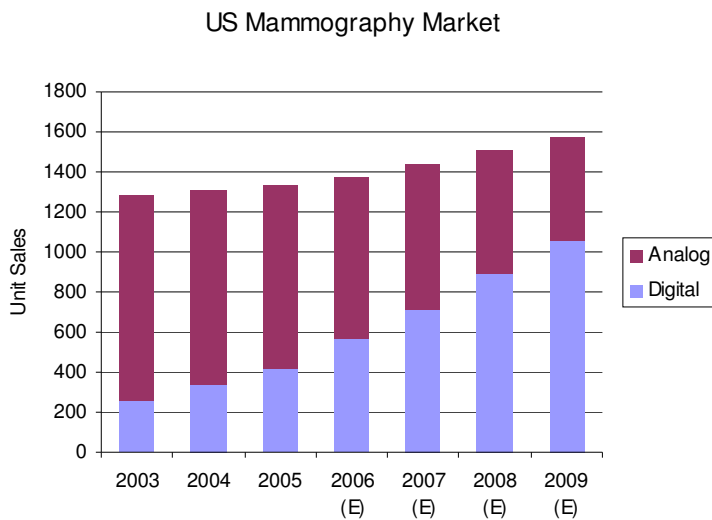
⁵ Ibid.

the R&D and Engineering departments augment this dynamic and effective information flow.

Every three to four months, Hologic’s product managers meet with small groups of lead users from different institutions. Hologic tries to bring a heterogeneous mix of users which represent many different markets, such as big hospitals, small facilities, and private practice offices. Hologic holds a 2-day retreat at which project managers and lead users discuss current products, upcoming technologies, and the future of the market.⁶

(iv)Future Growing

The estimate that one out of eight women in industrialized countries will be affected by breast cancer is a major driving force in the growth of the mammography market, which is expected to double over the next decade. Educational awareness initiatives in the US and other countries are increasing compliance with national screening programs, which have recently begun encouraging yearly exams from age 40 rather than age 50.⁷



Positive results from the American College of Radiology Imaging Network (ACRIN) trial⁸, a 2001 comparative study of digital vs. analog platforms comprising 49,528 women, confirm that digital mammography was significantly better in screening women under age 50, of any age with heterogeneously (very dense) breasts and pre- or perimenopausal women of any age. These results will certainly

contribute to the market growth of digital mammography and a consequent reduction of the analog market (but not in the same proportion, as the total market is growing).

⁶ Interview with Nikolaos Gkanatsios, Ph.D, *Director, Product Management, Breast Imaging Technologies (April 13th 2006)*

⁷ <http://www.smartlight.com/dfvcenter/market.htm>

⁸ http://www.acrin.org/dmista_qa.html & http://www.acrin.org/dmista_fastfacts.html

Hologic continues to rapidly gain market share in the US, with current share estimated at 40% (similar to GE) and Siemens, and others falling behind. Taking into account the early stage of penetration of digital mammography systems, Hologic is in a key position to continue growing in this sector (market expansion).

Currently, 60% to 70% of mammography placements are with established customers and 30% to 40% derives from new accounts⁹. This result confirms that Hologic continues to gain market share.

(v) Tomosynthesis

Digital Tomosynthesis is a three dimensional picture of the breast using x-rays and is seen as the next breakthrough technology in mammography. This is a high priority project at the company, with ongoing data collection underway. The platform has been shown to reduce recall rates by 42%, suggesting that it could ultimately be used as a primary, rather than secondary, screening system. The sales of this higher margin product could yield significant increase to revenues.

(vi) Sales Analysis

Year	Sales '000	Profits '000	US – INT'L Sales	Main Events
1997	\$106,700	\$17,700		
1998	\$115,600	\$10,400		
1999	\$84,100	\$-3,700		
2000	\$93,700	\$-18,600		
2001	\$178,500	\$-20,900		Closes a manufacturing plant in Littleton and phases out its film-based X-ray systems. Focus on profitable products.
2002	n/a	n/a	80% – 20%	
2003	204,035	\$2,882	68% - 32%	
2004	\$228,700	\$12,164		
2005	\$287,700	\$28,300	63% – 37% (1Q) only for Selenia	
2006 (E)	\$366,000	n/a	71% – 29% (1Q) only for Selenia	

⁹ Data from JP Morgan Market Equity Research

2006 - 2005 - First Quarter comparison¹⁰

During 2005, Selenia led mammography sales, with a strong international demand for analog systems and the MultiCare biopsy tables. Digital instruments grew by 40% and analog by 27%. Osteoporosis Assessment grew by 15% (y/y) representing 27% of total revenues (\$18.9mm), led by sales of bone densitometry systems and increased service revenue (because of a larger installed base).

During 2006, Selenia also led mammography sales, growing 80% from 1Q2005. There is a trend towards increasing computer aided-diagnosis: 64% of the systems sold included computer aided-diagnosis (CAD). Despite the growth in digital systems sales, the analog market remained well. Analog sales contributed \$8.5 million to the mammography group sales. The analog market is not disappearing, but is shifting to lower priced systems. Hologic will continue to target these customers with efforts on converting the systems to digital. Osteoporosis Assessment represents 23% of total sales, despite its reduced contribution to Hologic's revenues, it grew 17% from 1Q2005.

F1Q06: Revenues					
(US\$M)	JPM Est.	Change (Y/Y)	Actual Results	Change (Y/Y)	Notes
Mammography	\$54.20	28.80%	\$62.80	49.20%	97 Selenia systems sold in 1Q
Osteoporosis Assessment	\$20.10	16.90%	\$20.00	16.60%	Increase in Bone Densitometry
Other	\$6.20	-12.90%	\$5.20	-25.50%	Phasing out of DR systems
Total Revenues	\$80.50	21.30%	\$88.00	32.90%	

11

III. Class Concept: Product Management

The product offerings and evolution of Hologic products systematically fits into a model of a platform product with derivatives and enhancements. The concepts of a sustaining technology presented by Bower and Christensen in *Disruptive Technologies: Catching the Wave*¹² and the idea of derivatives as explained in *We've got Rhythm! Medtronic Corporation's Cardiac Pacemaker Business*¹³ are seen in Hologic's product portfolio.

¹⁰ Data from JP Morgan Market Equity Research

¹¹ Source: Company reports, First Call and JPMorgan estimates

¹² Bower, J. and Christensen, C. "Disruptive Technologies: Catching the Wave". Harvard Business Review 1995

¹³ "We've Got Rhythm! Medtronic Corp.'s Cardiac Pacemaker Business." Harvard Business School Case 698-004.

(i) Defining Product Management

In order to ensure an optimized product portfolio, a portfolio should contain products in each of the following areas: platform products, derivatives of the platform products, enhancements to the platform products, and finally breakthrough products. A **platform product** provides a set of core characteristics that match the primary market needs. It is suitable for the entire product generation, and it can lead to next generation products by being an expandable or enhanceable technical base. A platform product establishes a core architecture for a set of projects.¹⁴ A **derivative product** is an enhancement or expansion of a platform product which is developed without significant redesign. A derivative product may also be a more basic version of a current product without additional features.¹⁵ A **sustaining product** utilizes technologies that maintain a rate of improvement for an existing product. Sustaining products are characterized by enhancements or add-ons to a current product. A **breakthrough product** is a new core product to the product portfolio which also requires a new development process.

(ii) Product Management in Hologic

Hologic manages their business in four principal operating segments: mammography products, osteoporosis assessment products, direct-to-digital DirectRay detectors, all other which includes the mini C-arm imaging products. Since, Hologic's biggest product offerings stem from their mammography and osteoporosis assessment products, we focus on these two segments.

Hologic's mammography products include digital mammography systems, screen-film (analog) mammography systems, stereotactic breast biopsy systems, an Ultrasound breast imaging system, and a breast imaging soft copy workstations approved for interpretation of digital mammograms.

¹⁴ Bower, J. and Christensen, C. "Disruptive Technologies: Catching the Wave". Harvard Business Review 1995

¹⁵ "We've Got Rhythm! Medtronic Corp.'s Cardiac Pacemaker Business." Harvard Business School Case 698-004.

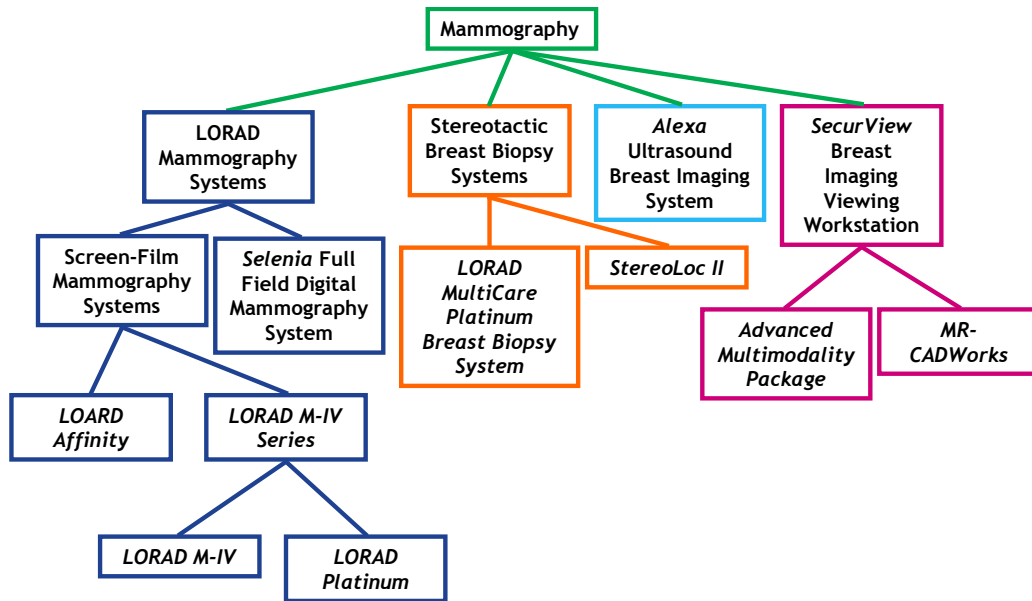


Figure 1: Organization of Hologic's Mammography products

Hologic's osteoporosis assessment products consist of x-ray bone densitometers, consisting of four different families of products, and a low cost ultrasound device.

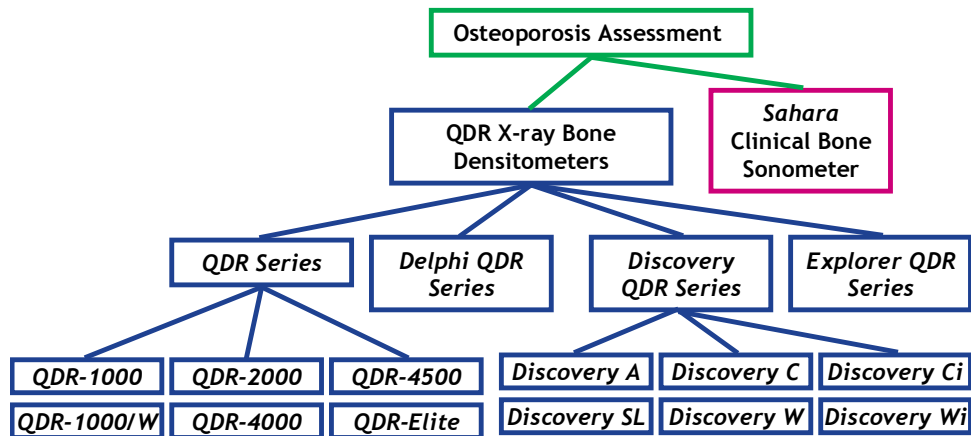


Figure 2: Organization of Hologic's Osteoporosis Assessment products

Hologic first introduced a product offering for osteoporosis assessment in 1986 with a breakthrough product, the *QDR-1000* bone densitometer. The patented dual energy x-ray (DXA) technology developed by Hologic¹⁶ proved to be a superior bone mineral density (BMD) measurement product by offering, cost-effective accuracy and reliability. This breakthrough product established the *QDR-Series* product line which allowed Hologic to release a new DXA product for BMD measurements every two to three years between 1989 and 1997. A new product was released in 1989, 1991, 1994, and 1997, each

¹⁶ Hologic, *Annual Report* (2005): 9

providing a product enhancement or incremental change over the previous model (ie. Whole Body analysis and the OnePass fan-beam technology). The release of incremental products suggests that the *QDR-Series* product line is a sustaining technology and is consistent with Bower and Christensen's assessment that "sustaining technologies tend to maintain a rate of improvement; that is they give customers something more or better in the attributes they already value". The timeframe of product releases also relates to their stance that timely launches are critical sustaining technologies.¹⁷

The *QDR-Series* established a platform for which more DXA products could be developed. This product strategy is consistent with the platform strategy adopted by Medtronic in 1987, in which Medtronic tried to leverage products as "derivative products that could extend their life and market reach" by designing the "initial platform product to accommodate the full range of derivative models from it without significant redesign."¹⁸ Derivatives, or spin-offs, for the *QDR-Series* allowed Hologic to release a new product every two years between 1999 and 2004. These include the *Delphi QDR-Series* released in 1999, the *Discovery QDR-Series* released in 2002, and the *Explorer QDR-Series* released in 2004.¹⁹ The *Delphi QDR-Series* was "the first bone densitometer to offer physicians the ability to simultaneously assess two of the strongest risk factors of osteoporotic fracture" by implementing its Instant Vertebral Assessment (IVA) technology.²⁰ The *Discovery QDR-Series* allows for a BMD and IVA scan in just ten minutes and the *Explorer QDR-Series* targets cost conscious practitioners. Although the *Delphi QDR-Series* and *Discovery QDR-Series* were product enhancements, the *Explorer QDR-Series* followed Medtronic's approach when it "created the highest-performance, most fully featured version of the product at the outset and then created derivatives by de-features and de-rating certain elements of that design, so that it could address other tiers of the market as well."²¹

In addition to Hologic's dual energy x-ray osteoporosis assessment products, Hologic also developed and released in 1996 a lightweight, portable ultrasound bone analyzer, called the *Sahara Clinical Bone Sonometer*. This product utilizes ultrasound to assess the bone density of the heel. This product is a breakthrough product because it is based on

¹⁷ Bower, J. and Christensen, C. "Disruptive Technologies: Catching the Wave". Harvard Business Review 1995

¹⁸ "We've Got Rhythm! Medtronic Corp.'s Cardiac Pacemaker Business." Harvard Business School Case 698-004.

¹⁹ Medical Imaging Magazine "Business Profile: **Hologic Inc.**" February 2001

²⁰ Hologic, *Annual Report* (2005): 9

²¹ "We've Got Rhythm! Medtronic Corp.'s Cardiac Pacemaker Business." Harvard Business School Case 698-004.

a new technology and represents a new core product. The process of developing and manufacturing the sonometers is entirely different from dual energy x-ray.

Hologic's Osteoporosis Assessment Product Management

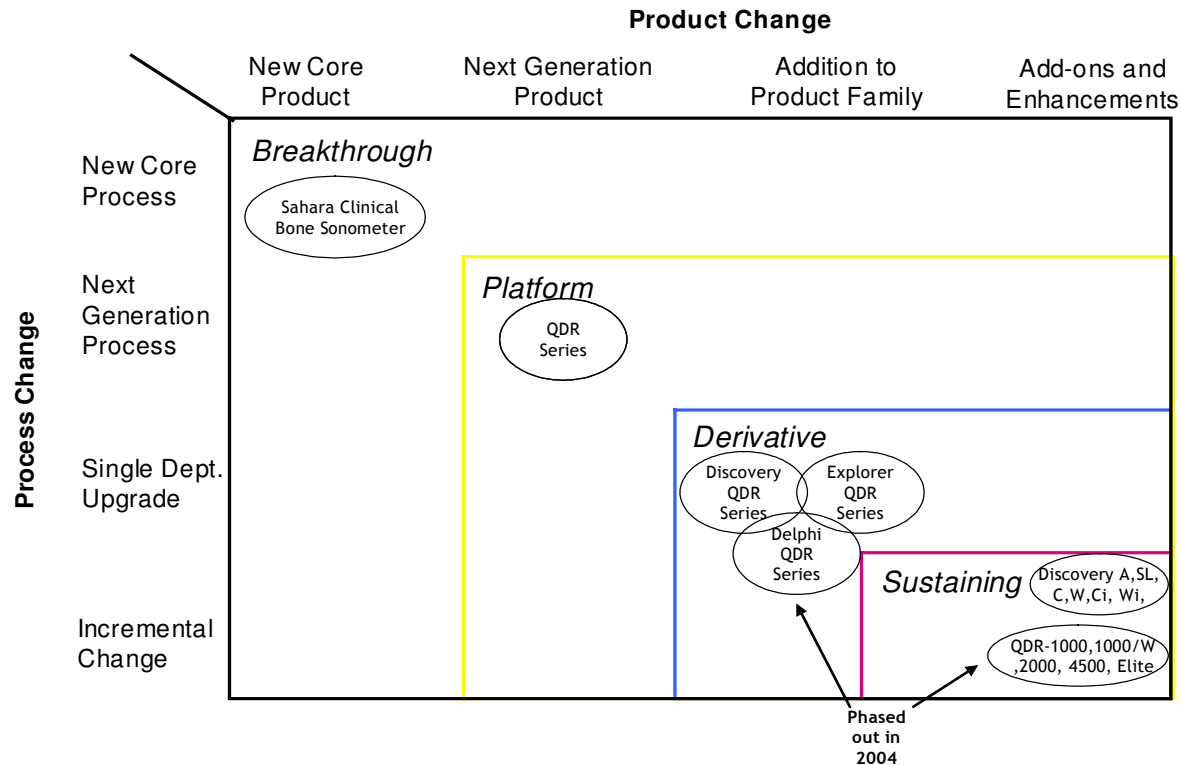


Figure 3: Product organization of Hologic's Osteoporosis Assessment products. Below is an explanation for the product categorization.

Breakthrough: *Sahara Clinical Bone Sonometer* – New core ultrasound based product which required new development processes than current x-ray based technology

Platform: *QDR-Series* – accommodated a full range of derivative models without significant redesign

Derivative: *Discovery QDR Series* – Enhancement to *QDR-series*; Speed of assessment increased

Delphi QDR Series – Enhancement to *QDR-series*; Added IVA to product family

Explorer QDR Series – More basic model of *QDR-Series* focused on lower tier market

Sustaining: *Discover A,SL,C,W,Ci,Wi* and *QDR-1000,1000/W,2000,4500,Elite* – incremental enhancements/add-ons to current products

Hologic's mammography product portfolio is structured very similarly to its osteoporosis assessment product portfolio. Hologic again set a platform product, the *LORAD Screen Film System*, which it released in 2000 following the acquisition of Trex Medical Corporation. The derivatives of this product were the Lorad M-IV and the LORAD Affinity. The LORAD Affinity, released in 2002, applied the strategy of a being derivative product by de-featuring elements of the platform product, so that it addresses lower tiers of the market. It is a disfeatured version of the *LORAD Screen Film System*. The *LORAD M-IV* is an enhancement of the base technology employed by the *LORAD Screen Film System* due to its increased speed of acquisition. The *LORAD M-IV Platform* is a sustaining product because it adds an incremental enhancement of the High Transmission Cellular (HTC) Grid for improved image quality, and the Fully Automatic Self-adjusting Tilt (FAST Paddle) for ease of use. There are two breakthrough products in Hologic's mammography product portfolio, the *Selenia Full Field Digital System* and the *Alexa Ultrasound Breast Imaging System*. Both systems required the integration of a new technology to Hologic's product portfolio: a digital detector and ultrasound technology. The *Selenia Full Field Digital System* is of particular importance to the product portfolio. Hologic believes that the product's incorporation of an amorphous selenium Direct Ray digital detector, a proprietary technology, and a 24x29cm detector size, the largest in the industry, positions them to be the market leader.²²

²² Hologic, *Annual Report* (2005): 5

Hologic's Mammography Product Management

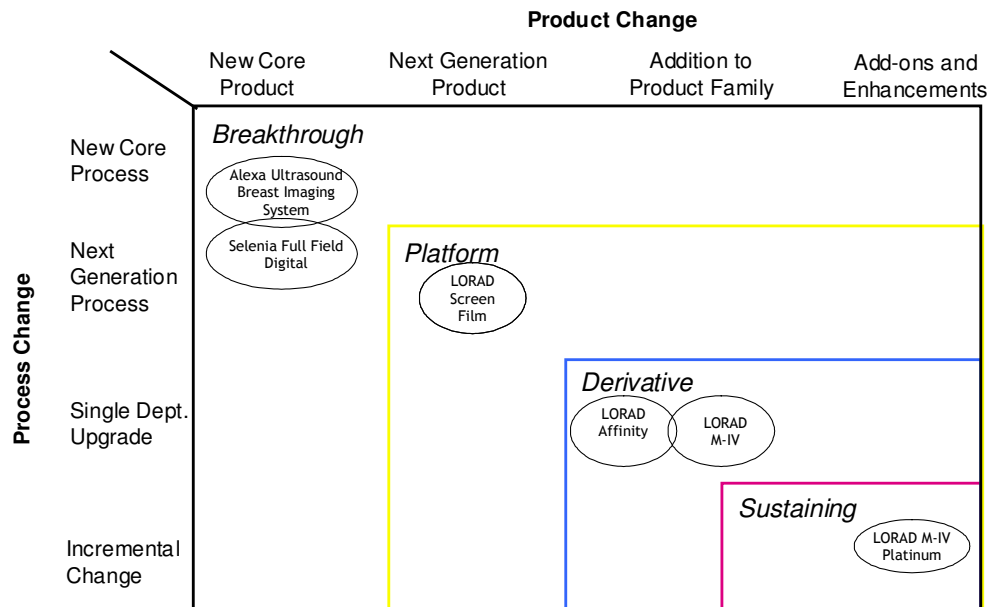


Figure 4: Product organization of Hologic's Mammography products. Below is an explanation for the product categorization.

Breakthrough: *Selenia Full Field Digital System*– New core digital-detector based product which required a next generation x-ray detection process

Alexa Ultrasound Breast Imaging System - New core ultrasound based product which required new development processes than current x-ray based technology

Platform: *LORAD Screen-Film* – accommodated a range of derivative models without significant redesign

Derivative: *LORAD M-IV* – Enhancement to *LORAD*;
LORAD Affinity – More basic model of *LORAD* focused on lower tier market

Sustaining: *LORAD M-IV Platinum* – incremental enhancement (HTC Grid and Fast Padde) to current *LORAD M-IV* product

Hologic superior product management is one of it's strengths. By establishing a platform product, Hologic ensures that a new product will be released every two years by creating derivative and sustaining products. New products are both enhancements of a platform or a de-featured model. In addition, Hologic stays ahead of the competition through breakthrough products like the *Selenia Full Field Digital System*.

IV. Profiting from Innovation

The ability of Hologic to capitalize the gains from its superior technology in medical imaging relies significantly on two key factors: the appropriability regime around its innovation and whether it possesses and controls critical complementary assets. Based on these factors, Hologic should decide whether to self-integrate or to contract with partners.

(i) Appropriability Regime

A regime of appropriability can be determined by the nature of the technology and the efficacy of legal mechanisms of protection.²³ Hologic appears to have established a fairly tight appropriability regime for its technology through a combination of patents, trade secrets, copyright and trademark laws, confidentiality procedures, and the Food and Drug Administration (FDA) approval process.²⁴

By 2005, Hologic owned over 150 US patents and has applied for an additional 56 US patents on its technologies. It has also owned or applied for patents in selected foreign countries. Whereas, patenting alone is not enough to safeguard the company from threats of imitators, because patents have expiration dates and can be invented around through reverse engineering with minor modifications. Trade secrets, copyrights, trademarks, and confidentiality procedures do not have time limits. However, the effectiveness of trade secrets and confidentiality procedures depend in large part on how the company can prevent them from being exposed to the public.

The FDA contributes considerably to the tight appropriability regime Hologic currently enjoys. Medical imaging devices are subject to regulation by the FDA. Before a company can market such devices for sale in the US, it must first obtain pre-market approval from the FDA, which is a rather complex, lengthy and costly process. The company must conduct extensive clinical testing on a device to obtain the necessary clinical data for submission to the FDA, and then the FDA will decide whether to grant pre-market approval based on the safety and effectiveness demonstrated by the device. The whole process may take several years, and the approval may restrict the number of devices for sale and may require additional patient follow-up for an indefinite period of time.

²³ David J. Teece, "Profiting from Technological Innovation: Implications for Integration, Collaboration, Licensing and Public Policy," *Research Policy* 15 (1986): 285-305.

²⁴ Hologic, *Annual Report* (2005): 16 – 18.

Being a market leader in mammography and osteoporosis technologies, Hologic has obtained FDA approval for many devices in its product lines and has accumulated valuable knowledge and experience in meeting FDA guidelines. The FDA approval process, coupled with Hologic's extensive patents and other Intellectual Property (IP) protection measures, provide the company an almost iron-clad shield against imitation by competitors, at least before its patents expire.

(ii) Complementary Assets

The tight appropriability regime provides Hologic an important competitive advantage over its rivals, but Hologic's success in the long run also depends on how well the company can maintain and control specialized complementary assets, such as brand names, distribution channels, manufacturing, and technical support.

Hologic attempts to market its brand-name products based on superior image quality, comprehensive product features, ease of use, product liability, and quality customer service.²⁵ The company entered into a strategic alliance with Siemens AG in 2002, in which Siemens has agreed to source exclusively Hologics's DirectRay technology for Siemens' Full Field Digital Mammography (FFMS) system. The alliance offers Hologic the benefit of proving the strength and quality of its technology through obtaining validation from a global leader in medical imaging.²⁶ Hologic's strategy to build reputation for its brands appears to bear fruits in 2005, when the company was chosen as one of the top 10 medical imaging manufacturers in the *Medical Imaging Readers' Choice Awards*.²⁷

Hologic has also moved toward stricter control over its distribution channels and technical support by placing a greater emphasis on direct sales and service force. In 2002, it centralized the management of the sales channels for all its product lines, and by 2005 its service force has consisted of over 130 field service engineers. In addition, over the past three years, Hologic has expanded its direct sales and service efforts for mammography into territories that were previous covered by independent distributors.²⁸

²⁵ Hologic, *Annual Report* (2005): 14.

²⁶ "Hologic and Siemens Medical Solutions Finalize Strategic Alliance," *Siemens Press Release*, July 22, 2002.

²⁷ Andi Lucas, "The People's Pick," *Medical Imaging*, December 2005. Available at: http://www.medicalimagingmag.com/issues/articles/2005-12_01.asp (Last accessed on April 30, 2006).

²⁸ Hologic, *Annual Report* (2005): 13.

Hologic keeps system-level integration in house, which primarily consists of assembly, test, burn-in, and quality control.²⁹ This strategy enables the company to effectively facilitate coordination among interdependent components, promote advancement in standards, and maintain a tight control over its essential IP.

(iii) Outsourcing

Hologic has been engaged in extensive outsourcing in distribution and manufacturing. It employs a network of independent distributors for the marketing of its technologies in foreign markets, and it outsources all of the manufacturing, except for electromechanical assembly and final integration.³⁰

By organizing some of its activities through contractual relationship, Hologic can avoid making the upfront investment necessary to match the capabilities of its competitors, which is often a difficult financial task for a company of Hologic's size. Outsourcing also allows Hologic to benefit from skills and expertise of outside companies, high-powered incentives offered by the market, and parallel experimentation among various suppliers. Moreover, the strategy helps Hologic bring devices to the market sooner. For example, Hologic used outsourcing to double the units of production for its Selenia systems in 2005 when the backlog orders for Selenia increased to 221 systems.³¹

Outsourcing is not without costs. Hologic relies on only a limited number of suppliers for some crucial parts or components. In particular, it sources all High Transmission Cellular (HTC) grids used in its LORAD mammography systems from a single supplier. If the supplier fails to provide the required quantity in a timely manner, Hologic may be subject to holdup problems, and its production process will be disrupted.³² The strategy also limits Hologic's ability to develop desirable know-how in outsourced fields, and poses the risk of losing key knowledge to partners.

After weighing the benefits and costs of Hologic's outsourcing strategy, we believe that this strategy is a smart and sound one. By integrating systemic design and outsourcing only autonomous components, Hologic is able to control related, complementary assets and at the same time take advantage of incentives and responsiveness delivered by virtual organization of autonomous innovation.

²⁹ Ibid at 15.

³⁰ Weyne Forrest, "Regulation Focus Sourcing," *Reed Business Information*, March 2, 2006.

³¹ Hologic, *Annual Report* (2005): 13.

³² Ibid at 15.

V. Hologic's ultrasound products as a disruptive technology

In this section we focus on Hologic's ultrasound breast imaging system Alexa and discuss whether it is a disruptive technology. Even though Hologic's ultrasound technology exhibits many characteristics that are typical for disruptive technologies, we conclude that Hologic has decided not to market its ultrasound devices as a disruptive technology. Instead, Hologic has been able to establish ultrasound imaging as a supplementary technology and has thereby further strengthened its position as market leader.

(i) What is a Disruptive Technology?

In his book "The Innovator's Dilemma" Clayton Christensen identifies two types of technologies: sustaining and disruptive. As defined before, a sustaining technology is a technology which improves an existing product according to the commonly accepted measures of performance. A disruptive technology in contrast typically under performs the existing technology if measured on the same set of attributes. However, disruptive technologies bring a different value proposition to the market. They often offer features that are not available in the original technology. Most disruptive technologies have some of the following characteristics: cheaper, smaller, simpler and easier to use. Often disruptive technologies start out in a niche market where they can ripen. Once the technology has gained traction in the niche market it can overtake the bigger market. Disruptive technologies are best illustrated with an example.

A good example for disruptive technologies is the hard drive industry. In the past 30 years there have been several generations of hard drives (from 14 inch down to 1.8 inch) and most of the new generations started out as disruptive technologies. Instead of reviewing the past, we will dare an outlook into the future. The next disruptive technology in the hard drive market could be flash memory. Flash memory offers an attribute the customers didn't specifically ask for: extremely small physical size. In regard of the attributes that are valued by the customers this new technology is inferior to the existing technology: the capacity is much lower and the price higher. However, flash memory is very appropriate for digital photography. Flash memory gained traction in this niche market and has improved a lot over the past few years. With time this new technology will improve even more and could even be deployed in mobile computers.

In his second book "The Innovator's Solution" Christensen uses the term "disruptive innovation" rather than "disruptive technology" because technologies are rarely intrinsically disruptive. It is much more the managing of a new technology, or an

innovation, that can be disruptive. Since we used the term "disruptive technology" in class, we will use it here as well.

(ii) Hologic's ultrasound breast imaging devices

Breast cancer is one of the leading causes of cancer-related deaths among women. As with all other invasive cancers, an early stage detection is important for a successful treatment. Detection of breast cancer is typically done with low-dose X-rays, but in recent years breast imaging devices using ultrasound, ductography and magnetic resonance imaging (MRI) have been developed. Nonetheless mammography remains by far the dominant technology for breast imaging. Note that *mammography* refers to the process of breast cancer detection with X-rays, while breast imaging is the more general term.

Ultrasound imaging is a technique that uses high frequency sound waves to create pictures of the breasts and other tissues and organs. As the sound waves pass through the body they are reflected back to the ultrasound machine in different ways, depending on the characteristics of the tissues they have encountered. The quality of the resulting images has been constantly improving, but is still below that of MRI or X-ray devices. Another disadvantage of ultrasound imaging is the additional training that doctors need to undergo in order to use the devices properly. Ultrasound imaging devices require the doctor to manually sweep the device over the breast, applying the right amount of pressure so that the best image quality is achieved. Therefore the effectiveness of an ultrasound test depends on the operator's level of skill and experience.

However, ultrasound imaging devices have also several advantages. First and foremost ultrasound imaging does not involve radiation. The devices are less expensive than X-ray devices and significantly cheaper than MRI systems. They are furthermore smaller and therefore mobile, allowing for the device to be moved from room to room, something that is unthinkable for the other types breast imaging devices. Clinical studies have also shown that ultrasound imaging devices excel when evaluating dense breast tissue. Finally ultrasound examinations can be performed during pregnancy while mammography should be avoided in this period.

(iii) Are Hologic's ultrasound products a disruptive technology?

Hologic's ultrasound products exhibit most of the characteristics that are typical for disruptive technologies, but are they one or will they become one? After a careful

analysis and discussion we came to the conclusion that Hologic's ultrasound products are *not* disruptive. As stated before, it is strategy that creates the disruptive impact and seldom an intrinsic feature of the technology.

Hologic is the market leader in digital and analog mammography. Disruptive technologies are typically pushed by small players, trying to gain market share. Hologic would cannibalize its own market share if it tried to push ultrasound as a disruptive technology.

Note that there are situations in which it is a good strategy for a market leader to pursue a disruptive technology and thereby maybe kill its current technology. One example for this is Hewlett-Packard's (HP) printer business in the late 80's, early 90's. HP decided to develop the cheaper, lower quality ink-jet printers which would be in competition to its laser-jet printers. There are two situations in which such a strategy is valuable:

1. If the disruptive technology is going to open the door to a new, larger market, then one should pursue it even if at the expense of the existing technology.
2. If there is reason to believe that the competition will be able to develop the disruptive technology, then one should not wait for them to disrupt the market but do it oneself.

Hologic and the other market players (General Electric, Siemens) have decided not to pursue ultrasound imaging as a disruptive technology. Instead of trying to establish ultrasound imaging as an alternative to mammography, they have successfully established it as a *supplementary* technology. Typically ultrasound scans are conducted when:

- evaluating dense breast tissue,
- evaluating a mass demonstrated on mammography,
- guiding a biopsy needle (for cyst aspiration).^{33 34}

This is a smart strategic decision since it allows these companies to commercially deploy the ultrasound technology and thereby establish a new revenue stream, without getting into competition with the mammography product line. The ultrasound products additionally strengthen Hologic's position as the market leader, allowing it to offer a

³³ C. Christensen, "The Innovator's Solution"

³⁴ SA Feig. 1999, Seminars in nuclear medicine. Role and evaluation of mammography and other imaging methods for breast cancer detection, diagnosis, and staging.

complete breast imaging system which includes mammography and ultrasound imaging.

(iv) How does Hologic's ultrasound product compare to Ecton's?

Hologic's and Ecton's ultrasound based devices have many things in common. The devices are cheaper and smaller, but also provide lower quality results than the established technologies. In both case the technology has the potential to become disruptive, if managed accordingly.

However, there is a big difference in the companies managing the technology. While Ecton was a start-up trying to enter the market, Hologic is the market leader in its industry. Both companies decided to bring their technology to market but not to try to disrupt the market - with different success.

We think that it would have been a valuable strategy for Ecton to attempt to disrupt the market. However, Ecton decided not to do so. Instead of targeting a niche market first where its product had advantages over the existing technologies, Ecton decided to step into direct competition with the established market players. This strategic orientation prevented it from growing fast enough and Ecton was acquired by its competitor Acuson.

Hologic did not attempt to disrupt the market either. Their motivation was a different one. Hologic did not want their ultrasound breast imaging product to get into competition with their mammography product line. However, ultrasound imaging has some advantages to offer and Hologic found a way to establish it as a supplementary product.

(v) Conclusion

Hologic's ultrasound technology exhibits many characteristics that are typical for disruptive technologies. However, few technologies are intrinsically disruptive. It is usually the managing of a new technology, or an innovation, that makes a product disruptive. Hologic decided not to market its ultrasound imaging devices as a disruptive technology, because there was little value in this strategy for Hologic as a market leader. Hologic saw an opportunity to bring ultrasound imaging as a supplementary technology to market and thereby further strengthen its position.

VI. Team Structure

Hologic employs a hybrid of several of the team structures discussed in *Organizing and Leading “Heavyweight” Development Teams*.³⁵ This hybrid is consistent with its method of acquiring and integrating other companies as a way to develop new products. At a high level, Hologic has a lightweight team structure in a company that is divided into several platform branches. In the subsequent parts of this section, we outline the different forms of team structure, discuss Hologic’s internal organization, and then try to fit Hologic into this structure

(i) Defining team structures

Following the model supplied in “Heavyweight Teams”, we break team structures into four distinct categories: **Functional**, **Lightweight**, **Heavyweight**, and **Autonomous**. These categories move from organization by activity (functional) to organization by product (autonomous) and is characterized by the internal power structure. **Functional teams** exist in companies who allocate resources and organize people by the skill set of the individuals. Employees report to managers who typically have the same background and skills. In this model, employees are evaluated and promoted based on their performance in their area. Functional teams employ an *over-the-wall* approach to projects that combine multiple tasks: one group hands their work to the next group with little communication. **Lightweight teams** are similar to functional organization, but employ lightweight managers to oversee the project. These lightweight managers are sometimes called information brokers because they oversee information on the status of the project. They report the state of the project to senior management, but typically have little ability to alter the course of the project. **Heavyweight teams** still reside in companies with a functional structure, but the project manager has legitimate control over the course of the project. The heavyweight manager often has her own budget and the ability to effect raises and promotions. Finally, **autonomous teams** are effectively independent companies within the same organization. In the reading, we discussed this in the context of HP and Kittyhawk, in which the new team had offices in separate trailers and had as independent goal and management structure.

From the vantage point of the individual employee, we make distinctions based on raises, evaluations and promotions. In the functional and lightweight teams, these roles are handled by functional managers who have the same skill set as the employee. In heavyweight teams, the heavyweight manager often has control over raises and

³⁵ *Organizing and Leading “Heavyweight” Development Teams*. Kim B. Clark and Steven C. Wheelwright.

evaluations that may even extend to promotions. In an autonomous team, the manager not only controls pay and promotions, but also has the ability to hire and fire.

There are, however, similarities between autonomous teams, functional teams and small companies. A small company typically divides the tasks internally by an employee's background and skills – similar to a functional organization. However, the project leadership is the company leadership – since the company has only one product in the early stages. Hence, the project leadership has the ability to hire and fire and has complete control over the budget. Likewise, employees with different skills often work very closely in a start-up in order to learn the demands and meet the needs of the market. An example of a small company with a product focus is Ecton Inc,³⁶ where President Michael Cannon was overseeing all aspects of the compact echo machine. We can view the team structure in Ecton either as functional or autonomous. To this end, Ecton functioned as an autonomous team built out of the previous staff at ATL and lead by Cannon. However, the engineers were lead by Christopher Knell, the VP of Engineering – giving the company a functional flavor.

(ii) Organization in Hologic

Internally, Hologic is broken into divisions based on broad divisions in their product offering.³⁷ Specifically, there are 3 divisions which are based on different product lines. Each of these three divisions are in physically distinct locations. Each location has its own R&D, its own software team and its own internal management structure. Central coordination is mostly run from one of the three sites, but high level management divides their time between facilities. These divisions were built by acquisition and are outlined below:

- Connecticut focuses on Mammography products
- Massachusetts includes product development in osteoporosis and MRI. In addition, most of the central coordination is based out of Massachusetts.
- The Delaware division, based on the acquisition of Lorad, focuses on detectors.

To emphasize the spread out nature of the company, the VP of Product Management who is based in Massachusetts spends 3 days per week in Massachusetts and 2 days per week in Connecticut.

³⁶ “Disruptive Technology a Heartbeat Away: Ecton, Inc.” Edward G Cape and Clayton Christensen.

³⁷ The entirety of this section is based on an interview with Nicolaos Gkanatsios, Director, Product Management, Hologic.

However, these three divisions are not completely separate companies, and there is some internal coordination. First, there is one VP of Manufacturing for the entire company who coordinates the manufacturing facilities and reduces duplication. From a technical perspective, the only overlap between the three divisions is the final integration – which must be done centrally. However, it seems that this is minimal, since OEMs integrate detectors themselves as well.

Internally we can understand the structure of organization by examining the role of Dr. Gkanatsios, the Director of Product Management in Breast Imaging Technologies. Based in Connecticut, he reports to the VP of Product Management in Massachusetts and fills a typical product manager role. He has a technical background, talks with customers, and work closely with both the sales team and the engineering team. When he has technical proposals, he pitches them to the engineering management who make decisions about resource allocation (people, budget, et cetera). He regularly goes on sales visits and to weekly engineering meetings. He emphasized that internal integration of each division is tight by explaining that when he needs to communicate with engineers, he goes directly to their office without using email or the telephone.

(iii) Classifying Hologic's Team Structure

Hologic shows characteristics of both autonomous teams and lightweight management – which we'll call an "ensemble of lightweight organizations". Because Hologic has three distinct divisions which cover three distinct platforms of products, it has characteristics of autonomous teams. These divisions operate separately and are individually responsible for key attributes, such as promotions, raises and resource allocations.

Yet, on the smaller scale of individual products on the larger platform, Hologic's structure is distinctly lightweight. Dr. Gkanatsios fits the description of the lightweight manager – functionally serving as an information broker. He is close to the details of the product and customer, overseeing large parts of the process. However, he does not directly manage individual members of the team and is not responsible for resource allocation, budgets, promotions or raises. This internal structure indicates that he does not have the power of a heavyweight manager. Further, instead of driving his own ideas directly, he presents his potential product ideas to engineering management – indicating that they make the final decisions about implementation. Often, a heavyweight manager would have the authority to pursue these ideas independently.

The hybrid nature of Hologic reflects its origins. Because divisions were acquired and were originally separate companies, they reflect the autonomous nature of startups. As these individual groups grew and developed platforms with multiple products, they began to develop functional organization internally. Yet Hologic as a whole did not create a downward force requiring that these three distinct divisions merge in culture and function.

VII. Conclusion

In applying the concepts from case studies, we have found that different concepts affect different companies in different ways. As a result, the concepts covered are just that: concepts and not rules. Because Hologic's market, industry and technology differ in subtle ways from the cases, one cannot dictate the best course of action. However, by understanding the distinctions between the cases and Hologic, rational decisions can be made. For example, we see that Hologic has taken what could be a disruptive technology and turned it into a non-disruptive product based on the nature of the market and competitors. Likewise, Hologic has implemented a new team structure that combines lightweight teams and autonomous organizations to reduce the costs in their acquisition based approach to growth. In some cases, the application of management technique is more related to the approach taken by other companies: it manages product development by looking across the spectrum from breakthrough to incremental advance, and uses complementary assets and a strong appropriability regime to protect against competitors. By making wise business decisions in uncertain circumstances, Hologic continues to successfully compete against larger companies.