



BRIEF CASES

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FormPrint Ortho500

"That time works for me, Bruce, I'll see you next week." said David Willis, as he pulled into the parking lot of FormPrint's Raleigh, North Carolina, headquarters. FormPrint's vice president of orthopedic products, Willis had just scheduled a meeting with Bruce Abbot, FormPrint's senior vice president of medical products. It was November 13, 2013. In only a week, Willis would present his recommendation for how FormPrint should market its newest orthopedic 3D printing system, the Ortho500.

FormPrint, an early entrant into the 3D modeling industry, was a manufacturer of 3D printers.¹ It focused on the health-care industry with products for dental, auditory, and orthopedic use. Surgeons in several large U.S. hospitals used FormPrint's orthopedic products to produce custom (also known as "bespoke") orthopedic implants and intricate orthopedic prototypes to aid them in surgical planning and execution. The prices of its suite of orthopedic 3D printing systems ranged from \$125,000 to \$490,000.

The new Ortho500 printed custom exoskeletal orthopedic splints, braces, and casts that conformed to a patient's body. Custom supports reduced the discomfort, chafing, and soreness that plagued patients who used standard one-size-fits-all braces. With a planned price of \$68,000, the potential market for the Ortho500 extended beyond large urban hospitals (the Ortho product line's existing market) to outpatient offices across the United States. The company wanted to establish an early U.S. presence in the bracing market and eventually hoped to expand internationally. Industry forecasts indicated there would be substantial demand for lower-priced 3D printers in international markets by 2020.

Willis was not convinced that FormPrint's existing sales team was the best channel to achieve Ortho500's strategy, which was to establish a footprint ahead of competition in order to become the U.S. market leader in exoskeletal bracing within three years. Instead, FormPrint could use commission-based Independent Sales Representatives (ISRs). Turnover in ISR organizations was high, however, and ISRs usually had less orthopedic knowledge than did FormPrint's salespeople. Would the effort required to manage and educate ISRs negate their potential sales benefit?

Willis thought about the comments Abbott had made during their phone conversation:

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The 3D technology for orthopedics is rapidly improving and decreasing in price as competition gets fiercer. FormPrint has long based its value proposition and approach on selling best-in-class product performance at a premium price. The Ortho500 is different, and it gives us a chance to establish a position in what's likely to be a substantially larger market segment in the U.S. in the future. There are different opinions about how we should sell the Ortho500. I need you to figure out which sales strategy we should pursue and the implementation requirements for the chosen path. Rising costs have put financial pressures on the company. The ramifications of a failed Ortho500 launch are serious and may include both compensation and staff reductions for your division. We want to be the vendor of choice in all orthopedic segments, including low-end bracing and support; I believe we can do so given our market strength in orthopedics. Becoming the market leader in 2014, while maintaining or increasing current levels of profitability, is critical to our longer-term success in this industry.

Industry and Market Overview

Also known as “additive manufacturing,” 3D printing referred to the production of tangible, three-dimensional forms that originated from a digital source and were transformed into physical products through a printing device. Because only a few companies held patents from the 1960s that were related to additive manufacturing approaches, new entrants were unable to capitalize on their printing R&D efforts until those patents expired (mostly between 2005 and 2010).

In subtractive manufacturing, a block of material was sawed, chipped, drilled, or shaved away until the final shape matched the desired product specifications. In contrast, additive manufacturing created products by layering millimeter-thin (or thinner) strips of material, in different lengths and depths, on top of each other. The layers were then fused together to solidify the printed three-dimensional form. Few mass manufacturers employed 3D printing due to lengthy print times, which ranged from a few hours to multiple days. This technology did not improve on mass manufacturers' existing machines, which could produce several hundred thousand batches of identical products within hours.

In contrast, manufacturers of custom products produced in individual or small-batch runs viewed 3D printers as a way to reduce costs. With subtractive methods, they not only paid for expensive labor to design and form custom molds but also purchased large quantities of excess material from which the custom product was shaped. In some cases, up to 95% of material was wasted.² Additive manufacturing slashed these costs; labor was automated, and only the precise amount of raw material required for production was needed.

Prices for industrial 3D printers ranged from more than \$700,000 for large, complex systems to less than \$10,000. By 2013, some consumer-focused 3D printers cost less than \$2,000. Technological developments fueled innovation, resulting in higher-quality finished products, improved 3D printer functionality, and broader applicability across industries. Life cycles for 3D printers shortened as successive generations became available at lower prices.

Estimates and forecasts for the 3D printing industry's size and growth rates varied widely. Within FormPrint, executives believed the worldwide 3D printing market was about \$2.25 billion in 2012 and would reach nearly \$3 billion by 2014. The larger markets for 3D printing systems included automobiles; aerospace; consumer; and medical/dental.³

FormPrint estimated the global 3D printing market in 2013 for health care was about \$235 million, and that the U.S. market represented 75% of this market; internal company estimates suggested the U.S. market had grown from \$98.7 million in 2012 to \$176.25 million in 2013. Risks for the health-care

segment included patient safety and future regulations (including FDA approval for 3D-printed implants).

See **Exhibit 1** for a list of health-care segments, how 3D printing systems serve and benefit them, and their estimated share of the overall health-care market.

FormPrint: Company background

FormPrint was founded in 1998 by an engineer who discovered how to construct prototypes from three-dimensional designs using patent-protected additive manufacturing principles. The company focused on health-care applications, and began growing rapidly in 2002 as advances in technology expedited the prototype manufacture process and improved product quality. By 2013, FormPrint had sales of \$42.9 million.

As the dental and hearing-aid markets approached market saturation, FormPrint's growth strategy centered on the orthopedic market, where it was one of five players in the U.S. for orthopedic 3D printing systems. Its orthopedic products, like its auditory and dental products, were of higher quality and technical sophistication than those produced by its competitors; and clients paid a premium price for these benefits. In 2013, management decided to expand its presence in orthopedics through new, lower-priced products for smaller hospitals and outpatient orthopedic clinics.

The company's orthopedic strategy included creating products to serve top surgeons, as well as outpatient practitioners in smaller medical facilities. Ideas for future products ranged from simple prototyping products (costing \$30,000 at the low end) to sophisticated bone and tissue implant printers that would be sold for upwards of \$500,000. In 2013, FormPrint's ProCast and Ortho product lines served the medical and dental markets (see **Table 1**).

Table 1 FormPrint health care product lines—2013

Product	Market Segment	Function	Distribution
ProCast1000	Auditory	Custom casings for hearing aids	U.S. and international
ProCast800	Dental	Precise custom crowns, orthodontic fixtures, and molds	U.S. and international
Ortho1700	Orthopedic	Custom prostheses	U.S.
Ortho1300	Orthopedic	Prototypes of patient bones and joints	U.S.
Ortho2000	Orthopedic	Custom orthopedic implants (knee and hip replacements)	U.S.

*Note: Each product line offered up to six variations of the base product.

Some 80% of FormPrint's Ortho sales went to large (more than 200 beds) hospitals, concentrated in major metropolitan areas. These customers, many of them teaching hospitals, purchased 3D printers for between \$95,000 and \$300,000. The remaining 20% of its printer sales were to a handful of smaller private hospitals and independent, third-party prototype providers, which produced prototypes from patient scans for smaller hospitals and outpatient centers that could not afford to purchase their own 3D systems.

Buying process for 3D printers in the orthopedic segment

In hospitals, interest in procuring a 3D printer typically began with an orthopedic surgeon's request to expand existing hospital services and/or embrace a technology upgrade. Once the hospital's board

of overseers granted approval, the purchasing department solicited vendor quotes and presentations, evaluated options with hospital staff, and negotiated prices with vendors.

FormPrint estimated that the fully-burdened (i.e., including both fixed and variable expenses) annual cost for one orthopedic salesperson was \$400,000. The sales process involved meetings and clinical demonstrations, which, for the Ortho 1300–2000, required special vehicles and packaging to transport machines that could weigh over 900 pounds. After evaluating competitive products, orthopedists selected finalists and sent their recommendations to the hospital procurement department, which managed the negotiation process. Rebecca Proctor, a sales executive with Form Print who'd been focused on orthopedics for four years, said:

The sales process for the Ortho machines can take between six months and a year. In the early stages, I'm selling to orthopedic surgeons who will use the machines themselves or collaborate with highly trained colleagues. I need to know our product, as well as current orthopedic research. I manage on-site product demonstrations conducted by clinical specialists. I also need to understand national health care trends and how legislation may affect my clients. At this stage, my clients are most concerned with performance, quality, and service. They want assurance that our products are capable of (and better than competitors at) meeting their needs, and that we understand the evolving orthopedics landscape and will maintain market presence as the industry evolves. They don't want to buy a \$500,000 machine from a company that may be defunct in a few years.

The later stages focus on economics. Hospital administrators value physicians' opinions, but focus on price and return on investment. I must discuss profitability. Every hospital's financial situation is unique because patient loads and projected machine usage rates are different for each orthopedic department. Traditionally, only the largest urban hospitals with sizable patient populations can justify the expense.

There are always other factors: for example, does the hospital specialize in orthopedics? Those that do are more willing to embrace new 3D printing technology to support their brand as an industry leader. Many smaller hospitals have strategic relationships with leading orthopedic centers and teaching hospitals and look to them for guidance.

Industry context: The Affordable Care Act's effect on hospital and physician spending

In March 2010, the Affordable Care Act sought to make health care available to all U.S. citizens. Proponents of the legislation forecasted that more than 10 million people would have health insurance for the first time, boosting business for hospitals and physicians, and fueling innovation in ancillary health-care businesses, including medical-device manufacturers.

Funding universal health care was a politically charged topic. Proponents did not want to increase the cost to consumers because they feared doing so would result in lack of support. Instead, legislators looked for ways to fund the program through approaches that were less visible to consumers. Medicare and Medicaid reimbursement allowances were reduced, and private insurers followed suit. Hospital and physician spending became less predictable across most specialties because of the increased costs related to tests and services that had been formerly covered by insurance payments. Some observers believed that the long-term results meant that the hospital market was becoming much more price sensitive, especially in its purchases of equipment, and that the non-hospital market and lower-priced products would become more important sources of growth for medical-equipment firms.

Another form of funding imposed a medical device tax of 2.3% on all sales of non-consumer medical devices after December 31, 2012.⁴ Medical-device manufacturers were responsible for this cost. Some of these companies felt that higher sales volume would compensate for the cost of the tax. Others argued that because most newly insured patients were younger and healthier, they would not immediately need cutting-edge medical technologies, such as implants.

Table 2 summarizes competitors' strategies for 2013. **Exhibit 1** shows market shares and estimated revenues for 2012 and 2013; **Exhibit 2** indicates their orthopedic revenue and market share estimates.

Table 2 3D printing system manufacturers in the health-care segment

Company	Description	Average Price
Ashokal	Industry leader in 3D printing systems, with 60% of company revenue from consumer segment and 10% from education. Entered market in 2009 with well-received prototyping system for dental market. Exoskeletal is only ortho offering, focused on high performance and functionality.	Low (<\$100K)
DragonBend	Early entrant in health-care segment. Focused on high-end markets, including orthopedic implants, and complex prototyping for internal and orthopedic markets. Large, urban hospital presence only.	High (\$100K–\$300K)
LoganStar	Newest entrant in orthopedic industry. Big presence in intricate custom prostheses. Small presence in orthopedic implants.	High (\$100K–\$300K)
PrintFlex	Low-price strategy across markets (manufacturer, health care, and consumer). Exoskeletal bracing is only health-care offering in 2013.	Low (<\$100K)

Two of the largest personal-computer printer manufacturers were rumored to be entering the 3D printing market, in 2015 with consumer-focused products and in 2016 with health-care products. Specific details regarding which health-care segments would be targeted were unknown.

FormPrint medical products division: Organization

FormPrint was organized by business unit (see **Exhibit 3**). The medical-product division, led by Bruce Abbot, had five division heads. One was responsible for developing foreign operations in Asia and Europe; the remaining four led (1) U.S. auditory unit, (2) U.S. orthopedic unit (David Willis), (3) U.S. dental unit, and (4) U.S. sales and distribution (led by Mark Wittenberg), which had three distinct sales forces: auditory product sales, dental product sales, and orthopedic product sales. Each sales group developed deep expertise within its business unit and focused only on selling products from that unit. Management believed that an auditory salesperson, for example, did not have the depth of industry and product knowledge required to successfully sell orthopedic or dental products.

Abbot attributed the slowdown in his division to several factors: increased competition for high-end printing systems; saturation of auditory and dental markets; and uncertainty about the effects of universal health care on hospital and physician spending budgets. To control costs, he had instituted a hiring freeze through 2014.

As the VP of the orthopedic systems business unit, David Willis managed three departments:

1. Product development: Developed new products and upgrades to existing products.

2. Marketing communications: Created print and electronic marketing collateral for sales; managed marketing and public relations campaigns, and sponsorship of industry events.
3. Business development: Acted as the liaison between orthopedic marketing and sales, helping with product training, competitive analysis, customer factory visits, and national accounts. Communicated marketing strategy to sales staff.

Carly Wallace was Ortho's business development manager:

I spend a lot of my time talking to our sales, product, and marketing teams about product attributes, benefits, and sales strategies. Our salespeople are best at selling technology-leading products to sophisticated buyers. They are a great source of information for our product development. Sales executives give me client feedback for product managers and share opinions on sales strategies. I also work with Mark Wittenberg, the VP of national sales for ortho and internal medicine. Mark and his sales staff often see our corporate division as out of touch with the market. I have to develop and nurture relationships with the sales team: I can't fly in for a day, tell them what to sell and how to sell it, and then leave. They won't listen to someone they don't know and trust. It takes time and effort to build credibility with them. And Mark is truly revered by his salespeople.

Mark Wittenberg led FormPrint's sales efforts across divisions, including six sales representatives for orthopedic products. He was very knowledgeable about the orthopedic industry and the attributes of the products under his umbrella. One of his direct reports noted: "Mark is dedicated to FormPrint's growth, and is widely respected. He's true to his word, and cares about his sales team personally and professionally. I've worked in three other sales organizations, but never for a leader I trust as much or work as hard for as Mark."

Wittenberg believed in building personal relationships with orthopedists and attributed sales success to those relationships, as well as in-person product demonstrations to doctors and others at hospitals. Wittenberg had made it clear to both Willis and Abbot that he wanted his sales team to have the opportunity to sell the Ortho500. In an email to both, he said: "The best approach to selling the Ortho500 machines is to first focus on how patients and orthopedists benefit, and then address the economic benefits. Hospital administrators (and some in our own marketing organization) may disagree, but physicians have the most influence on this decision."

Before 2011, FormPrint's sales compensation was 80% salary and 20% commission, tied to dollar-volume sales by each rep. Wittenberg increased the incentive for his team to close deals. He adjusted the compensation scheme so that, in 2011, 70% of a salesperson's compensation was salary and 30% commission.

The Ortho500

The Ortho500 was scheduled to launch in early 2014. It could print an exoskeletal brace—typically a finger splint, wrist support, or forearm cast—designed for an individual patient in a few hours, eliminating the need for patients to wait days for brace delivery or for orthopedic offices to order and stock a varied inventory of braces. The improved fit was also more comfortable for patients and was at times thought to speed recovery. The Ortho500's simple interface was designed to enable physician assistants and technicians to operate the machine without technical assistance from other personnel in a hospital or other health-care facility. Hence, the Ortho500 was designed primarily for outpatient orthopedic physicians, rather than physicians at hospitals who treated severe orthopedic injuries. It

was less complex with less functionality than FormPrint's existing orthopedic 3D solutions, and its price of \$68,000 reflected that. The process behind exoskeletal brace production required different design inputs and less expensive materials than FormPrint's other Ortho machines. As a result, cannibalization of existing products that could not produce braces was not expected.

FormPrint estimated that, in 2014, the Ortho500 could produce competitively priced braces and supports that improved on existing, off-the shelf approaches for roughly 3% of all outpatient orthopedic injuries; but that percentage was expected to grow over time with improved technology and physician familiarity. FormPrint believed that the average charge from clinics to patients for a 3D-printed support would be \$175, with an expected insurance reimbursement rate to the clinic of 70%. Variable costs to the clinic varied depending on brace size and complexity, but averaged \$68 per brace.

FormPrint projected the 2014 market for exoskeletal bracing printers would be between \$8 million and \$12 million, but was poised for rapid expansion, domestically and internationally, through 2018. Product manager Sophia Thompson's marketing plan for the Ortho500 included the following elements:

Place: The country's largest non-hospital orthopedic clinics comprised Ortho500's target market. Thompson's research found 65% of target clinics (each with an annual patient visit of at least 100,000 visits a year) clustered in just three of the largest metropolitan areas (New York, Los Angeles, and Chicago) and 85% of similarly sized clinics located in 15 U.S. cities.

Product: During development, improved system technology became available that could minimally advance the Ortho500's functionality. Incorporating the new technology would add at least 12 months to the development cycle and increase the price point. Thompson observed:

We debated whether to delay the Ortho 500's launch to incorporate new technology. It forced us to think about what product leadership really meant to our company, at this point in time. Would prioritizing performance over price and value propel us to our goal of speedy execution and a leading market share by 2017? We decided the benefits of early market entry and low price point, as well as evolving trends in the direction of lower-priced and ease-of-use products, outweighed the minor advancements the new technology would bring.

An analysis that Thompson conducted in 2013 found three competitive products. She evaluated each machine across a selection of factors, including overall performance, price, reliability, print speed, ease of use, and functionality (i.e., the number of functions the end-product was able to perform) of finished products. These results are shown in **Table 3**.

Table 3 3D printing systems for bracing and support – 2013]

Company/Product	Strength	Weakness	Price
Ashokal/AK450	Functionality and reliability	Price, Print Speed	\$80,000
FormPrint/Ortho500	Ease of use, overall performance	Functionality	\$68,000
PrintFlex/OP700	Price	Performance, Reliability	\$60,000

Thompson believed that outpatient orthopedists' priorities were as follows: (1 = most important) performance; (2) price; (3) ease of use; (4) reliability; and (5 = least important) functionality.

Price: The Ortho500 would be sold for \$68,000. Said Thompson: “FormPrint is looking to the Ortho500 to break into the non-hospital market, establish awareness among outpatient orthopedists, and foster a respected brand. We believe that competitive rather than (as with our other products) premium pricing will help us achieve these goals.”

Planned Promotion: Promotion for the Ortho500 in 2014 included one conference sponsorship per quarter, at four orthopedic conferences (three in the U.S. and one in the U.K.); a direct email campaign targeting outpatient orthopedic clinics in major metropolitan areas; a public relations campaign designed to capitalize on general consumer and reporter interest in the 3D printing industry; and product and marketing information available on the FormPrint website.

Ortho500: Sales tasks and distribution options

Marketers and sales executives agreed that using FormPrint’s orthopedics sales force benefited long-term relationship building, but that it would require a large financial investment. With a hiring freeze, Willis considered whether to sell the product through independent sales representatives (ISRs). While ISRs would not have the same product and company knowledge held by FormPrint’s sales force, were those qualities critical to the sale of the Ortho500, whose sales cycle was expected to take less than 60 days? The Ortho500 was designed to be functionally simple and easy to use. It was much smaller and more portable than other 3D printing systems. Product demonstrations were straightforward and could be conducted by ISRs with basic training in product functionality and use. In contrast, the more complex Ortho models required expensive and lengthy on-site demonstrations by highly trained clinicians (with weeks of follow-up questions). Said Thompson:

Non-hospital outpatient clinics differ from hospitals in how they evaluated, selected, and paid for technological enhancements. Decision makers are physicians. Many own their practices. Price and return on investment are just as important to orthopedists in this market as performance and reliability are. Our research also indicated that physician interest in 3D exoskeletal printers is high, but ownership is low. Cash-flow concerns compel most non-hospital practices to lease high-cost products, and financing terms and availability are key purchasing criteria. ISRs have lots of experience with lease and other financing arrangements, across a range of manufacturers; our sales force does not.

Those in favor of ISRs (mostly marketers) felt there was limited risk because ISR contracts usually had a 60-day termination clause if sales targets were not met. Ashokal and PrintFlex had used ISRs in 2012 for their orthopedic products, but switched to in-house sales a year later. Willis suspected the switch was due to high ISR turnover and training costs, as well as perhaps an unwillingness of ISRs to focus on products whose attributes were more complex than the Ortho500 and whose 60-day sales cycle was longer than that for the simpler and less expensive products that ISRs typically sold. He wondered how FormPrint might resolve those issues, should it use ISRs.

In 2012, FormPrint estimated that an average Ashokal and PrintFlex salesperson generated annual sales of \$800,000 in exoskeletal 3D printer sales. Willis knew that Wittenberg would need to motivate the sales team to sell the Ortho500 if FormPrint were to use the internal sales force; he would also need to lead—and pay for—training and management of ISRs if that path was pursued.

Willis invited Wittenberg to lunch, and they discussed the challenges and opportunity. Willis said:

Your sales force is stretched thin already. Their orthopedic expertise is unparalleled, and their ability to cultivate relationships with leading specialists is invaluable for high-end systems; but these qualities are not critical to the Ortho500. Besides, will our salespeople

have the energy or desire to develop new non-hospital relationships for a lower-priced product? They would be selling the Ortho500 alongside the Ortho1300, 2000, and 700, which are much higher-ticket items. The Ortho500 is not a compelling income motivator for salespeople who earn commissions on dollar-volume sales. Ortho500 sales will also mean more price and financing negotiations, and our people don't have much experience with that. We must establish a non-hospital market presence quickly, and the Ortho500 might not get sufficient attention from our salespeople. We also have a hiring freeze and by using multiple ISR organizations, we can provide better coverage of a fragmented outpatient market. We can always move to a direct sales approach if things don't work out via the IRS channel, and, in the interim, your people won't be distracted.

Wittenberg disagreed with Willis's belief that the sales force would not want to sell the Ortho500:

Spending is uncertain as hospitals anticipate how future regulations will impact revenues and budgets. My team will embrace an incremental revenue stream that will help them meet their quotas and maximize commission compensation; and I can adjust commission percentages by product as appropriate. Their relationships with hospitals are invaluable. In health care, smaller hospitals look to research and teaching hospitals for technology cues, and many doctors in outpatient clinics work at hospitals where my people sell our existing product line. With the Ortho500, we will be the only company in our industry that competes across all product segments of the 3D orthopedic market. We should take advantage of that. Plus, the variable costs of selling the Ortho500 will be far lower than it is for other orthopedic products, because the product is smaller and easier to demonstrate. My reps can allocate less time to on-site demonstrations and follow-up training. The Ortho500 will mean more focus on negotiations, lease arrangements, and reimbursement procedures, but those skills can be taught; loyalty to FormPrint cannot.

The costs of training ISRs, and providing them with sample Ortho500s for demos, will come out of my sales budget, unless you have creative ideas about how to defray or split those costs. I interacted with ISRs in my last job. Their product knowledge was shallow, as each was juggling at least ten products from different manufacturers. They lacked customer follow-up and ongoing service. We had to hire someone to manage them, and that increased our cost. When we started, the average cost of using ISRs was 28% of sales. After we hired the manager, the cost jumped to 37% of sales. And their high turnover, plus purely commission-driven compensation, fosters a very short-term sales culture.

Danny Frank, a leading FormPrint salesperson for orthopedic products, offered his perspective:

A third of orthopedists I know at large hospitals run smaller outpatient clinics that would consider carrying the Ortho500; but these clinics will not take the decision to purchase this product lightly. Given the uncertainty related to declining reimbursement rates, overall clinic spending is down, especially for larger-ticket items. They are more likely to purchase from someone they already know and trust, or someone recommended by colleagues. Also, it will be critical to develop selling skills for the non-hospital market. The Ortho500 offers an opportunity to do just that. Over the long term, having a direct sales force with these skills will benefit FormPrint. The sales team can begin to learn about the buying requirements in this market through this product.

Sophia Thompson, Ortho500's product manager, focused on the new product's 2014 sales goals. She agreed that ISRs had limited product-specific knowledge, but felt the Ortho500 was easy to use and demonstrate. Thompson also thought ISRs could perform on-site demos themselves. She said:

Outpatient offices will value the economics of the business decision more than the long-term relationship with us. They also tend to negotiate long-term leases instead of outright purchases. Many ISRs have 20 years of sales and negotiations experience; they better understand outpatient clinics and how our product can affordably meet their needs. My research shows that the commission-based ISR costs will be roughly 23% of sales, and I believe the ISR approach is best for our sales and profitability.

Was there a way, Willis wondered, to create a blended ISR–direct sales approach that would result in more favorable sales results? Or would the aggregate costs and organizational complications of implementing a hybrid approach outweigh any sales benefits?

If the Ortho500 failed to establish a leading market share in exoskeletal bracing in 2014, FormPrint’s medical products division could face layoffs. With rising competition and increased costs stemming from the 2.3% sales tax, Bruce Abbot had made it clear that he was focused on quickly establishing an installed base for the Ortho500 while maintaining profitability, and he expected that any go-to-market recommendation would be supported by a rigorous analysis of various considerations, including:

- Projected breakeven figures for the ISR versus the direct sales approach.
- Feasibility of success in either approach given current market uncertainty and competitive environment. Do other options exist, and, if so, what are their benefits/problems?
- Was the ISR option viable? What were its benefits, challenges, and risks – internally within the company as well as externally in the market?

Exhibit 1 3D Printing Functions by Health-Care Market Segment^a

Segment	3D Printing Functions	3D Printing Benefits	% of Market
Orthopedic	1. Surgical Prototyping (creating realistic models of bones and joints to aid in surgical preparation) 2. Implants and reconstructive surgery parts (hip, knee etc.) 3. Prostheses 4. Exoskeletal braces and supports	1. Improved diagnostics — Physicians can study and analyze a realistic prototype instead of 2D scans to diagnose problems 2. Improved safety—Surgeons use prototypes of injured joints and bones to plan and practice intricate surgeries, reducing surgical errors 3. Reduced costs—Using prototypes to prepare and practice for surgery shortens actual surgical times 4. Comfort—Improved fit and comfort from prostheses and braces designed specifically for a patient's body	15%
Auditory	1. Hearing aid casings	1. Comfort—Casings are customized to the shape of a patient's ear	27%
Internal Medicine	1. Surgical Prototyping: Creating realistic, pliable models of tissues, organs, and internal systems	1. Improved diagnostics—Physicians can touch, study, and analyze prototypes of internal systems instead of relying on scans to identify and diagnose problems. 2. Improved safety—Surgeons use prototypes of injured joints and bones to plan and practice intricate surgeries, reducing surgical errors 3. Reduced costs—Using prototypes to prepare and practice for surgery shortens actual surgical times	9%
Dental	Custom dental molds and caps	1. Comfort—Molds and caps are molded perfectly to fit the shape of a patient's mouth	35%
Other	Bioprinting, vehicles for improved medicine delivery	1. Enable access to repair tissues and organs once available only through donor programs 2. Reduced error rates from devices that can measure and distribute precise amounts of medicine	14%

^a Casewriter research.

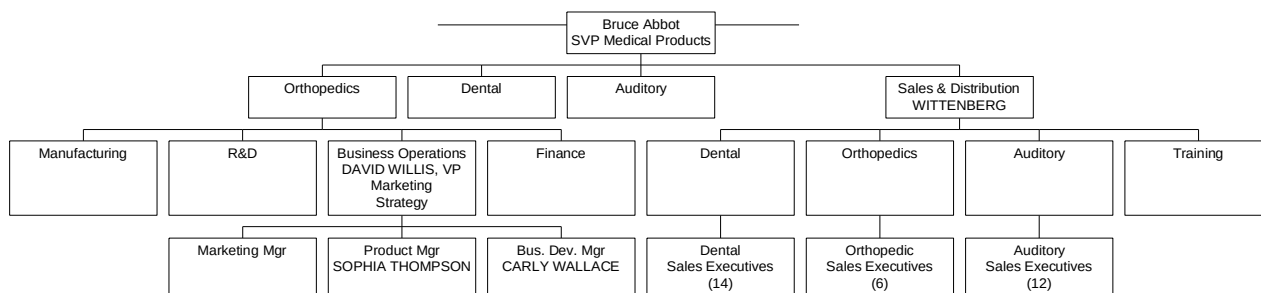
Exhibit 2 3D Printing Health Care: Top 5 Systems Manufacturers – Revenue and Market Share

3D Printing: Health Care Segment: US 2013		2012		2013		
Company	Rank	Revenue	Market Share	Rank	Revenue	Market Share
Ashokal	1	\$25,380,000	24%	1	\$44,062,500	25%
FormPrint	2	\$22,207,500	21%	2	\$38,775,000	22%
Dragonbend	3	\$21,150,000	20%	3	\$29,962,500	17%
PrintFlex Systems	4	\$19,035,000	18%	4	\$35,250,000	20%
Loganstar	5	\$14,805,000	14%	5	\$21,150,000	12%
Other	6	\$ 3,172,500	3%	6	\$ 7,050,000	4%

Exhibit 3 3D Printing Manufacturers: Revenue from Orthopedic Segment – Units Sold, Average Price

Orthopedics	Units Sold	2013 Revenue	Market Share	Average Price
Ashokal	50	\$3,965,625	15%	\$ 80,000
FormPrint	48	\$9,442,752	30%	\$198,700
Dragonbend	30	\$5,287,500	20%	\$175,000
PrintFlex Systems	53	\$3,172,500	12%	\$160,000
Loganstar	28	\$5,551,875	21%	\$201,000
Other	15	\$ 528,750	2%	\$ 35,000

Exhibit 4 FormPrint Organizational Chart



Endnotes

¹ The phrase “3D printer” refers only to the printing device (or machine) used to produce a three-dimensional product, and does not include: (1) the materials required to make the product, (2) the software required to prepare an object for printing, or (3) the 3D-printed, finished product.

² Adding and taking away, *The Economist Online*, December 31, 2013, accessed August 28, 2014

³ 3D Printing to Quadruple to \$12 Billion in 2025. *Journal of Transportation*, May 17, 2014, Factiva.com, accessed August 28, 2014.

⁴ Consumer devices were medical products sold at retail for consumer use: eyeglasses, contacts lenses, and hearing aids.