Future of the Coronary Stent Market: 
Who Will Win and Why?

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May 11, 2005
Executive Summary

Heart disease and heart failure are two of the most prevalent health conditions in the US and approximately 13.2 million Americans have heart disease.¹ To combat coronary artery disease, the medical field has been innovating new surgical techniques and devices. The newest innovation in the coronary artery disease treatment market is drug eluting stents. Currently, there are two main players, Johnson & Johnson and Boston Scientific that are fighting for the dominant position in the drug eluting stents market.

This market is estimated to be worth $5 billion as of 2005.² The paper attempts to answer the following question, “Who will win the coronary stent war?” and “Who is best positioned to capture the value of the next wave of innovation in the stent market?” Applying different frameworks used in the Technology Strategy class, we will cover the brief history of the market place, the main players, the market dynamics (major drivers), and what uniqueness and complementary assets are needed for one (or more) of these players to capture the market going forward. It is our hypothesis that the market will remain an oligopoly between two firms (Johnson & Johnson and Boston Scientific) for now, and any new entrants will be limited to Medtronic and Guidant (who recently merged with Johnson & Johnson) that possess strong complementary assets. Hence, we believe that the market place will continue to support these four companies as major coronary stent players.

Brief History of Stent Technologies

Coronary artery disease is the blockage or narrowing of the coronary arteries, which supply blood to the heart itself. Coronary arteries run over the surface of the heart and provide nutrients for the highly active heart muscle. Excess lipids and cholesterol in a person’s bloodstream can be absorbed by the cells lining the inside of blood vessels and eventually can accumulate to form atherosclerotic lesions.³ The evolution of the surgical and device innovations used to treat coronary artery disease are as follows:

Coronary Artery Bypass Graft (CABG)

In the 1960’s, physicians relied on Coronary Artery Bypass Grafts surgeries to treat coronary artery disease. CABG procedures are open, highly invasive procedures which require long recovery times for the patients. The patient’s veins are harvested (usually from the leg or arm) and transplanted to “bypass” the narrowed areas (or blockages) in the coronary arteries. This allows the blood flow to continue to the heart to maintain support for the cells of the heart. This will hopefully prevent highly debilitating, and often fatal, heart attacks in the future.

Angioplasty

Then in the 1970’s physicians developed a new procedure to treat coronary artery disease called angioplasty. The original technology was developed by Andreas Gruentzig. He used a catheter inserted percutaneously into the patient’s body then inflated a balloon inside the patient’s clogged coronary vessels to open up the blocked area. This soon came to be called PTCA: Percutaneous Transluminal Coronary Angioplasty. PTCA was a key innovation in that it was significantly less invasive for the patients. It was a lot less costly and the patients had a quicker recovery time, however had a high rate of restenosis (re-blockage of the coronary artery), about 40% of the cases within 6 months. Although PTCS was less effective in preventing restenosis than a CABG procedure, PTCA was widely adopted by the medical community throughout the 1980’s because of the huge benefits of it being less invasive.

Bare Metal Stents

In the early 1990’s bare metal stents were developed. This was pioneered by Julio Palmaz, a physician-inventor. The bare metal stent was a huge leap forward in treating the problem of restenosis. Like angioplasty, the stent is inserted percutaneously through the femoral artery and then is expanded in the coronary vessel. Having the stent in place, holding open the artery, decreased the restenosis rate to roughly 20-25% instead of 40%.

Johnson & Johnson (“JNJ”) owned stent technology and acquired Cordis as a way to enter the cardiology market and marketed the first bare-metal stent.\textsuperscript{8} Other competitors soon followed JNJ including Guidant, Boston Scientific, and Medtronic. Guidant soon took the majority market share of bare metal stents as it was easier to use for physicians.\textsuperscript{9} However, the in-stent restenosis was still a serious problem for some patients and this spurred the medical device companies to come up with a solution that was more effective at preventing restenosis.

**Drug Eluting Stents**

In the late 1990’s the first drug eluting stents (DES) were developed as a solution to the problem of restenosis. Drug eluting stents are now replacing conventional stents as the dominant therapy for coronary artery disease.\textsuperscript{10} In 2004, DES was estimated to reach utilization in 87% of all angioplasty procedures, an amazing penetration rate given DES had only been launched one year earlier.\textsuperscript{11} DES has already achieved a 0% restenosis rate in many cases.\textsuperscript{12}

Please see Appendix A for the S – curves that illustrate the evolution of coronary procedures and products.

**Key players in the Drug Eluting Stent market**

The Cordis subsidiary of JNJ has maintained a #1 to #2 position in the cardiology market over time and has a full range of products (balloons, stents, accessories).\textsuperscript{13} Cordis possesses a very large and strong sales force and is often noted in the industry as a fast innovator in the cardiology market and had strong IP position in the DES market.

Boston Scientific (“BSC”) has battled with Cordis to maintain the #1 or #2 position in the cardiology market. BSC was an innovator in balloons and catheters in the 1980s, but its technology had been applied to the periphery of the body. Boston Scientific acquired SciMed in the mid-1990s to enter the coronary cardiology market and now has a full range of products.

\textsuperscript{8} “Merger Mania Strikes Device Industry”, Medical Device and Diagnostic Magazine, January 1996.
\textsuperscript{10} Interview with Jan Wald, Wall Street Transcript, January 12, 2004.
\textsuperscript{11} “Cardiovascular: The New World Order”, SG Cowen, August 2004, page 16.
\textsuperscript{13} Cordis company website.
(balloons, stents, and accessories). In addition, BSC has a large cardiology sales force and has been a fast-follower in the cardiology market (usually not the first to market). BSC has strong IP in the DES market.\textsuperscript{14}

Other two main players in this market are Guidant and Medtronic. Guidant has been #2 or #3 in the cardiology market and has pacemaker and stent divisions. They currently have a moderate range of products but are mostly focused on stents. Guidant has a moderately-sized sales force and did not have strong IP on DES; they were sued by BSC and lost. However, with the recent acquisition by JNJ, the future of Guidant in the DES market is bit unclear. Medtronic has been a second tier player in the cardiology market and is a diversified health care company which acquired AVE to enter the cardiology market. They have a moderate range of products and a moderately sized sales force. Medtronic has also been late in developing a viable DES platform and hence are not expected to enter the DES market until late 2006.\textsuperscript{15}

Overall, Cordis and Boston Scientific were early pioneers of the DES technology. Cordis launched the first DES in 2003 called the CYPHER. Cordis was unable to meet the high demand for drug eluting stents and hence had a large backlog of orders which it could not meet. BSC then launched TAXUS and captured the number one position in the DES market. As stated above, Medtronic and Guidant were blocked from entering this market by IP lawsuits from both JNJ and Boston Scientific.

We see many waves of technology in this space. In the past, there were three main technological disruptions with more possibly to come in the future. The DES market is currently ramping up and is in the “takeoff” stage of the “S” curve; it has not reached maturity yet. The two attributes that are most important in leading the technological changes are the degree of invasiveness for the patient and the rate of restenosis.

\textsuperscript{15} “Cardiovascular: The New World Order”, S.G. Cowen, August 2004, page 73.
Market Dynamics and Market Leadership

Drivers of the Market
Industry evolution in the coronary stent market is largely driven by new inventions and the constant demand from physicians for improved patient outcomes. The physicians constitute a largely homogenous market, so once a “better” device is invented intense rivalry ensues and that device usually captures the majority of the market. In addition, the interventional cardiologists are often known to be early adopters in the field of medicine, and have been adopting new technologies rapidly.

Uniqueness and Complementary Assets
Uniqueness and complementary assets play a large role, if not the largest, in shaping the path of this industry. The companies’ need for complementary assets limits this industry to 3-4 players. Uniqueness also plays an important role in this industry through IP protection.

The two largest complementary assets in the stent industry are the sales force and the manufacturing capabilities and capacity. The top players in this industry have a strong sales force. Every product in the DES market is sold through a sales person in the operating room or the doctor’s office, hence the relationship of a sales person with the physicians are highly important in making the sales. The manufacturing capacity is important as was demonstrated when BSC overtook JNJ in the DES market because JNJ could not keep up with the demand for their product.\(^{16}\)

IP is the main source of uniqueness. This uniqueness is not always easy to maintain; over time companies can copy technology and innovate around the IP, however for the player who is first to market, it provides a tangible competitive advantage in the shorter term.

The two winners in the DES market, JNJ and BSC, have both complementary assets and uniqueness in their favor. Gaining these complementary assets (sales force and manufacturing capabilities) is expensive and there is a limited amount of room for a cardiac sales force. For example, a doctor can only be contacted by a few sales people before the doctor refuses to be detailed by anyone else. One of the key reasons is that the sales forces are often in the

operating room instructing and advising doctors how to use their products. The doctors refuse to see more than one salesperson at a time. In addition, medical device sales are highly relationship-driven and these relationships are not easily replaceable.

The manufacturing capability is also a very important complementary assets in this industry. The lack of manufacturing capacity shifted leadership from JNJ to BSC in the DES market in matter of weeks of BSC’s entrance to the market and have been attributed as their key competitive advantage in the market place.

Having tight IP enabled JNJ and BSC to block Medtronic and Guidant from entering the DES market, at least in the short term. This was a large win for JNJ and BSC and it allowed them to continue to dominate the market and collect large rents. The following table describes the five main players and their current possession of complementary assets and uniqueness.

<table>
<thead>
<tr>
<th></th>
<th>Complementary Asset</th>
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<tbody>
<tr>
<td>Johnson &amp; Johnson</td>
<td>Yes</td>
</tr>
<tr>
<td>Boston Scientific</td>
<td>Yes</td>
</tr>
<tr>
<td>Medtronic</td>
<td>No</td>
</tr>
<tr>
<td>Guidant</td>
<td>Yes</td>
</tr>
<tr>
<td>Abbott</td>
<td>No</td>
</tr>
</tbody>
</table>

**Leadership**

As shown in the graph below, leadership in the coronary stent market shifted many times. The first shift occurred when Guidant stole leadership from JNJ. This was driven by product innovation. The next shift occurred when JNJ introduced DES and regained leadership. This was driven by innovation and IP. The most recent shift happened when BSC stole DES leadership from JNJ. This was driven primarily by capacity problems at JNJ.
Value Creation and Value Capture

Medical device firms have historically created high value for patients and captured that value over a limited period of time (i.e. 3-7 years). The DES market seems to have followed this pattern. By radically lowering the rate of restenosis, DES represented a significant improvement (value creation) over previous stents, which allowed their manufacturers to demand much higher rates of reimbursement from payers. In the past these periods of value capture have lasted until the next generation of stents is released, at which point the old stent loses significant value in the marketplace.

Medical device firms are able to capture this value by using a mix of complementary assets and uniqueness. The complementary assets needed to market a cardiac stent are tightly held and difficult for any newcomer to obtain. Uniqueness is easy to maintain for the first 3-4 years and then becomes more difficult as science advances with greater innovation and the patent protection expires.¹⁷ Hence the industry shifts from a “big win” to a “complementary assets play” over time.

Future of the Stent Market

Who will win the drug eluting stent market? We have to remember that the market is still on its take-off stage, and has much more room to grow. Our team currently predicts that there will be a duopoly between JNJ and BSC for at least near term as it is now. This is based on the prevailing characteristics of the market, the history of the market, and a bit on the Industry Evolution Flight Simulator model (discussed later in this section). There are few major movements in the market that might shift this tightly working model:

- “Drug” part of “drug eluting stent” becoming more valuable
- Entrance of Guidant as JNJ’s subsidiary
- Entrance of other players

Value of the Drug

First, it is still debatable whether the drug on the drug eluting stents are more valuable than the stent itself. If the drug does become the value-added feature, then the actual device can become more of a commodity and the medical device companies will capture very little value. However, if the drug becomes more generic, then the medical device companies will continue to capture the value. Although the jury is still out on this question, it is our team's belief that the drugs will become more generic and that the actual device is where the value will be captured. In this scenario, all the companies have similar advantages. However, if in the future, the drug part of the device becomes significant value creator, then, JNJ will be at an advantage boasting a huge pharmaceutical company in-house.
Guidant as JNJ’s Subsidiary
Guidant is still developing its own drug eluting stents, although it was discouraged from previous generations of devices through IP lawsuits. In addition, as part of a JNJ company, this new partnership will pose a serious threat to BSC in the near future. Guidant has a great reputation amongst the interventional cardiologist and will no doubt capture some market share when entering the market with what will probably be improved drug eluting stents. The main question is, would it cannibalize JNJ’s market share or take BSC’s market share? The team believes that it will do little bit of both, hence, benefiting JNJ and hurting BSC in the long run.

Other Players
The other entrance to the market poses little threat. Medtronic, the other larger player in the market, does not boast much of a sales force, especially compared to the newly merged entity of JNJ and Guidant or BSC. Unless Medtronic’s new product is significantly easier to use and clinically superior, which might be hard to do with the currently optimized products in the market, the threat from Medtronic seems to be small.

In addition, there are other smaller companies such as Abbott that possess the IP to drug eluting stents, but do not possess the appropriate complementary assets. Again, for a company to truly capture value in the market, it needs to possess both complementary assets and uniqueness.

Overview of the SD Model
We used the Industry Evolution Flight Simulator model developed by Henderson and Sterman to model the future of the stent industry based on the current characteristics of the industry. The model looks at the competition between the two industry leaders in the DES market, BSC and JNJ. The variables we used in the model are detailed in Appendix B. The important considerations are as follows:

1) There are no complementary goods.
2) The attractiveness of the product is almost completely dependent on the functionality and is not based on the price at all. Some of the attractiveness is due to marketing and availability of the product.
3) We characterized the competitors as pricing neutral and going after 60% market share aggressively.
4) A lot of the profit of the product is spent on marketing.
5) The two competitors behave the same way in regards to competitor strategy:
   a. Price level: neutral – Neither JNJ or BSC have history of competing on price to gain market share, hence, we believe that the two players will continue to have a neutral pricing strategy.
   b. Target market share: 60% – Although both BSC and JNJ would like to gain 100% market share in an ideal world, both companies do recognize that in the long run, having 60% of the market share will represent a successful story.
   c. Share strategy: aggressive – These two companies, as before, will continue to have an aggressive market share strategy through marketing and pushing their sales personnel to capture greater sales.

Outcomes of SD simulations
After running the model with the above characteristics (detailed in Appendix B), we found the following predictions for the future. These are the results after 10 years.

<table>
<thead>
<tr>
<th></th>
<th>Competitor #1</th>
<th>Competitor #2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market Share (%)</td>
<td>50.9</td>
<td>49.1</td>
</tr>
<tr>
<td>Price ($/Unit)</td>
<td>274.43</td>
<td>327.17</td>
</tr>
<tr>
<td>Unit Direct Costs ($/Unit)</td>
<td>184.4</td>
<td>248.82</td>
</tr>
<tr>
<td>Total Unit Costs ($/Unit)</td>
<td>270.41</td>
<td>356.88</td>
</tr>
<tr>
<td>Revenue ($/Year)</td>
<td>109.79M</td>
<td>118.48M</td>
</tr>
<tr>
<td>Net Income ($/Year)</td>
<td>10.21M</td>
<td>10.39M</td>
</tr>
<tr>
<td>Product Development Expenditure ($/Year)</td>
<td>8.783M</td>
<td>9.478M</td>
</tr>
<tr>
<td>Marketing Expenditure ($/Year)</td>
<td>21.95M</td>
<td>23.69M</td>
</tr>
<tr>
<td>Process Development Expenditure</td>
<td>1.097M</td>
<td>0</td>
</tr>
<tr>
<td>Cumulative Profit ($)</td>
<td>115.63M</td>
<td>96.63M</td>
</tr>
</tbody>
</table>

The price in the model dropped significantly from $3,000 to around $300. This is a much bigger decline than you would usually see in the medical device market. Also, in 10 years a completely disruptive innovation could enter the market and wipe out the use of stents completely. (One such disruption, though it is still related to the stent, is bioabsorbable stents). The cumulative profits are also much lower than what is currently found in the medical device industry. The team believes the overall cumulative profit number will be much higher than the model predicts and the price of the unit will stay high for the next 2-3 years before it drops drastically. However, even with these limitations, the model is predicting a split of the market, rather than the scenario with one big winner. This is due to both competitors behaving aggressively and pursuing
market share but not competing on price. This is consistent with what is seen in the marketplace.

**Future of Coronary Artery Disease Treatment**

**Potential Changes in Important Attributes**
In the future, the attributes that are currently important in this market, the rate of restenosis and the level of invasiveness, could be replaced by other attributes. Currently, the percentage of restenosis has already been maximized with DES. It is conceivable that the future surgeries could be even less invasive but there is not a lot of room for improvement in this area. The next generation of treatment for coronary artery disease will potentially compete along different product characteristics. For example, the ease of placement and invasiveness to the blood vessel itself.

**Potential Disruption to Current Stent Market**
Bioabsorbable stents are currently being developed by small start-up companies. These are stents that could dissolve in the body after placement. These stents would be competing on the attribute axis of invasiveness to the artery. Bioabsorbable stents would be less invasive because they disappear after time and the foreign substance will not remain the body.

Again, we believe that the current main players, JNJ (including Guidant), BSC, and Medtronics are best positioned to win this future battle. Although the innovation might come from some smaller start-up companies, we believe these companies will be quickly acquired by the larger players. This way, the bigger companies can gain uniqueness through acquisition, and continued to offer complementary assets that they already possess. The key in this new market is who will be the first one to market, because that will give a sufficient lead to the first player. However, as we have seen in the drug eluting stents market, the second comer also wins big if they can convince the doctors of the superiority of their product and if they have better supply management.

In particular, we believe JNJ is well positioned to capture this market because they currently possess the stent technology capability as well as bioabsorbable material capability through their other medical device operating companies. In addition, with Guidant being brought in-house, they will have almost doubled the R&D efforts for the next generation of stents.
However, as seen before, BSC is great at being a second comer and capturing a huge value in the market. Again, this market will also be similar to that of the current drug eluting stent market, where duopoly will exist with a leader and maybe a second comer, but probably will not support many more players.

**Conclusion**

In conclusion, the stent market has historically been a lucrative market with 3-4 main players battling for the profits. The market has evolved with technological change and the outcomes currently for patients with coronary artery disease are much better than they were 30 years ago. The market that is taking off right now is the DES market and while our team predicts a splitting of the market between JNJ/Guidant and BSC, this future is far from certain. Another big questions remains as to what the next technological innovation that will disrupt the market will be and who is best positioned to capture this market.

As stated in the main body of the paper, the next innovation could possibly be bioabsorbable stents, which JNJ is positioned well to capitalize on. While it is uncertain what the future of the stent industry will look like, it is certain that there will be a lot of competition as the companies battle for the next big technological breakthrough and try to lead this medical device market. Overall, through these technological advances, we will fight the disease better and there will be better patient outcome. The drug eluting stents market is one to watch carefully in the years to come.
Appendix A
S-curves for the Coronary Stent Industry:

- Decreasing Invasiveness of Surgical Procedure
- Decreasing Incidence of Restenosis

Effort / Time

Drug Eluting Stents
Bare Metal Stents
PTCA
CABG
## Appendix B

### Key Inputs to model for drug-eluting stents:

#### Industry Settings & Market Demand
- Initial size of relevant population **2.1M**
- Population growth rate **8%**
- Initial industry maturity **intermediate**
- Strength of word of mouth **high**
- Impact of marketing on adoption **high**
- Sensitivity of industry demand to price **low**
- Product durability **10 years**

#### Customer Preferences [MDs]
- **Sensitivity of product attractiveness to:**
  - Product functionality **1.0**
  - Marketing **0.5**
  - Availability comp.goods **0.0**
  - Compatibility with others **0.0**
  - Product availability **0.75**
  - Price **0**

#### Technology
- Initial price: ($/unit) **$3,000**
- Unit direct costs, fraction of initial price **10%**
- Fraction of direct costs that are variable **50%**

#### Product
- Max level product functionality **200**
- Productivity of innovative effort **medium**
- Functionality spillovers? **yes**
- Spillover time **2 years**

#### Process
- Lifetime of capital plant **20 years**
- Learning curve strength **medium**
- Experience spillovers **no**
- Spillover time **1 year**

#### Complementary goods
- **[No need for complementary goods]**

#### Competitor Strategy
- Competitor price level relative to your’s **neutral**
- Competitor target market share **60 %**
- Competitor share strategy **aggressive**
- Does competitor embrace your standard? **yes**

#### % costs
- Product development **8%**
- Process development **1%**
- Marketing **20%**
- Complementors **N/A**

#### Time Horizon 10 years