

*Michael Stephan<sup>1</sup>, Klaus Jennewein<sup>2</sup>, Eric Pfaffmann<sup>3</sup>*

**Case Study JPS Medica Corporation:  
Global Product Development and  
Market Launch in the Orthopaedics  
Implant Business**

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- <sup>1</sup> Dipl. oec. Michael Stephan, Center for International Management and Innovation. Contact: Department of International Management (510K), University of Hohenheim, D-70593 Stuttgart, Tel: ++49 711 459 3761, Fax: ++49 711 459 3446, Email: [stephanm@uni-hohenheim.de](mailto:stephanm@uni-hohenheim.de)
  - <sup>2</sup> M. A. Klaus Jennewein, Center for International Management and Innovation. Contact: Department of International Management (510K), University of Hohenheim, D-70593 Stuttgart, Tel: ++49-711 459 3761, Fax: ++49 711 459 3446, Email: [jennewein@uni-hohenheim.de](mailto:jennewein@uni-hohenheim.de).
  - <sup>3</sup> Dr. Eric Pfaffmann, DB Cargo AG, Projekt Prozess Redesign Produktion (PRP), Contact: ++49 6131 15601 99, Fax: ++49 06131 1561064, Email: [Eric.Pfaffmann@bahn.de](mailto:Eric.Pfaffmann@bahn.de).

It was November 1998 11 p.m. Wes Montgomery and his colleague, Mircea Heart, were still working on the proposal for a global product development project at the JPS Medica Corporation (JPS) headquarters in Warsaw, Indiana (U.S.). The following day they had to present the detailed proposal to the management board. Two weeks ago, the board of directors had assigned Wes and Mircea to work out a plan for the development of the new global product line - spinal implants. Mircea had been head of the Marketing and Product Development department at JPS for a number of years already. Wes Montgomery joined JPS in 1985 and progressed quickly through research and development holding positions. Wes was elected as Vice President Research and Orthobiologics of JPS only in April that year. As Vice President Research he also held the appointment of the Chief Technology Officer and was responsible for coordinating the activities at the research facilities in Warsaw and Tuttlingen (Germany). He and Mircea had managed the complete research and development activities of JPS, or at least the activities in the U.S. The German subsidiary in Tuttlingen was working quite autonomously of the U.S. operations. Since the acquisition of the German subsidiary in the beginning of the 1990s, hardly any coordinated R&D effort had been carried out.

## ***1. History of JPS***

Many changes had taken place at JPS since Montgomery's arrival in 1985. In the middle of the 1980s, JPS was still a medium-sized company in the orthopaedic implant business. The main product lines at that time included hip and knee implants. JPS had a long history. The first roots of the company date back to the end of the last century. JPS was founded by Gunter Maschke in 1895 in Warsaw (Indiana). Maschke started his business („Maschke Splint Manufacturing Company“) with the manufacturing of wood fibre splints to take the place of the wooden splints which at this time were almost entirely employed for the fixation of bone fractures. Later on the company diversified into other sectors of the orthopaedic market and started to manufacture bone drills, screws, plates, nails, and soft goods. After Maschke's death in 1938, the company remained in family ownership. During World War II, business received a modest boost with the increase in demand of military hospitals. However, in the subsequent decades, growth of the Maschke Splint Manufacturing Company was hampered by family owners who were not willing to invest in manufacturing ca-

capacity, R&D, and marketing efforts.

In 1965, the community of heirs sold the company for a price estimated on some \$3 to \$6 million to a group of investors from New York City. The same year, the company changed its name from Maschke Splint Manufacturing to JPS Medica Corporation (JPS). With the new owners substantial financing was available. JPS placed additional emphasis on growth by new product development and acquisitions. In 1967, the company acquired the exclusive marketing rights of the Mueller Total Hip. The Mueller Total Hip was developed by Prof. Mueller at the University of Bern and was one of the first total hip prostheses used in orthopaedic surgery. Due to the acquisition of the marketing rights, the company's image had changed from that of a soft good and external fixation device manufacturer to that of an orthopaedic implant manufacturer.

In 1974, the German group Boehringer-Mannheim purchased JPS from the group of investors. During the following decade, the company had expanded its product line and diversified into other business lines like total knee-systems and shoulder systems. Nevertheless, geographically JPS still focused on domestic business in North America. The situation changed in 1990 when Boehringer Mannheim purchased the German company Beta Medizintechnik GmbH, located in Tuttlingen. Beta Medizintechnik had been a major competitor in the hip implant business in Europe. The company's hometown, Tuttlingen, was similar in size to Warsaw and hosts a number of companies of the medical devices industry. Besides two major orthopaedic products manufacturers several material suppliers, processing companies and tool makers had their headquarters in Tuttlingen. Beta Medizintechnik had a long history in the orthopaedics business. The company started in 1947 to manufacture a variety of orthopaedic instruments. In 1955, Beta Medizintechnik was approached by the surgeon Sir John Charnley who required an instrument to assist in the fixation and treatment of femoral neck fractures. Together with Beta Medizintechnik Charnley developed and established the gold standard of total hip replacement, known simply as the Charnley hip. In 1962, Beta Medizintechnik introduced the first routine artificial hip replacement to the market.

## ***2. International Organisation of JPS***

Following the acquisition by Boehringer-Mannheim, Beta Medizintechnik was integrated into the JPS business and subsequently renamed into JPS Medica International Ltd. With the acquisition of the German subsidiary, JPS expanded its geographical focus on Europe and other international markets outside North and Latin America. Subsequent minor acquisitions in Europe and Asia followed. Prior to the acquisition of Beta Medizintechnik, JPS' international sales accounted for only 5 percent of total sales compared with almost 50 percent in the beginning of 1998. By spring 1998, JPS operated major manufacturing bases in Tuttlingen (GER), Warsaw (U.S.), and in New Brunswick (U.S.). Major R&D labs were located at the headquarters in Warsaw and at the European headquarters in Tuttlingen (the former Beta Medizintechnik labs). Apart from manufacturing and R&D facilities, the company had 12 international subsidiaries (among others in Germany, France and Japan) that provided customer service to local surgeons and hospitals. However, the general management in Warsaw still had a strong U.S. focus. JPS fitted the stereotype of a multinational company. However, this situation came to a sudden halt in spring 1998 when the health care giant Johnson & Johnson Inc. acquired JPS for the amount of \$3.5 billion. With the change in ownership, the former vice president Research and Chief Technology Officer resigned and Wes Montgomery became his successor.

## ***3. Product Lines of JPS***

The acquisition of Beta Medizintechnik GmbH in 1990, had not only enlarged the geographical portfolio, but also broadened the technological horizon of JPS. Since the formation of the company in the late 19<sup>th</sup> century, JPS had always been at the leading edge in the orthopaedic business. Orthopedic products traditionally comprised product applications related to the skeletal system. Until the 1920s and early 1930s, orthopaedic business mainly comprised the manufacturing of external splints made of wood fiber and wire. Developments in the orthopaedic field received a boost during World War II with the rapid scientific technical advances in orthopaedic surgery and the quantities of fracture equipment required by military hospitals all over the world. The development was closely linked to advances in surgery and surgery equipment, like bone drills and saws. In the 1950s and 60s, orthopaedics advanced

from simple splints to internal fixation devices and replacement parts for the human skeleton. As Mircea Heart explained:

*„Today, one can differentiate between two segments of orthopaedic products: First, re-constructive implants (prostheses), and second, trauma or bone healing devices. Since the late 60s, we have been active in both fields. In 1998, trauma devices represented about 30 percent of our revenues. Orthopaedic trauma has for subject the management of bone fractures. Trauma devices are designed to achieve bone healing, or „union“, as well as the restoration of alignment and full range of motion in patients. Traditionally, JPS offered fixation devices made of metal like plates, splints, and nails. In the 1990s, our subsidiary in Germany also developed re-absorbable polymers which substitute for traditional metals, making obsolete the subsequent operative treatment to remove devices.“*

In 1998, JPS generated the overwhelming part of its revenues, almost 70 percent, in the orthopaedic implant and prostheses business. Traditionally, JPS supplied various kinds of devices replacing limbs and joints. Hip joints represented the largest segment in the implant business. Although hip joints were the most commonly talked about, the company also produced prostheses for knees, shoulders, elbows, and fingers. The aim of implants and prostheses was usually to substitute and/or surpass physical properties of natural bone, with the exception of stiffness. If the degree of deviation in stiffness and strength of prostheses and implants compared with natural bone was too big, then stress concentrations might occur at the interfaces between the implant material and the host bone or elsewhere in the skeleton.

Market success of JPS in the implant business was mainly based on its superior competencies in the use of advanced materials. Originally, non-corrosive metals (titanium alloys) had proved to be the prevailing material in the implant and prostheses segment, though, in the 1970s and 1980s polymers (ultrahigh-molecular weight polyethylene) became more common in a growing number of applications. In the 1990s, titanium alloys were partly replaced by improved cobalt and vanadium steels, and by advanced ceramics (aluminum oxide and zirconia oxide ceramics), which proved to be stronger and lighter.

#### **4. Diversification into the Spinal Implant Business**

By leveraging on its technological competencies in biomaterials, JPS started to explore new business opportunities in the orthopaedic implant business. One such opportunity represented the field of spinal implants. Spinal implants were used in surgery to support the fusion of damaged or malformed vertebrae. As Wes noted:

*„In spring 1992, JPS had been approached by academic researchers from the Orthopaedic Biomechanics Lab at the University of Southern California School of Medicine. The guys from the academic lab were looking for an industry partner ready to sponsor laboratory research and testing in the field of vertebrae implants. It was not the first time that we collaborated with the University of Southern California. From time to time, we even recruit R&D staff from the School and a number of previous research collaborations ended with beneficial results for both partners. We therefore decided to go for it and sponsor the research over five years.“*

In 1997, the yielded laboratory results at the Orthopaedic Biomechanics Laboratory looked very promising. The main research issue had been the overall design of a spinal implant. The prototypes developed by the Orthopaedic Biomechanics Laboratory were hollow, threaded cylinders that were implanted between two or more vertebrae. The implants were packed with bone graft to facilitate the growth of the vertebral bones through the holes in the cylinder. Fusion was achieved when adjoining vertebrae grew together through and around the implants, resulting in stabilization. Figure 1 visualizes the first prototype. It became clear that the threaded cylinders would provide for controlled insertion of the implants. Further, the threads minimized the migration of the implant and enhanced three-dimensional stability of the spinal segment. The lab had also tested various materials with regard to biocompatibility and investigated various kinds of porous coatings. Titanium alloys proved to be the superior material for the device. The strength of the alloy and the cylindrical design enabled the device to withstand the significant compressive forces which would occur in the spine.

**Figure 1: First Prototype of the Spinal Implant**



Was outlined to the casewriters:

*„As preliminary design and laboratory testing had been completed by the Orthopaedic Biomechanics Laboratory, it became apparent to our researchers that the next steps towards the development of a marketable spinal implant had to be carried out in-house. We had to decide whether to engage in in-house development or to completely abandon the activities.“*

The post research product development process in the orthopaedic implants business usually followed a homogeneous pattern. The first step in the product development process usually involved further testing which resulted in concept development

and initial prototyping for clinical use. A critical issue in testing was biocompatibility of the implant materials. Biocompatibility referred to the long-term acceptance of the products by surrounding tissue. As products stay a long period, ten years and more, in the human body, it was difficult to assess the biocompatibility of the materials. Minor biochemical effects and tissue reaction could lead to a cumulative deterioration over such long time-scales. Therefore, testing for biocompatibility was necessary wherever a new material or design concept was to be used in implants. Subsequent stages in the development process involved clinical testing and management of regulatory affairs. Table 1 sums up the major stages in the product development process of orthopaedic products.

**Table 1: Stages of the Product Development Process**

Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
<ul style="list-style-type: none"> <li>▶ Final Laboratory Testing</li> <li>▶ Concept development</li> <li>▶ Initial Prototyping</li> <li>▶ Business Plan</li> </ul>	<ul style="list-style-type: none"> <li>▶ Preliminary Testing on Patients</li> <li>▶ Redesign Prototype</li> <li>▶ File Patent</li> <li>▶ Planning of Regulatory Affairs</li> </ul>	<ul style="list-style-type: none"> <li>▶ Finance&amp;Investment Plans</li> <li>▶ Finalize Design</li> <li>▶ Clinical Trials</li> <li>▶ Prepare&amp;Submit Application (Begin of the Regulatory Cycle)</li> </ul>	<ul style="list-style-type: none"> <li>▶ Manufacturing Scale-up</li> <li>▶ Regulatory Clearance (PMA &amp; 510(k))</li> <li>▶ Plant Inspection</li> </ul>	<ul style="list-style-type: none"> <li>▶ Submit Application to Foreign Regulatory Bodies</li> <li>▶ Foreign Clearance</li> <li>▶ Begin Foreign Sales</li> </ul>

As Mircea could remember:

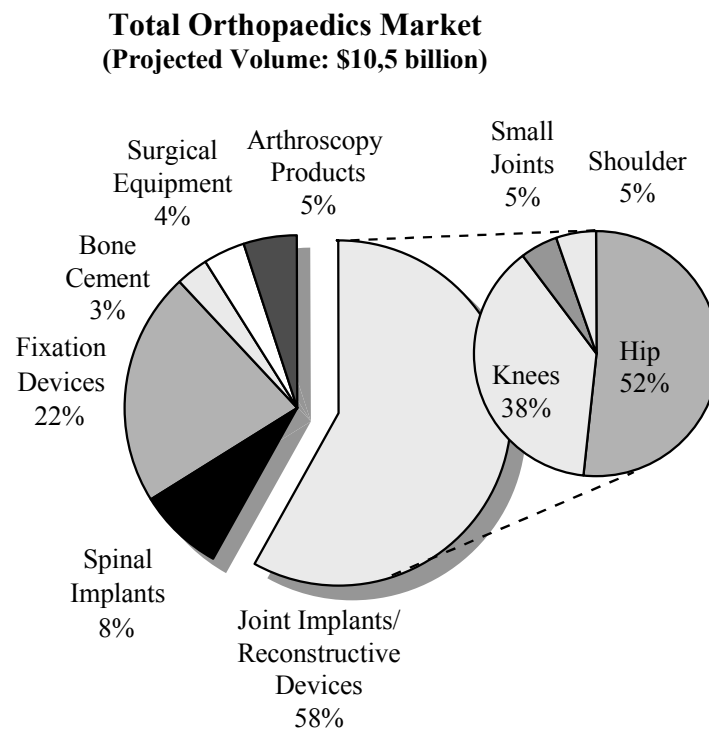
*„It was around the same time, in fall 1997, it became clear that a major European competitor of JPS, the Sulzer Corporation from Switzerland, intended to invest heavily in R&D activities in the field of spinal implants. In fact, one year later, Sulzer acquired Spine-Tech Inc., a Minneapolis-based implant manufacturer that was heavily engaged in the development of a spinal implant. That provided much pressure for us to take action. As an initial step towards the final decision on the development of the new product line, we decided to analyze the market potential of spinal implants. So we did in late 1997, where our marketing division carried out a thorough analysis of the orthopaedic market and in particular of spinal implants.“*

## **5. The Orthopaedic Market**

In the 1970s and 1980s, the orthopaedic market experienced rapid growth. These high growth rates could mainly be attributed to two factors: The aging population being more prone to degenerative bone diseases (arthrosis) and the growing number of sports and road accidents by young to middle-aged candidates. The situation changed one decade later. In the 1990s, the traditional segments of the orthopaedic

marketplace registered a slack in demand. Increased cost containment in the health care sector of the Triad countries led to a serious decline in business growth rates in most of the segments. However, some niches with newly developed technology offered good promises for future growth despite an overall modest business climate. It was expected that spinal implants would become one of the fastest-growing sub-segments. Based on hospital and surgeon surveys, the marketing department predicted an estimated market volume of \$1.1 billion for the year 2005. Figure 2 visualizes the projected sales composition in the orthopaedic products market in the Triad countries in the year 2005. It was estimated that Europe would account for approximately 38 percent of the sales and the U.S. for almost 35 to 36 percent.

**Figure 2: The International Marketplace for Orthopaedic Products in 2005**



As Wes clarified:

*„It became apparent that spinal implants would offer us promising potentials for our future business. However, before our board of directors was able to take the decision to enter the spinal implant business, it became clear that Johnson & Johnson Inc. intended to buy our company! As a consequence, all strategic decisions were suspended until things were sorted out, and in fact, the takeover was completed.“*

## **6. Diversification into Spinal Implants and Adoption of a Global Strategy**

The change in ownership led to a significant change in the management of JPS. Almost half of the board members resigned. Most of the vacant positions were occupied with Johnson & Johnson staff and a few with younger JPS staff members - Wes Montgomery being one of them. The change in ownership also brought about a change in a couple of business policies at JPS. Itself being a truly global company, Johnson & Johnson introduced an integrated global business strategy to JPS. Although international sales played a crucial role in JPS' business the strategic focus of the company was still multinational at the time of the change in ownership. The international business was carried out separately from the domestic operations. The German subsidiary in Tuttlingen developed products for the European market. The U.S. operations in Warsaw and New Brunswick served the American marketplace.

For a couple of months, the new board of directors was almost exclusively engaged in restructuring and post-merger integration activities. The personal fluctuation in the board and new Johnson & Johnson directives led to a certain neglect of business issues. The decision on the engagement in the spinal implant business had been postponed for almost half a year. In October 1998, the new board of directors put the topic on the agenda again. On the second October board meeting the issue was discussed. The parent company Johnson & Johnson announced its support of the diversification move but at the same time demanded a more global approach. As Mircea remembered:

*„Johnson & Johnson wanted to use the spinal implant market entry to become a precedent for a global product strategy. At the board meeting in October, Wes and I were assigned to work out a global product development plan.“*

## **7. Global Product Development**

Wes added:

*„It soon became clear that the global product development plan should address two key issues: Mircea and I had to specify the agenda for further work on the product prototypes, that is what to do, and to decide where the work should be carried out. The latter meant to decide Where to do it. As head of a interdisciplinary team of scientific advisors from the labs in Warsaw and Tuttlingen, I worked out the redesign and testing tasks in stages one and two of the development process. Future work on the implant prototypes required minimal improvements of the implant design, as well as further testing of the biocompatibility of the coatings and the development of a proprietary instrumentation. Design improvements encompassed the insertion of*

*holes in the cylinder walls of the implant. The holes were designed to carve bone from the vertebrae into the cylinder during insertion, supporting the bone graft the surgeon typically obtains from the patient's hip. To supplement the changes in design, further biocompatibility testing of the porous coatings was required. The porous design allowed for substantial bone growth through the holes of the implant to facilitate fusion.*

*Mircea assisted:*

*„A very important issue was the development of a proprietary instrumentation. Surgical instruments were customized to the size of the implants to assist in safe insertion. Spinal implantation instruments should be used for posterior, which means from the back, for anterior, that is from the front. In the future, it may also be possible to use spinal implantation implements for the anterior laparoscopic implantation of the implant device. By offering several surgical approaches, we wanted to provide surgeons with the flexibility to choose whichever approach would be appropriate.“*

*Wes concluded:*

*„We knew that the decision on where to develop and how to organize the development process would depend on several major determinants, such as, first, our competencies of the development facilities in Warsaw and Tuttlingen, second, existing relationships of our development facilities to local research labs active in the field, and last not least, the regulatory environment in Europe and the U.S.. But however, we were not quite sure if we already considered all relevant aspects.“*

## **8. Development Competencies of the R&D Sites**

JPS had two historically grown R&D labs, one located at the company's headquarters in Warsaw (U.S.) and the other, resulting from the acquisition of Beta Medizintechnik, in Tuttlingen (Ger.). The U.S. lab was equipped with some 45 researchers, whereas the EU lab only had a research staff of approximately 20 scientists. Although the two labs had been active in the same fields, prosthesis and trauma devices, they were working completely autonomously and no joint research project had been carried out in the past. The research lab in Warsaw had concentrated on the development of orthopedic products for the Americas region. The lab in Germany focused on the European region.

Due to the significant differences prevailing in the product liability in the EU and the U.S., the two labs were building up different competencies in the field of materials. The U.S. product liability was much stricter than the European legislation. In the U.S. two forms of tort liability existed: Liability for negligence (fault liability) and strict liability (or no-fault liability). In the case of medical device failure, a U.S. orthopedic manufacturer might be held responsible only on the account that a product had caused harm, no matter how thoroughly it had been tested and assessed according to Food and Drug Administration (FDA) standards. Thus, the Warsaw lab was fol-

lowing a more conservative policy with respect to the use of new material classes in orthopedic products than the Tuttlingen lab. The U.S. based lab concentrated its development activities on more classical materials in the orthopedic industry principally titanium and steel. Moreover, the lab's materials competencies in the field of metal treatment were complemented by small metal casters and tool makers in the Warsaw area. The laboratory had also good and long-standing relationships with local hospitals and universities. As Wes made clear:

*„In the EU a trend from metal to new lighter and more wear and tear resistant materials was prevalent. In this respect polymers and ceramics appeared as the most promising materials classes due to their physical and biocompatible properties. Since June 1992, when we brought the first polymer-ceramic hip-joint implant on the market, the Tuttlingen lab was almost completely concentrating on these two materials classes. Metals such as steel and titanium were only of secondary interest. An important research partner represented the University of Tuebingen. Joint research projects mainly focused on the improvement of the stiffness of polymer implants and increased biocompatibility.“*

## **9. Medical Device Regulation - The Rationale Behind**

The management of regulatory approval procedures was an integral part of the product development process in the orthopaedic implant business. Medical device regulation aimed to promote public health by balancing the need to keep unsafe or ineffective products off the market with the need to assure patients timely access to medical products. In order to avoid or compensate the harmful effects of unsafe medical products, legislators in Europe and the U.S. had established approval standards and imposed control procedures to assess and avoid the risks inherent to new products. Risk assessment and avoidance addresses numerous factors that might result in device failure, such as product design principles, manufacturing quality assurance, reliability assessment, and product failures related to biological responses, material degradation, and user actions. Regulatory clearance, a recognised seal of approval, served as a step towards market acceptance. Those products that gained approval might face reduced competition since regulation acts as a hurdle to entry.

## **10. Medical Device Regulation in the United States and Europe**

In the United States and Europe, the medical devices industry was subject to extensive regulation by a number of national, state and local agencies. Of particular importance was the Food and Drug Administration (FDA) in the U.S.. The FDA was the

principal consumer protection agency of the Federal government. The enabling laws provided FDA the authority and jurisdiction over all businesses. Among the laws that affected the medical device industry, the Medical Device Amendment of 1976 (MDA) had the most direct influence. The provisions of the MDA had been modified and further intensified by the Safe Medical Devices Act of 1990. This legislation defined how medical products should be brought to market and authorised the FDA to categorise all medical devices into three classes based on risk, with regulatory rigor increasing from Class I to Class III. Table 2 lists the risk categories in more detail.

**Table 2: FDA Risk Categories of Medical Devices**

Type	Description	Examples	Premarket Clearance Requirements
<b>Class I</b>	Low risk devices	Tongue depressors, gauze	510 (k) unless exempt
<b>Class II</b>	Moderate risk devices	Physiological monitors, PTA, some vascular grafts, embolectomy catheters, angiography catheters	510 (k) and performance standards, if set
<b>Class III</b>	<ul style="list-style-type: none"> <li>▶ Most significant risk devices: life supporting or sustaining products, implantables</li> <li>▶ All products with major/ significant changes from pre-amendment devices</li> </ul>	Heart valves, PTCA catheters, hip joints, cancer diagnostics	<ul style="list-style-type: none"> <li>▶ PMA</li> <li>▶ 510 (k) for devices substantially equivalent to pre-1976 products until FDA requires a PMA submission</li> </ul>

In the European Union the patchwork of regulatory schemes of the 15 member countries was replaced by a single uniform regulatory system. The EU directive 93/42/EEC of 14 June 1993 on medical devices and the EU directive 90/385/EEC of 20 July 1990 on implantable medical equipment served as a basis for national regulations on medical devices in the individual member countries. The objective of both directives was to harmonise the conditions for placing medical devices on the market and putting into service, in order to create an equal basis for the protection of the health and safety of patients throughout the EU.

In contrast to the USA, in the EU a single responsible authority, such as the FDA in the U.S., did not exist. The different national authorities, e.g. in Germany the Federal Institute for Drugs and Medical Devices (BfArM), were responsible for the evaluation

and risk assessment of medical devices. Under the guidelines of these national authorities, safety and clinical performance evaluations are carried out. Moreover, the national authorities were also responsible for the authorisation of the finished medical devices.

In the EU medical devices were divided into four different risk classes (I, IIa, IIb, and III). Risk category I comprised products with a very low risk potential, like a sweater or operating clothes, whereas risk category III comprised products with a significant higher risk potential, like artificial organs and cardiovascular devices. Orthopaedic implants were usually ranged in the categories IIa, b and III. With increasing risk category, certification requirements to the biomaterials products were ascending. Manufacturers of all medical devices, irrespective of their risk classification, were obliged to introduce and maintain a quality management system according to DIN EN ISO 9000 and DIN EN 46000. Furthermore, the manufacturer had to take part in the European auditing and reporting system on medical devices. A certification procedure via a notified body was required for devices of classes IIa, b and III.

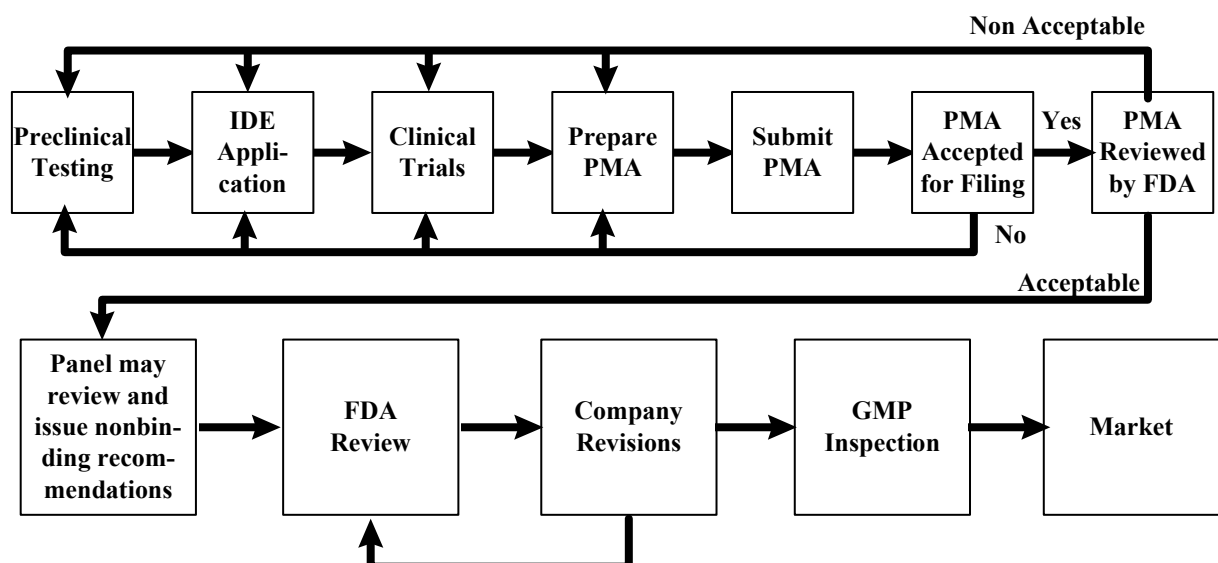
In the U.S. as well as the EU applied, for all medical devices, irrespective of their risk classification, measures of general control like good manufacturing practice standards and safety performance rules. Furthermore, two types of premarket clearance procedures for new medical devices were defined: (a) the Premarket Approval (PMA), a detailed review was required for all class III products and for class I, II, IIa, and b respectively that featured substantially new materials and design principles or were aimed at new fields of application and; (b) the 510(k), a more routine notification was demanded for products sufficiently similar to other legally marketed class I or class II devices. Once PMA or section 510(k) pre-market notification was received, the product could be marketed.

#### *PMA (Premarket Approval)*

The PMA process involved a rigorous premarket review. To gain approval, devices often had to undergo clinical trials in humans as well as a wide range of physical, scientific, biological, and engineering tests. Before human testing could begin on a device, an institutional review board (panel of experts) had to grant approval. In addition, devices that present significant risks to patients, required an Investigational Device Exemption (IDE) from the legal authorities. Companies had to describe the

design of the trial, types of patient, expected results, and anticipated risks and precautions. Once granted, an IDE would allow the device to be used in patients for clinical trials only. The PMA process could take many years to complete. Once a PMA had been approved, the holder had to submit a PMA supplement for any design, labelling, indication, or manufacturing change that affected the safety or efficacy of the device. Figure 3 illustrates the PMA process.

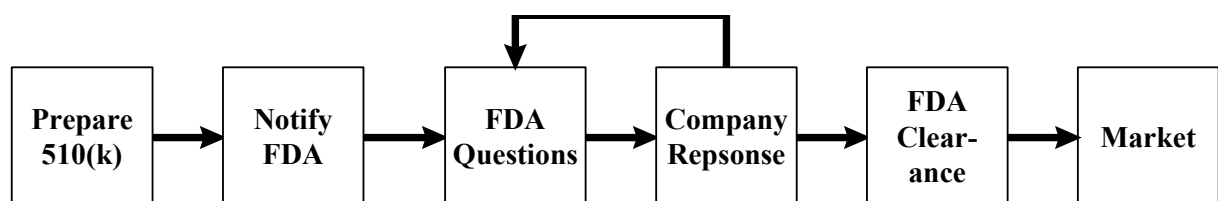
**Figure 3: The PMA (Premarket Approval) Process**



#### *The 510(k) Premarket Notification*

The 510(k) process was a more routine-like procedure and usually much shorter than the PMA process. A company undergoing the 510(k) process had to demonstrate that its product was substantially equivalent to a legally marketed device - that was, the device had the same intended use and technological characteristics as the legally marketed device. Once the legal authorities had granted clearance, the company might sell the product. Figure 5 illustrates the 510(k) process.

**Figure 5: The 510(k) Process**



## **11. Increased Complexity of Regulation**

Over the past 20 years, medical device regulation in Europe and the U.S. had expanded to a level of tremendous complexity. Although legislation in the EU and the U.S. broadly laid out device approval requirements, the regulatory bodies still had considerable discretion to determine specifics.

Mircea noted:

„While the law ostensibly specifies what the manufacturer of a new product must show, its inevitable general language does not significantly constrain the regulatory bodies' appetite for elegant and costly information. As complexity in both countries has grown, the uncertainty surrounding the regulatory process increased also. To give you an example, in a number of cases it was not clear whether the devices required a 510k or a PMA. Furthermore, product review requirements were quite sketchy and the exact length of the review process was unknown.“

Wes further explained:

„The complexity and, closely related, the predictability of regulation had a considerable impact on our decision to invest and innovate. An unpredictable regulatory environment precluded rational assessments of decisions to invest or not to invest. Companies attempting to predict requirements were shooting at a moving target and they inevitably overestimated or underestimated actual requirements. As regulatory burdens increased, fewer investment opportunities appeared attractive to us.“

Mircea remarked:

„With the adoption of a global product development strategy, the predictability and complexity of national regulation became critical determinants for us where to invest and to innovate, and where not. Many companies might be discouraged by extensive product review times and complex, unpredictable requirements. They might therefore decide to develop and manufacture products in other locations with less daunting regulatory requirements or to abandon development of some products entirely. For our final decision where to develop the spinal implant, Wes and I had therefore to take into account the regulatory conditions in each location.“

## **12. Differences between the European and the U.S. regulatory systems**

In the EU as well as in the United States, the 510(k) process had become significantly more complex. No longer willing to base „substantial equivalence“ decisions on design, materials and technical performance alone, the legal authorities in Europe and the FDA insisted that manufacturers provide evidence from clinical experience. In 1984, the U.S. 510(k)s averaged 24 pages, in 1998, they averaged 82 pages. A similar development took place in the EU. The PMA complexity increased even further in both countries. This instance was caused by the fact that for truly new devices, the PMA process was often hampered by lack of familiarity of the regulatory

bodies with the new technology embodied in the device. Regulatory bodies frequently failed to delineate requirements until after clinical results were already available. As a consequence, companies frequently had to restart clinical trials due the sequential scientific process. This led to extraordinary long review cycle rate.

In recent years, European regulatory authorities reacted to increased complexity with an effort to restructure and to provide for a more efficient review process. One of the major changes in the EU system was to permit third party involvement in the review and approval process. For that reason, authorities in the European Union countries were able to minimise increases in review times. Consequently, in 1998 review times in Europe were considerably shorter than in the U.S. In the U.S., FDA review times for medical devices had increased dramatically. By 1998, the average time to 510(k) clearance increased to 216 days. PMA review times were substantially longer and amounted to 823 days on average. Table 3 and 4 provide a comparative overview of the average review times in the EU and U.S.

**Table 3: Average Review Times in the U.S.**

	1993	1994	1995	1996	1997	1998
<b>PMA process</b>	348 days	415 days	633 days	310 days	799 days	823 days
<b>510 (k) process</b>	82 days	98 days	102 days	126 days	195 days	216 days

**Table 4: Average Review Times in the EU**

	1993	1994	1995	1996	1997	1998
<b>PMA process</b>	N.A.	245 days	259 days	260 days	301 days	250 days
<b>510 (k) process</b>	82 days	101 days	98 days	95 days	102 days	100 days

### ***13. Export Requirements and Non-tariff Reductions***

Devices that were legally marketed in the U.S. could be legally exported, subject to the requirements of the recipient country. Similar regulations applied to the European Union: Intra-Union trade was completely liberalised and medical devices could be exported to non-EU member countries, subject to the requirements of the recipient countries. In 1998 the European Union and the U.S. signed a mutual acknowledgement agreement concerning regulatory device approval. Medical devices that were subjected to premarket clearance procedures in the U.S. were largely accredited in

the European Union and vice versa. To bring the devices to the market, only marginal additional filings and registration was necessary. No further testing was required, both in the U.S. and in the EU. Although JPS itself had not made use of the mutual acknowledgement agreement until the end of 1998, early precedents with competitors indicated that additional time and review requirements to bring new devices to the foreign market were rather limited.

In their November 1998 meeting, Mircea and Wes extensively discussed the proposal they would have to present the next day. What should they suggest? Where should they continue the spinal implant development? How could this endeavor be organized effectively? They really wondered if they could manage to work out an intelligible and feasible solution on time, and would therefore be grateful for any help offered.