Case Study

CVRx® Manages Risk and Accelerates Time-to-Market with PTC Integrity

CVRX

CVRx is a privately held medical device company in Minneapolis, Minnesota, that has developed proprietary active implantable technology for the treatment of high blood pressure and heart failure.

Summary

CVRx is developing a second-generation system to provide Baroreflex Activation Therapy. This system, called XR-1, will be evaluated to determine its efficacy and safety. After using IBM® Rational® DOORS® as the requirements management engineering platform for approximately one year, CVRx replaced it with PTC Integrity. CVRx selected PTC Integrity for its flexibility, integration of multiple disciplines in a single solution and capacity to provide comprehensive traceability between artifacts. By using PTC Integrity, CVRx has compressed development cycles, improved productivity, mitigated risk, and streamlined regulatory and internal reporting.

Background

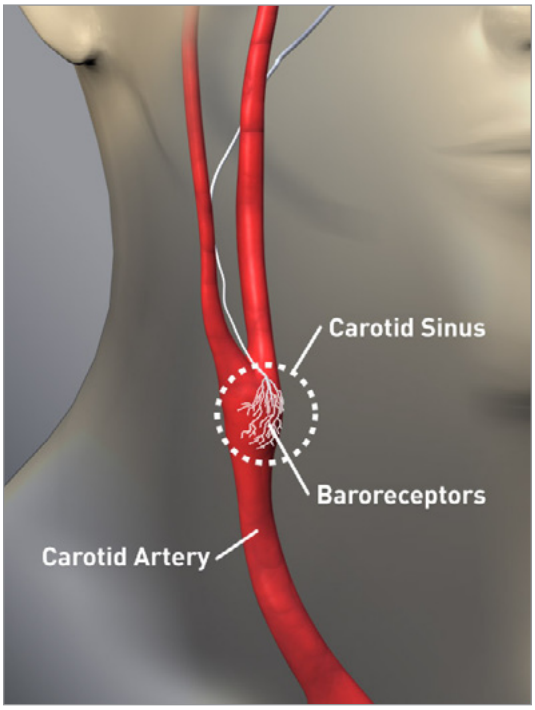
As a privately held company that is venture capital funded, CVRx must move its development projects quickly to clinical trials — without sacrificing quality — due to long regulatory approval cycles. Ultimately, accelerating time-to-market is key to providing a return on investment by expanding or establishing new markets within tight cost constraints. With an aging population worldwide, and an estimated 73 million Americans alone suffering from hypertension-related heart issues — at an annual cost of $69.4B — the XR-1 System could have huge ramifications for human health, quality of life, lifespan and the economics of healthcare.

The XR-1 System is an implantable technology that electrically activates the body's system for regulating blood pressure. Signals are sent to the central nervous system and the body interprets these signals as a rise in blood pressure. In response, the brain then sends signals to dilate blood vessels. This allows blood to flow more freely, reducing the heart rate and encouraging the kidneys to release fluid.

The XR-1 System is a Class III medical device — an FDA classification that indicates it could support or lengthen human life, prevent a serious health issue or potentially pose a significant health risk if not properly evaluated. Class III devices are subject to the most stringent FDA regulation and are subject to premarket approval — scientific trials designed to ensure the product is both safe and effective. The XR-1 System is investigational and is being implanted in ongoing clinical trials in Europe.

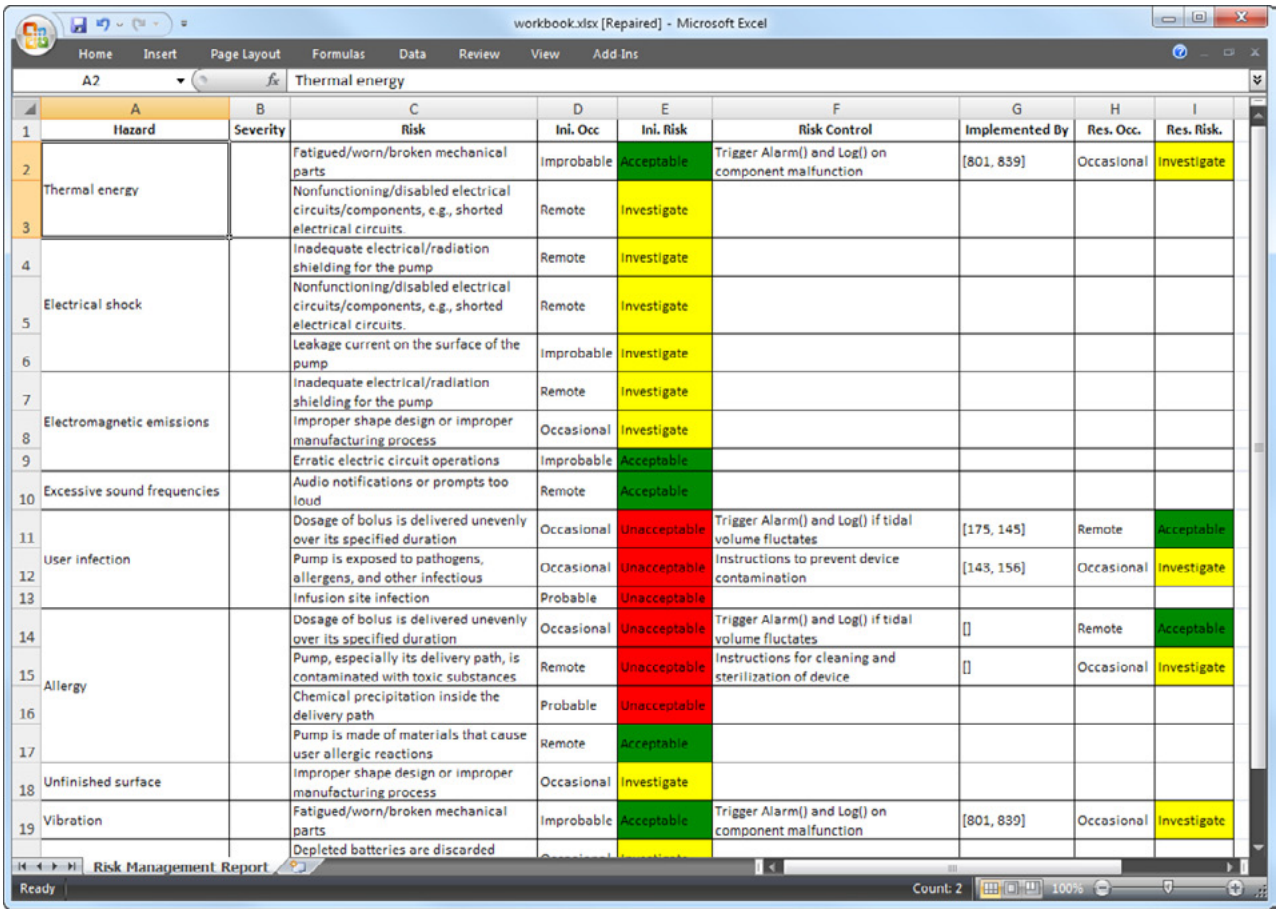
Since it is a Class III medical device, the XR-1 System is subject to the reporting requirements of the FDA Code of Federal Regulations (CFR) 21, which stipulate that a design control plan must be in place for new product development. As part of this, procedures on design, design history, product requirements, specifications, test plans and change control must be documented in a design history file (DHF) and a device master record (DMR). The European Union requires a similar set of documentation called a "Technical File."

The Challenge



The company's initial engineering platform was designed for research purposes, with all documentation based on Microsoft Word. In 2007, CVRx embarked on a project to architect a new flagship product (XR-1) to replace the current research system and create a viable commercial platform. The new design would deliver the same therapy but use new electronics, a new mechanical design, new external instrumentation and new firmware and software.

The launch of XR-1 created an immediate need to automate requirements management and, based on prior knowledge of the product and its capabilities, CVRx selected IBM Rational DOORS, a well-known requirements management tool. However, after using DOORS for approximately one year, CVRx required an engineering documentation and development platform that was more flexible, configurable and customizable — and one that also facilitated requirements reuse. As the project evolved, CVRx recognized a growing need for a broader toolset capable of more than simply requirements management.



Hazard	Severity	Risk	Ini. Occ	Ini. Risk	Risk Control	Implemented By	Res. Occ.	Res. Risk.
Thermal energy		Fatigued/worn/broken mechanical parts	Improbable	Acceptable	Trigger Alarm() and Log() on component malfunction	[801, 839]	Occasional	Investigate
		Nonfunctioning/disabled electrical circuits/components, e.g., shorted electrical circuits.	Remote	Investigate				
Electrical shock		Inadequate electrical/radiation shielding for the pump	Remote	Investigate				
		Nonfunctioning/disabled electrical circuits/components, e.g., shorted electrical circuits.	Remote	Investigate				
		Leakage current on the surface of the pump	Improbable	Investigate				
Electromagnetic emissions		Inadequate electrical/radiation shielding for the pump	Remote	Investigate				
		Improper shape design or improper manufacturing process	Occasional	Investigate				
		Erratic electric circuit operations	Improbable	Acceptable				
Excessive sound frequencies		Audio notifications or prompts too loud	Remote	Acceptable				
User infection		Dosage of bolus is delivered unevenly over its specified duration	Occasional	Unacceptable	Trigger Alarm() and Log() if tidal volume fluctates	[175, 145]	Remote	Acceptable
		Pump is exposed to pathogens, allergens, and other infectious	Occasional	Unacceptable	Instructions to prevent device contamination	[143, 156]	Occasional	Investigate
		Infusion site infection	Probable	Unacceptable				
Allergy		Dosage of bolus is delivered unevenly over its specified duration	Occasional	Unacceptable	Trigger Alarm() and Log() if tidal volume fluctates	[]	Remote	Acceptable
		Pump, especially its delivery path, is contaminated with toxic substances	Remote	Unacceptable	Instructions for cleaning and sterilization of device	[]	Occasional	Investigate
		Chemical precipitation inside the delivery path	Probable	Unacceptable				
		Pump is made of materials that cause user allergic reactions	Remote	Acceptable				
Unfinished surface		Improper shape design or improper manufacturing process	Occasional	Investigate				
Vibration		Fatigued/worn/broken mechanical parts	Improbable	Acceptable	Trigger Alarm() and Log() on component malfunction	[801, 839]	Occasional	Investigate
		Depleted batteries are discarded						

An example of an exported hazard report from PTC Integrity.

To meet compliance regulations and ensure quality while still maintaining an aggressive schedule, CVRx needed a comprehensive solution that could manage its requirements, specifications, test cases, change requests, defects and other documents, processes and records — as well as automate compliance reporting. Assembling the necessary documentation while providing the required traceability between engineering artifacts can be a daunting task, but it is essential in effectively managing and evaluating risk and ensuring that only safe and viable medical devices reach the consumer.

The Solution

By standardizing on a single engineering documentation and development platform, rather than implementing several different tools, CVRx would gain full collaboration and communication capabilities across the engineering organization and across the lifecycle. This decision to standardize led CVRx to select PTC Integrity — a comprehensive, integrated solution that could meet current needs and be flexible enough adapt to changing requirements as the business evolved and grew. In addition, PTC Integrity could provide traceability between disciplines, which is necessary in effectively managing risk. Regulatory reporting requirements could be easily automated with customized "one-click" reports. PTC Integrity's ability to leverage existing code between engineering projects would support shortening iterative development cycles to six months.

In 2008, CVRx then replaced IBM Rational DOORS with PTC Integrity for requirements management. Based on initial success and the desire to manage multiple engineering artifacts with one application, the scope of PTC Integrity was broadened to include source code management, with ties to tasks and workflow management between requirements and source code. As such, risk management, development issue management, and standards requirements capabilities — as well as capabilities for linking standards to those requirements that satisfy the standards — were added to the platform. Finally, in 2009, CVRx moved their quality management processes and documents into PTC Integrity, creating a complete end-to-end development management system.

All these artifacts today are now linked through PTC Integrity, enabling traceability from risks to mitigations to requirements, source code and verification tests. As part of the project, many new processes have been defined and documented, and dozens of standard operating procedures (SOPs) and work instructions (WIs) have been created. This work can be leveraged in future CVRx projects, accelerating development and time-to-market. In February 2011, the first XR-1 System that used PTC Integrity for development from start to finish was implanted in a patient.

The Results

- Full traceability across such critical aspects as requirements, risks, mitigations and source code facilitates risk analysis, management and reporting
- Risk Priority Number (RPN) tracking supports System Risk Analysis and Failure Mode and Effects Analysis (FMEA) and ensures safety and quality
- Use of one platform to support multiple engineering roles reduces cost to implement, maintain and manage
- Generation of a DHF can be accomplished without requiring additional personnel
- Rapid response capability to regulatory audits preserves time-to-market projections and positions CVRx for growth
- Ability to reuse assets such as source code, requirements, specifications and test suites (e.g., protocols) enable six month project lifecycles

The Next Steps

Due to the success of this project, PTC Integrity will be deployed across the entire CVRx development organization. Additional custom reports will be created and refined, and role-based view sets will be designed and customized for improved ease-of-use and simplified management.

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