

Rational Software Brings Harmony to Cochlear's Software Development Process

Cochlear engineers use Rational Rose,® Rational TeamTest, Rational SoDA® and the Rational Unified Process™ to develop software for their state-of-the-art technology which helps individuals with profound hearing loss.

Some companies choose to support their legacy systems for budgetary reasons, others simply because the challenge of making the most of new technology is too daunting. Cochlear, the world's technology leader in cochlear implants has a much better reason: as "Partners in Hearing for Life," it is their corporate mission to support every one of their older systems. Since 1982, Cochlear has been the pioneering force in cochlear implants, technologically advanced medical devices which simulate sound in the cochlea by electrically stimulating the hearing nerve. Because Cochlear and their users expect the implants to last for the rest of their lives, Cochlear does not have the option of discontinuing support for even the earliest generations of their products. And because Cochlear is committed as an industry leader, they continue their work on the leading edge of this extraordinary technology. Cochlear continues to support every device they have ever manufactured while continuing to make dramatic new advances.

Its Not Just Hardware: Software is Crucial to Customer Satisfaction

The software that audiologists use to fine-tune cochlear implants is the primary responsibility of Peter Wyatt, Software Manager of Cochlear's Design and Development Department in Sydney, Australia. This department, which employs 100 engineers and technicians, is the R&D branch of the industry's largest and

most experienced research, clinical and technical support team. Wyatt manages a team of software engineers and testers, whose main charter is to maintain and develop the Diagnostic and Programming System (DPS) that is used by clinicians, technicians, audiologists, and speech pathologists to ensure that implant recipients are getting the best possible performance from their devices. The DPS software enables clinicians to adjust the speech processor's maps—sets of customizable parameters that are tuned for each individual recipient. A recipient might select a different map for work, parties, evening quiet times, or sleeping. There are essentially two different versions of the DPS, both of which are 32-bit Windows applications. The Portable Programming System (PPS) allows programming of speech processors through a serial port, enabling clinicians to travel to an implant recipient's home or school. The Clinical Programming System (CPS) uses a proprietary PC hardware to program the speech processor, and offers more features than the PPS.

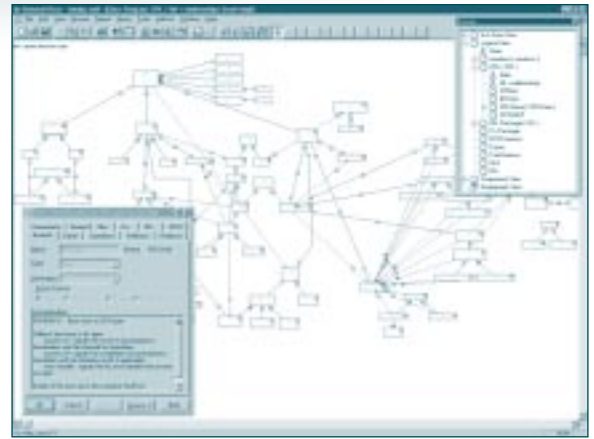
The original DPS application was written primarily in C and C++, and documented through specification documents and design documents. As Cochlear developed better implants and processors, new software was developed to keep pace, but there were many devices in the field that required continuing support as well. "When we build a product, we build it for the life of the human being. The legacy was getting bigger and bigger," Wyatt explains.

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The system's documentation, which has to meet the strict regulatory guidelines of the United States Food and Drug Administration (FDA) and similar agencies from other countries, was also becoming a heavier burden—"Our documentation seemed as if it were instantly out of date. We needed a way to manage information better; to stop wading through piles of paper; to understand more about our system." Cochlear made the decision to move to a more object-oriented approach and they turned to Rational® Software for help.

Rational Rose is a Sound Choice for Cochlear

For the software engineers at Cochlear, the first step in developing a more thorough understanding of the software they had created was to build a visual model of the entire system. Rational Rose, Rational's award-winning visual modeling software was the perfect tool for the job. A visual model is a graphical representation of the structure and interrelationships of a system. The Unified Modeling Language (UML), which Rational pioneered, is used in Rose to make complex systems easier to understand, improve communication, shorten development time, and create architectures that are easier to implement and maintain. Wyatt's staff made use of Rational's unparalleled support team to help get them started. Davyd Norris, a software engineering specialist at Rational Software in Sydney, worked together with Cochlear engineers. Using Rational Rose they reverse-engineered a model from the existing code base. Norris remembers, "They had this mountain of Borland C++ code and they wanted to sort it out and put some architecture around it. We started off with some training, and then we reverse-engineered the library piece by piece with Rose—creating diagrams and building up an architecture. After we pulled everything in, we asked Cochlear's lead architect to explain what it was about. He said 'In the simplest form it looks like this,' and drew a quick sketch as a back-of-the-envelope kind of thing. From that diagram, we were able to drag and drop the classes directly in a new Rose



Rational Rose model of Cochlear PPS application

diagram and the model began to take shape. It developed very quickly. When the architect saw the new model, he said 'That's exactly what it looks like.' All the relationships and functions became apparent as well. It took about five minutes to pull out the core architecture once it had been reverse-engineered. It was a tremendous benefit." Wyatt agrees, "The reverse engineering of C++ in Rose is very configurable. With Davyd Norris' help, we got it to work pretty easily. We found the Rational support to be very good—they have very knowledgeable people. We could not be happier with the results."

After they generated the comprehensive and accurate model, the team spent a little time reorganizing the underlying code. "We pulled out a component diagram of the dependencies from the header files—it looked like Custer's last stand—arrows going everywhere," Norris reports. "Rational Rose then rearranged the header files, and all the models looked much cleaner, and their environment and architecture was simplified enormously."

From the start Wyatt and the Cochlear engineers had wanted to be able to do round-trip engineering—to be able to make changes in the code that were automatically reflected in the model, and vice versa—and Rational Rose had enabled them to do just that. Once they achieved that goal, they decided to take a slightly different approach. Wyatt explains, "After we were able to round-trip engineer our system, we decided that we wanted to change our work process and practices. We made the decision to live and breathe in the Rose model, not in the code. We believe strongly in the Rational Unified Process' principle that you model first, and that

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the code is just an artifact of the model. We are finding that to be a more streamlined process, one that gives us better turnaround on our projects.” He continues, “As long as our model is correct, then we know our code is correct. It is when you make changes in the code that are not reflected in the model that you get into trouble. We decided that was not the way we were going to work.” Wyatt’s team then added comments to the Rose model, and began to work in the model directly.

Today, as they add new functionality, the developers at Cochlear first make the changes in the model, and allow Rational Rose to generate all their headers, dependencies, and stubs. They rarely reverse-engineer any of the code, although they can if they want to.

Another Substantial Benefit

In addition to improved team communication, a cleaner architecture, and shorter release cycles, Wyatt has found that Rational Rose offers another considerable advantage. In today’s IT employment climate, with qualified IT professionals in short supply, and the high frequency with which workers are switching jobs, small development teams are at the greatest risk of losing information and vital development time when an employee leaves for greener pastures. “When you have a small team like ours, and people leave, knowledge walks out the door. It is especially dangerous in our business where the knowledge is very specialized, and people require about 6 to 8 months of training to come up to speed on the basics. One of the things we like best about Rational Rose is that we have captured our architecture and the obscure dependencies of our system. When new people

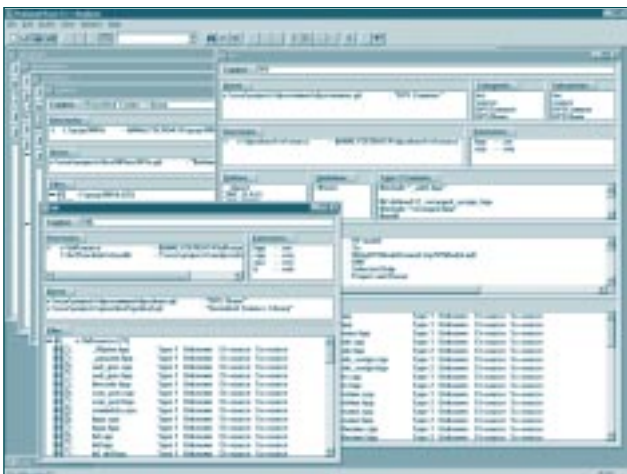
join the team we can walk through the commented model, and they can easily see how the system works. They do not have to resort to reading source code. That to us is a huge plus,” Wyatt notes.

Cochlear’s software engineers are continuing to develop both their applications and the methods they use to create them. For example, they are beginning to automate some of their frequently performed Rational Rose tasks with Rose scripts. They are also considering the Rose Delphi Link from Ensemble Systems to help them round-trip engineer the Inprise Delphi portions of their user interface. Wyatt is enthusiastic about the way Rose fits in with many of their existing processes, “We have had a lot of success integrating Rose with our other tools including our configuration manager. It took just a quick e-mail to Rational customer support and it was up and running.” In addition, Cochlear is using Rational SoDA (Software Document Automation) for automated project documentation and reporting. Rational SoDA is tightly integrated with Rational Rose, and is helping Cochlear meet the documentation and auditing requirements of the various government agencies that regulate their industry.

Using Rational TeamTest for Automated Testing

Of the 18 engineers on Wyatt’s staff, there are four that work primarily as testers. They use Rational TeamTest to test the user interface of the DPS, which is written in Delphi, as well as the lower level DLLs written in C++. The decision to use TeamTest was not Wyatt’s alone: “We are a democratic organization. When we have to purchase a tool, it is the team’s choice—it is not my choice. They are the ones that have to live in it. To me, you cannot pick a product based on one feature, you pick it based on all the features it has. Another reason we chose Rational, after considering other tools, is that Rational looked like the company for the future.” After a short learning period, Wyatt’s team is realizing the rewards of using Rational’s Object Testing technology.

Rational Rose Analyzer provides detailed application and architecture information



A cochlear implant is not a conventional hearing aid. Hearing aids amplify sounds, making them louder. However, even the most sophisticated hearing aids will not offer much benefit to people with profound hearing loss. The inner ear contains the cochlea that includes the sensory cells for hearing, called hair cells. People with sensorineural hearing loss have damaged hair cells, which do not allow the electrical impulses to reach the nerve fibers that carry information to the brain. Unlike a hearing aid, a cochlear implant does not make sounds louder; it bypasses the damaged or absent hair cells by providing direct electrical stimulation to the nerve fibers in the inner ear, allowing the individual to perceive sound.

A small, directional microphone located in a headset near the ear picks up sounds, which are then filtered, analyzed and digitized by a small microprocessor, called a speech processor. The coded signals are then sent to the implant where they are used to stimulate the auditory nerve fibers. The entire processing time is just microseconds, enabling implant recipients to hear sounds essentially as they occur. Because each recipient is unique, the speech processors are programmable, allowing audiologists to fine-tune each processor to an individual’s hearing needs and preferences.

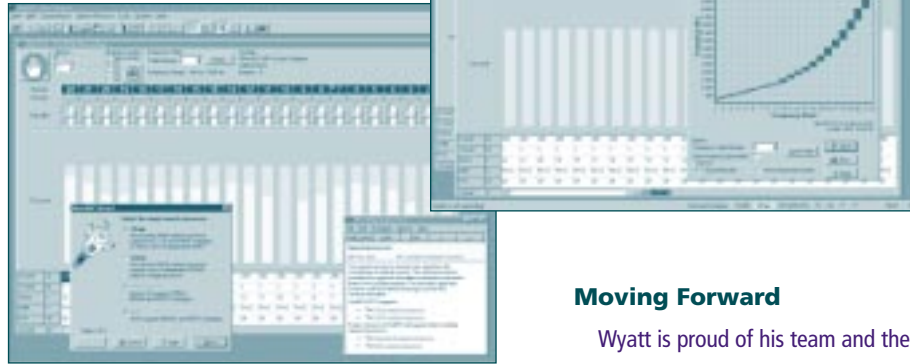
We feel that Rational

is part of our business—

a partner. We rely on

Rational's tools to help

us get our jobs done.



Cochlear's application for programming and adjusting implant performance

This unique technology tests all of the hundreds or thousands of properties of an object, even if they are invisible. The testers began using Rational TeamTest to test the user interface, and then moved down into the DLLs, making use of TeamTest's extensibility. Wyatt is satisfied that the time spent learning TeamTest was well spent, "You do have to invest some time in learning about the testing tools. A lot of people think a tool has to benefit them immediately to be worth their while. No tool really is a silver bullet, you need to give them some time and invest a little time in the beginning of the process. Right now we are working on building a test infrastructure that will set us up for the next 3 to 5 years. TeamTest is going to be a huge advantage." And because TeamTest is integrated with Rational Rose, Wyatt's team can use the model they work with in Rose to plan and implement the testing of their DPS and PPS software using TeamTest.

Moving Forward

Wyatt is proud of his team and the work they are doing. "We do not have hackers. No one here is called a programmer; everyone is a software engineer. We believe software engineering is a discipline." More fortunate than many engineers, the Cochlear team occasionally gets to see the impact of their work directly. Wyatt explains, "As an engineer that has worked in a number of areas, I get a real thrill when I see how a person's life is improved. When we get to go along to a clinic and help switch on a 10-month old baby that can hear for the first time—and the parents are emotional—it is just a great feeling."

In the near future, Cochlear is preparing for new markets opening in Europe and Asia. They are continuing their internationalization efforts and trying to make the user interface as "thin" as possible. And, of course, they are working with Rational Software at every step of the software development and testing process to make sure they reach their goals.

Wyatt summarizes Cochlear's success with Rational simply, "We are very happy with Rational. We are more conservative than most companies for two reasons: first, because of the nature of the business, and second because of our small size. We cannot just throw money at a problem. We find that Rational has optimized the productivity of our team, given us great support, and encouraged us to move forward and expand our efforts. But they haven't pushed us, like other organizations that try to jam a tool down your throat. We feel that Rational is part of our business—a partner. We rely on Rational's tools to help us get our jobs done."

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