

Testing Pioneering Intelligent Ventilation Solutions



Hamilton Intelligent Ventilation

Since the advent of the micro-processor controlled ventilator in the mid 1980's, Hamilton Medical has been the leading force in providing intelligent ventilation systems for intensive care patients. The company develops and manufactures products and accessories for ventilated patients in hospitals and sub-acute care facilities worldwide. Hamilton Medical combines the quality of Swiss manufacturing systems with global resources and the reliability of a focused organization.

Case Study: Hamilton Medical

Hamilton Medical's latest state-of-the-art ventilator product is called Galileo, which has proved highly effective with hard-to-ventilate patients. Adaptive Support Ventilation (ASV), invented by Hamilton Medical, guarantees that the patient receives set minute ventilation, automatically fine-tuning settings to the patient's needs. Central to Galileo's success is the integrated software used to control its systems.

The software used to run Galileo needed to be tested to the highest standards. Research and Development Director Urs Reidt was given the task of identifying suitable tools. He identified IPL's Cantata testing tool as the front runner. He remarks, "Cantata impressed us with its track record in testing high integrity software such as avionics and military applications, and of course in medicine. It was the natural choice for us."

ADAPTABILITY

First of all though, there were technical issues that needed to be considered. Hamilton Medical used their own proprietary system, built for their applications. "We were unsure that we could get tool support for this platform, as it is a unique environment", said Christian Frehner, lead software developer on the project. "An out-of-the-box solution would not be possible. We were very impressed therefore when IPL said they could provide a custom port of Cantata, specifically for this environment. **IPL had a very professional approach to meeting our particular needs.**"

EMBEDDED UNIT AND INTEGRATION TESTING

Hamilton Medical's development on this platform was in the C language, using functional decomposition techniques. Cantata was used first to test the system calls at unit and integration level. The tool's batch-mode facility was very useful, helping to automate the Galileo tests by using command files. "Once the first test had been run, we developed a framework based around Cantata that allowed developers to use templates. Soon all developers were testing to exactly the same standard. Maintaining each other's test scripts became much easier as a result of this standardization," said Rolf Keller, software engineer on Galileo.

IPL's technical support and training was crucial in these early days to help establish this framework effectively. **"IPL's technical support capability is fast and efficient. Responses to difficult problems were often received within 1 hour.** The fact that support and training was available in German too was an added bonus for us", said Christian.

PROCESS INTEGRATION

For the new generation of ventilators, Hamilton Medical upgraded their proprietary solution to the Tornado/VxWorks environment from Wind River Systems, and upgraded seamlessly from Cantata to Cantata++ at the same time. Hamilton Medical needed to port existing software from their older system to the new environment. "Once again Cantata's flexibility and extensive platform support really helped us", says Gion Durisch, the project leader for the introduction of VxWorks. "We ported our existing tests, and used Cantata to verify that our software still behaved as expected. In doing so, we found several bugs in third party libraries". Hamilton Medical used fault injection methods to deliberately stress-test their functions, and used Risk Analysis techniques to determine which operating system functions should be avoided.

COVERAGE AND FDA GUIDELINES

Hamilton Medical also used Cantata's coverage analysis facilities. Encouraged by both the FDA Guidelines on Software Development, and their own rigorous internal standards Hamilton Medical elected to check for 100% decision coverage on all code, using Cantata++'s stubs and wrappers to increase coverage and simulate difficult-to-test conditions. **"Using coverage helped us to really think about whether certain functions and blocks were needed"**, says Rolf Keller. "We optimized our code, eliminated unnecessary code, and refactored parts of the application to make them more efficient. We confirmed the great confidence in our software that everything had been tested to 100% decision coverage."

FUTURE PLANS

And so what about the future? Hamilton Medical is now using the UML tool Rhapsody from I-Logix into which Cantata++ has a powerful integration. IPL's very close technical partnership with Windriver is also important to Hamilton Medical. "We are pleased that these market-leading tools are working together, and that the vendors have such close co-operation. We are looking forward to using Cantata++ directly within Rhapsody, and within the Eclipse-based Workbench from Wind River when this becomes available", said Rolf. "We have standardized now on IPL's testing tools," concluded Gion. **"Cantata++ will be used for all new C or C++ developments."**

IPL would like to say "vielen Dank" to Hamilton Medical in Bonaduz for agreeing to publish this case study. We wish them well in their future projects.

The text for all IPL product case studies is agreed and approved by our customers.



Galileo Images

FDA Information

General Principles of Software Validation;
Final Guidance for Industry and FDA Staff
issued 11 January 2002 available at
<http://www.fda.gov/cdrh/comp/guidance/938.pdf>

FURTHER INFORMATION

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