Workspace: a fast and low cost methodology for delivering commercial applications based on Research IP

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THE CHALLENGE

Research organisations worldwide have Intellectual Property (IP) artefacts that have been developed for specific research purposes and which could have value in a commercial context. Unfortunately, most such commercial opportunities are not realised because of inherent limitations in the form of the IP. In the case of software this is mainly caused by the fact that the software was not designed with the goal of a commercial release in mind. Converting this type of IP to a commercially exploitable form via traditional software development processes incurs significant cost and delays - and often the market potential is too small or too short-term to justify such additional investment. Workspace, CSIRO’s scientific workflow framework, provides a comparatively fast and low cost methodology for delivering commercial applications based on such Stranded IP. The Workspace development process is heavily predicated on high levels of re-use of both processes and components between different applications. The goal of the Workspace project, which has been under development within CSIRO for 10 years, is to produce a single environment for both 1) scientific workflow development and collaboration during the development phase and 2) to simplify the path to commercial-quality application development during the commercialisation phase. Workspace team members come from diverse backgrounds such as game development, telecommunications and software consultancies, so the team is well placed to continue enhancing the Workspace framework as a commercial quality codebase while addressing the challenges of both scientific application development and software engineering best practices. Since Workspace’s external release at eResearch Australasia in 2014 it has consistently been one of CSIRO’s most downloaded applications. To date, there have been more than 5500 downloads of Workspace and more than 1500 downloads of Workspace based applications. Uptake has been strongest in Australia, US and UK with good interest also from Canada, New Zealand, Switzerland, China and Germany.

WORKSPACE

Workspace is a powerful, proven, cross-platform workflow and application development framework designed to enhance productivity, enable collaboration and software reuse and to enable the commercialisation of software products [1, 2, 3, 4]. Industrial (and other) processes can often be modelled as workflows i.e. networks of tasks or operations connected together with directed data flows and an order of execution. Users can construct scientific workflows, custom user interfaces or complete applications quickly and easily. These workflows, plugins and applications can be targeted to run on the Linux, Mac and Windows operating systems. Although there are a number of other Workflow platforms, the range of features and facilities, such as licensing, visualisation and deployment makes Workspace unique amongst its peers. Workspace significantly speeds the time to market by providing an environment that supports more productive and sustainable software development and use. It is designed to seamlessly integrate the scientific algorithms and workflows of multiple disciplines on a single development platform. This means that innovations in multiple sciences can be brought together to facilitate multi-science applications. Products have been successfully developed for industrial process modelling for the mining and manufacturing industries, disaster modelling and virus analysis.

WORKSPACE–BASED APPLICATIONS

Examples of Workspace based applications include:

- CSIRO-3DP - developed for Oventus Pty Ltd - customised 3D printing of titanium products for alleviating sleep apnoea. See the Use Case section for more specific details on this application.
- Spark[5,6] - developed for emergency management agencies, bushfire experts, researchers and local councils - a bush fire spread modelling software.
- Amicus[7,8] - developed for researchers and experts in bushfire modelling – an Australian bushfire behaviour analysis tool -
- GrainScan[9] - developed with CSIRO’s Agriculture Business Unit - software product to measure grain size and colour from scanned images.
- **SpotSizer** - developed in conjunction with University College London - automates analysis of large volumes of photographic images of growing microbes.
- **Dive Mechanic** - developed for AIS and Diving Australia - visualisation and athlete-specific optimisation of diving. See the Use Case section for more specific details on this application.
- **GF-mill** - a proprietary commercial product for predicted particle flows in grinding mill applications in the mining industry.

**USE CASE: CSIRO-3DP**

Many industries need to rapidly commercialise IP to seize a market opportunity. The CSIRO-3DP application developed for [Oventus Pty Ltd](#) is one such example. CSIRO-3DP is built with Workspace and uses a workflow to reconstruct a virtual 3D representation of a patient’s jaw directly from a simple CT scan and enables customisation of the design of a titanium sleep apnoea device. This ensures that patients benefit from an optimal fit of their 3D printed titanium sleep apnoea device without the need for physical casts or other uncomfortable or expensive procedures. The result is increased customer satisfaction and reduced delivery timeframes. Use of the CSIRO-3DP software has enabled scaling up to commercial mass-market delivery by allowing dental professionals to customise sleep apnoea devices quickly and easily. CSIRO-3DP uses a number of built-in Workspace capabilities and provides a simple to use UI and design workflow for dental technicians. This has supported Oventus’ rapid entry into this market and strong growth trajectory.

![Figure 1: The CSIRO-3DP application developed for Oventus Pty. Ltd.](#)

**DIVE MECHANIC**

Dive Mechanic [10] is a 3D interactive software tool based on detailed physics and athlete specific data that allows coaches and athletes to visualise and experiment with the aerial phase of platform and springboard dive technique without subjecting the athlete to possible injury risk or training poor technique. The technique of a diver (or a pair of divers in synchronised diving) can be viewed and modified to suit the desired performance and then this technique modification can be trained by the athlete. The software tool helps the coach communicate technique modifications to athletes in an intuitive interactive 3D environment and to demonstrate the consequence of good and poor technique. Improving synchronised diving is also facilitated by independently adjusting the techniques of two diver models. Dive Mechanic is unique in its capability and the accuracy of the physics and athlete models, and its intuitive software interface constitute a strong benchmark for any future competitors to meet. This tool is helping to provide elite level Australian divers with a technological edge.

Dive Mechanic integrates several technologies including:

1. Biomechanical dynamics algorithms that have been developed within Data61 combined with the customised, intuitive user interface, providing a capability that is not matched in the market.
2. The application code is written in C++ and is built using the Workspace platform, thus leveraging many of the aspects Workspace has to offer such as OpenGL visualisation plugins, higher level graphical programming using workflows, software packaging and software licensing.
3. Workspace’s modular design allows the software or components from this software to be easily embedded in other future biomechanics applications and to be extended or modified for other sports.

4. The digitised dive technique data is stored in standard file formats including .xml, .osim, .mot and .vtk thus complying with the requirements of standard visualisation and biomechanics applications such as Maya and OpenSim.

5. The application is platform independent and runs on Windows, Linux and Mac.

Figure 2: The Dive Mechanic application developed for Diving Australia and the Australian Institute of Sport.

SUMMARY

The growing list of Workspace-based applications and the number of varied scientific domains in which they are created, validates the applicability and usefulness of the Workspace platform. Not only does it make the process of doing science simpler and easier but it allows organisations to rapidly capitalise on both new and Stranded IP.

REFERENCES AND LINKS

7. Amicus: A national fire behaviour knowledge base for enhanced information management and better decision making, A Sullivan, J Gould, M Cruz, C Rucinski and M Prakash, 20th International Congress on Modelling and Simulation, Adelaide, Australia, 1–6 December 2013
8. The best of both worlds: Fire spread predictions from the head and the heart, M Plucinski, A Sullivan, C Rucinski, M Prakash, 5th International Fire Behaviour and Fuels Conference, April 11-15, 2016, Melbourne

11. Demonstration videos for Workspace and some Workspace-based applications are provided at the Workspace YouTube channel: https://www.youtube.com/channel/UCwFGBWC4WQvyAiM8tdTpYkA.

ABOUT THE AUTHOR(S)

Matt Bolger is a senior software engineer in CSIRO’s Computational Modelling and Simulation Group. Matt has a BSc (Computer Science) from the University of Melbourne and started his career working in the computer game industry before joining CSIRO in early 2010. He has worked on commercial software products ranging from children’s games, aircraft and sports simulations to more recent work in industrial processes, disaster modelling and cross-platform workflow frameworks. Matt currently works across a number of research and commercial projects in areas such as CFD, computer vision, 3D rendering, human kinematics and additive manufacturing. Matt’s work involves developing on a wide range of computing environments using a variety of programming languages and frameworks.

Paul Cleary is a Chief Research Scientist at CSIRO and specialises in the development and application of particle based computational methods and the development of software and visualisation tools. These include the DEM and SPH methods which are now used extensively for simulating industrial, biomechanical / biomedical and geophysical / geotechnical flow problems involving combinations of particulates, fluids and bubbles. He is also the leader of the Workspace development program.

Raymond Cohen is a Research Scientist within CSIRO’s Computational Modelling and Simulation Group who specialises in computational modelling of fluid dynamics, biomechanics and flooding. His application areas include elite sports modelling - platform diving with Diving Australia and swimming with Swimming Australia; urban flood modelling for several Australian councils; and strategic research into automated motion capture. Raymond is the principal developer behind the Dive Mechanic application which is built using Workspace. Raymond holds a PhD in Mechanical Engineering from the University of Melbourne.

Simon Harrison completed his bachelor’s degrees of Engineering (Mechanical) and Science (Chemistry), and a PhD in the simulation of soft tissue deformation at the University of Western Australia. Subsequent to this, he held a Research Fellow position at the University of Melbourne in which he investigated the biomechanical causes of equine limb injury and human knee osteoarthritis. After a short tenure at DSTO looking at human performance and injury models, he took a position as a Research Scientist at CSIRO in 2011. Currently he applies mesh-free particle methods to problems in the areas of human performance, injury, food digestion, and health.

Lachlan Hetherton is a senior software engineer from the Computational Modelling and Simulation Group in CSIRO, specialising in developing visualisation capabilities for Workspace. Specifically, he has implemented Workspace’s 3D scene rendering and grid plotting capabilities, as well as the recently added NetCDF and GeoSpatial plugins. Prior to joining CSIRO in 2009, Lachlan worked as a consultant for Accenture, designing and developing solutions for a diverse range of projects in the telecommunications space.

Chris Rucinski is a software engineer in CSIRO’s Computational Modelling and Simulation Group. He graduated as a computer scientist from Monash University in 2011 and since then has been a developer on the Workspace team. He has developed a number of computational modelling and data analysis tools that are used internally by the Computational Modelling and Simulation Group and which are also deployed externally in commercial particle-based simulations software packages. Chris collaborates with researchers from multiple flagships to design and build user-friendly software tools relating to mining, metallurgy, bushfires and urban sustainability. Chris is the lead developer on Amicus, AlteTreat and other Workspace-based applications.

David Thomas is a senior software engineer in CSIRO’s Computational Modelling and Simulation Group. He currently manages and develops commercial software using Workspace, providing user interfaces for complex scientific applications. He has a first-class Bachelor’s (Hons) degree in Mathematics, and a Master’s in Mathematics and Chemical Engineering, both from The University of Manchester in the UK. He is a software developer with over 20 years’ commercial experience, the majority of this time spent working in the CAD industry, working on core functionality used
by some of the biggest product vendors such as Autodesk, SolidWorks, NX and CATIA. He has also provided consultancy work for SolidWorks.

Damien Watkins is a Research Team Lead in CSIRO’s Computational Modelling and Simulation Group. His team produces a number of software applications, including Workspace which is a scientific workflow engine used across a number of projects within CSIRO. Prior to working at CSIRO, Damien worked for Microsoft/Microsoft Research for ten years. Damien holds a Ph.D. in Software Engineering from Monash University.