BUMBLE

Boosting cross-discipline collaboration with blended modelling

The ITEA project BUMBLE (Blended Modelling for Enhanced Software and Systems Engineering) has created a system and software development framework based on textual and graphical modelling notations/languages, providing automatic generation and management of fully-fledged blended modelling environments from arbitrary domain-specific modelling languages (DSMLs).

European industry is strong in the development of complex systems in which innovation is realised primarily through software, such as high-end vehicles and robotics, but the interconnected nature of software-intensive systems is causing software to exponentially grow in complexity. In combination with increasing functional demands, this leads to development time and cost increases. Model-driven engineering aims to counter this with domain-specific abstractions and automation, while modelling tools focus on specific notations (such as text, diagrams, tables or forms) and engineers may have different notation preferences. This limits communication, particularly across disciplines.
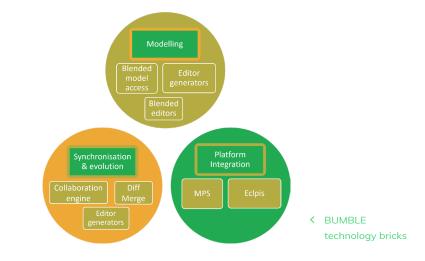
BUMBLE has created a different manner of using models, enabling a mixed representation of a single system so that engineers can work in their preferred set-up. Changes made in text, for instance, are automatically reported graphically. This co-evolution of blended models allows for collaborative work on a system while avoiding inconsistencies in the overall model, which is expected to greatly boost the development of complex, multi-domain systems that feature heterogenous components and stakeholder roles. BUMBLE has achieved this via a consortium that involves end-user companies facing complex system design, tool providers that sell licenses for tools used by designers and consultancy companies that can open up new business models in coaching and support services.

Technology applied
At the core of its technological innovation, BUMBLE allows for the generation of blended modelling environments from DSML specifications and the generation of mechanisms for on-the-fly synchronisation of notations. The subsequent collaborative blended modelling based on customised multi-representation model versioning and co-evolution of blended models enable seamless, concurrent use of graphical and textual modelling. Another key development is BUMBLE Technology Bricks (BTBs), a toolset for providing continuity between requirements, design and implementation. Technical reporting and reviews are structured according to the BTBs, which cover areas like platform integration and blended model access;

different combinations lead to different blended solutions for specific platforms and use-cases and can be used to refine a project's scope and measure its success in a practical manner.

BUMBLE has also demonstrated these innovations in various domains, highlighting the diverse applicability of the technology. Canon, for instance, has applied BUMBLE's results to allow engineers with different backgrounds (such as architectural developers with a high-level view and programmers using C code) to collaborate on printer technology development. In civil engineering, meanwhile, Pictor has used the project to add value to blended system modelling via 3D visualisation of DSML for large infrastructure (such as bridges), which experts in different domains can work on and then bring together. These industrial partners have been supported by universities, which pushed forward the research boundaries of the project, and end-user Unibap, which tested the tools in aerospace development. This has allowed BUMBLE to cover the entire range of fundamental to applied research.

< BUMBLE technology bricks

Making the difference

By enabling a new level of cross-discipline collaboration, BUMBLE's primary benefit is less time spent modelling complex systems. On average, this is 30% faster with blended modelling tools compared to the traditional approach; however, the actual savings depend on the domain and existing approach, so certain applications have seen even greater improvements. This translates into fewer modelling costs and a quicker time to market. Crucially, given the project's user focus, BUMBLE has also demonstrated that 94% of engineers consider blended modelling useful and 75% prefer the project's solutions to non-blended modelling, indicating a strong potential for uptake.

In relation to this, BUMBLE has already demonstrated fast exploitation by tool providers, which can integrate the results into existing products and services or explore new business models such as coaching, consultation and support services. In the former category, MVG has improved DClare, a general-purpose declarative language based on Java, with collaboration and blending capabilities. Similarly, HCL Technologies has fully implemented textual notation and an editor for state machines of RTist, a modelling and development environment for event-driven, real-time applications. As for end-users, BUMBLE enables the development of more complex solutions due to the greater understanding granted to engineers, but also allows for easier communication with customers at a level that both sides can understand. This enables better customisation and faster prototyping with less time wasted for both parties, thereby boosting customer satisfaction.

As in all projects that combine academia and industry, a balance is required between the need for universities to publish results and for companies to protect trade secrets. BUMBLE has managed this by making their core technology available in the Eclipse Modelling Framework and JetBrains MPS, the two major open-source platforms for domain-specific modelling, as well as the BUMBLE GitHub repository. In tandem with ongoing dissemination, including over 40 articles and 10 theses, this should help the project to reach a larger audience without compromising the intellectual property of the consortium. In turn, this will allow BUMBLE to bring in more disciplines and expand the reach of blended modelling even further.

Major project outcomes

Dissemination
> I. David, K. Aslam, I. Malavolta, P. Lago: "Collaborative Model-Driven Software Engineering – A Systematic Survey of Practices and Needs in Industry" in Journal of Systems and Software, (2023).
> M. Latifaj, F. Ciccozzi, M. Mohlin: "High-order Transformations for the Generation of Synchronization Infrastructures in Blended Modeling" in Frontiers in Computer Science (Front. Comput. Sci), 2023.
> A tutorial at the 20th International Conference on Software Architecture, 2023 "Blended Modelling for Software Architectures" https://blended-modeling.github.io/icsa/

Exploitation (so far)
> Technology-agnostic engine for providing a cross-platform and language-independent real-time collaborative capabilities for already existing language and modeling workbenches.
> HoTs for generation of synchronisation / migration transformations.
> DclareForMPS - improved Dclare with BUMBLE functionalities in terms of collaboration features and blending capabilities.

Standardisation
> github - open-source software: platform (MPS, Eclips, EAST-ADL)

Spin-off
> Timing & Variability in EATOP EAST-ADL

BUMBLE
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Partners

Austria
> AVL List GmbH
> EclipseSource Services GmbH
> Johannes Kepler University Linz
> TU Wien
> WU Vienna

Netherlands
> Canon Production Printing Netherlands BV
> Modeling Value Group
> Sioux Technologies BV
> VU University Amsterdam

Sweden
> Alten
> HCL Technologies Sweden AB
> Mälardalen University
> Pictor Consulting AB
> SAAB AB
> Unibap AB
> University of Gothenburg
> Volvo Technology AB

Türkiye
> Ford Otosan
> Hermes Iletisim
> Mantis
> Turkcell Teknoloji
> UNIT Information Technologies R&D Ltd

Project start
November 2019

Project end
June 2023

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Project website
https://itea4.org/project/bumble.html

ITEA4

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