

Call for Proposals

No. 59

24 June 2021

Priority Programme “Daring More Intelligence – Design Assistants in Mechanics and Dynamics” (SPP 2353)

In March 2021, the Senate of the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) established the Priority Programme “Daring More Intelligence – Design Assistants in Mechanics and Dynamics” (SPP 2353). The programme is designed to run for six years. The present call invites proposals for the first three-year funding period.

To respect ecological and societal responsibilities and challenges as well as to account for stricter and more complex regulations, future systems design has to become increasingly multidisciplinary. Computer-based support as employed today in mechanics and dynamics, mostly limited to system analysis only, is not sufficient anymore. Even in advanced design workflows, usually large-scale, simulation-driven parameter studies are conducted and inspected only manually to iteratively alter a candidate design based on experience and expert knowledge. This process is not only very time consuming but also typically based on subjective rather than on formalised mathematical objectives.

The research in the established Priority Programme shall aim at the development of design assistance systems combining methods from optimisation, artificial intelligence, and dynamics/mechanics to assist in and partially automate the interdisciplinary design of engineering systems. This may not only result in designs that are actually optimal with respect to formalised criteria, but such design assistants may equip design engineers with an artificial intuition supplementing their own specialised expertise. This way, criteria nowadays only considered in later design stages may be taken into account early on, improving resulting systems in a much more fundamental manner than today’s incremental improvements following established design paradigms.

The key to realising design assistant systems of practical impact in dynamics and mechanics is to go beyond the state of the art in system analysis, optimisation, and design by integrating methods from artificial intelligence and machine learning. For instance, machine learning methods can be valuable tools to infer surrogate models and response surfaces that can be used to make manageable the calculation effort for large-scale analysis as part of automated design procedures relying on multicriteria optimisation. Methods from artificial intelligence may even directly make certain creative design decisions. However, since machine learning and artificial intelligence have recently thrived mostly in fields far from the design of dynamic systems, it is, as yet, rather unclear which methods will be best-suited and, in particular, how they can be combined with system analysis and optimisation to achieve better designs. Therefore, a central goal of the Priority Programme is to develop benchmark processes for various applications that can demonstrate the functioning and

advantages of a design process supplemented by artificially intelligent design assistants. These benchmark processes shall pave the way from an analysis-centric to a criteria-centric design process. Ideally, the design assistant components should be highly flexible with easily accessible interfaces so that they can be combined modularly to build up increasingly holistic, assisted design procedures, and to serve as a foundation for continued research in the second funding period.

It is the aim to pool the expertise in dynamics/mechanics, mathematics, information technology, and control engineering in Germany, and to create new and strengthen already existing networks to achieve the set goals.

In the first funding period, the Priority Programme will drive research towards the following areas:

- replacement of subjective evaluation criteria by formalised objectives in all application fields of dynamics in mechanics and mechatronics, as well as the introduction of data-driven instead of rule-based criteria and the evaluation of new and advanced kinds of systems that incorporate, e.g., artificial intelligence, network communication, and/or advanced dynamic control methods;
- development of methods for the flexible coupling of different analysis programmes, used for the acceleration and systematisation of the search for optima by relying on machine learning and artificial intelligence;
- validation of design assistant systems in various application fields, including the development of benchmark processes to demonstrate the resulting advantages; application fields and design goals may include, e.g., the multicriteria optimisation of kinematic properties and the dynamic behaviour of mechanisms, robots, and flexible multibody systems, the choice and design of control strategies for mechatronic systems, and the robustness of designs with respect to aleatoric and epistemic uncertainties.

Project proposals should ideally address all three areas. In any case, submitted applications must clearly put emphasis on design assistant components and comment on the positioning of the project proposal within the framework of the overall research programme, and on its contribution as well as the added value in the above-mentioned areas. Furthermore, it is expected that proposals provide clear visionary aims with a strong connection to specific engineering design questions from mechanics and dynamics. In contrast, projects solely restricted to either theoretical or numerical methods in artificial intelligence, machine learning, optimisation, modelling, surrogate modelling, model reduction, system analysis, or pure control engineering will not be supported by this programme. There must be an explicit link to design questions beyond the established state of the art. Consequently, also projects solely focusing on classic single-criterion topology or shape optimisation are excluded.

Within the central coordination project the different proposed design assistant components will be connected. It is expected from every project to support these software activities by sharing and providing modules.

Applications for the first three-year funding period are now invited. Besides individual projects, joint proposals of two applicants from different research fields are welcome in order to obtain the required high degree of multidisciplinary. Larger-scale cooperation should, however, develop between the projects of the Priority Programme and not instead happen solely within individual projects. Therefore, project proposals with three or more applicants are discouraged.

Proposals must be written in English and submitted to the DFG by **2 November 2021**. Please note that proposals can only be submitted via elan, the DFG's electronic proposal processing system. To enter a new project within the existing Priority Programme, go to Proposal Submission – New Project/Draft Proposal – Priority Programmes and select “SPP 2353” from the current list of calls.

In preparing your proposal, please review the programme guidelines (form 50.05, section B) and follow the proposal preparation instructions (form 54.01). These forms can either be downloaded from our website or accessed through the elan portal.

Applicants must be registered in elan prior to submitting a proposal to the DFG. If you have not yet registered, please note that you must do so by **27 October 2021** to submit a proposal under this call; registration requests received after this time cannot be considered. You will normally receive confirmation of your registration by the next working day. Note that you will be asked to select the appropriate Priority Programme call during both the registration and the proposal process.

The review panel meeting is scheduled for February/March 2022. The first funding period is planned to start in July/August 2022.

Further Information

More information on the Priority Programme is available under:

www.itm.uni-stuttgart.de/en/spp_2353

The elan system can be accessed at:

<https://elan.dfg.de/en>

DFG forms 50.05 and 54.01 can be downloaded at:

www.dfg.de/formulare/50_05

www.dfg.de/formulare/54_01

For scientific enquiries please contact the Priority Programme coordinator:

Prof. Dr.-Ing. Prof. E.h. Peter Eberhard, University of Stuttgart, Institute of Engineering and Computational Mechanics, Pfaffenwaldring 9, 70569 Stuttgart, phone +49 711 685-66388, peter.eberhard@itm.uni-stuttgart.de

Questions on the DFG proposal process can be directed to:

Programme contact: Dr.-Ing. Xenia Molodova, phone +49 228 885-2374, xenia.molodova@dfg.de

Administrative contact: Bianca Becker, phone +49 228 885-2489, bianca.becker@dfg.de