# Research and Development of Protection Equipment Against Harmful Substances (PEAHS)

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This bachelor assignment was executed for the Coördinatiecentrum Expertise Arbeidsomstandigheden en Gezondheid (CEAG) of the Dutch Ministry of Defence. The project is carried out in a multidisciplinary team in which the University of Twente supplies required Design Engineering (DE) knowledge, Utrecht University contributes physiological and biological data and CEAG provides information about the design problems and corresponding requirements. Previous contributions to this project were present in the form of multiple use scenarios, various solution directions, physiological parameters and biological factors influencing potential product development directions.

Previous contributions are placed into context and based on a 'typical' Design Engineering Process (DEP). This project revolves around the research and development of testing environments for PEAHS. Testing is an important stage in the Design Engineering Process (DEP) (see Fig. 1 top) and essential in advancing the project. The current prevalent testing practices have a strong focus on real-world, or in vivo, testing. In the context of this project however, this testing approach is expensive, slow and could provide significant challenges. A different approach is identified, testing and experimentation in the digital domain, or in silico.

This can be done via the use of Digital Twins (DT), a relatively new technology only made possible by developments over the last two decades. These DTs mirror the real world which removes the need for physical testing subjects. Developing such a DT takes time but earlier, more basic iterations can already provide important data to aid the design of PHEAS. Moreover, a DT can ultimately allow PEAHS designs to be tested in every scenario thinkable. This keeps the DT relevant not only now but also in the future.

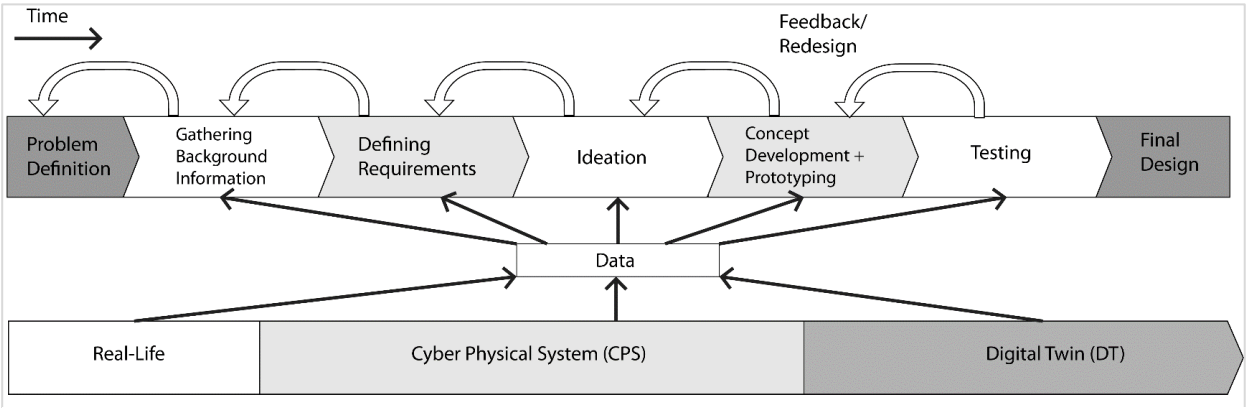


Figure 1. The Design Engineering Process (DEP) cycle supported by the Computational Design Tools (CDT).

The use of a DEP cycle creates a better scope of the possible phase-structures and process flow of the project. This in turn could be used to find gaps in the DEP and to find directions in which the project could be further developed. One of the main steps identified in the DEP was to enable testing of- and experimentation with prototypes. This can be done using models coupled with a multitude of scenarios conducted in digital-virtual environments and setups.

Cyber-Physical Systems (CPS) function as an intermediate step towards a fully digital model and environment, namely the DT. The idea to create several CPSs to test a variety and diversity of complex

physiological factors and challenges is key to this project. All the generated data and information will assist in the creation and development of the DT (see Fig. 1 bottom).

The testing setup and material which is now available make it possible for the project to progress to a point where more emphasis can be laid on the designing of potential PEAHS solutions for future product development.