

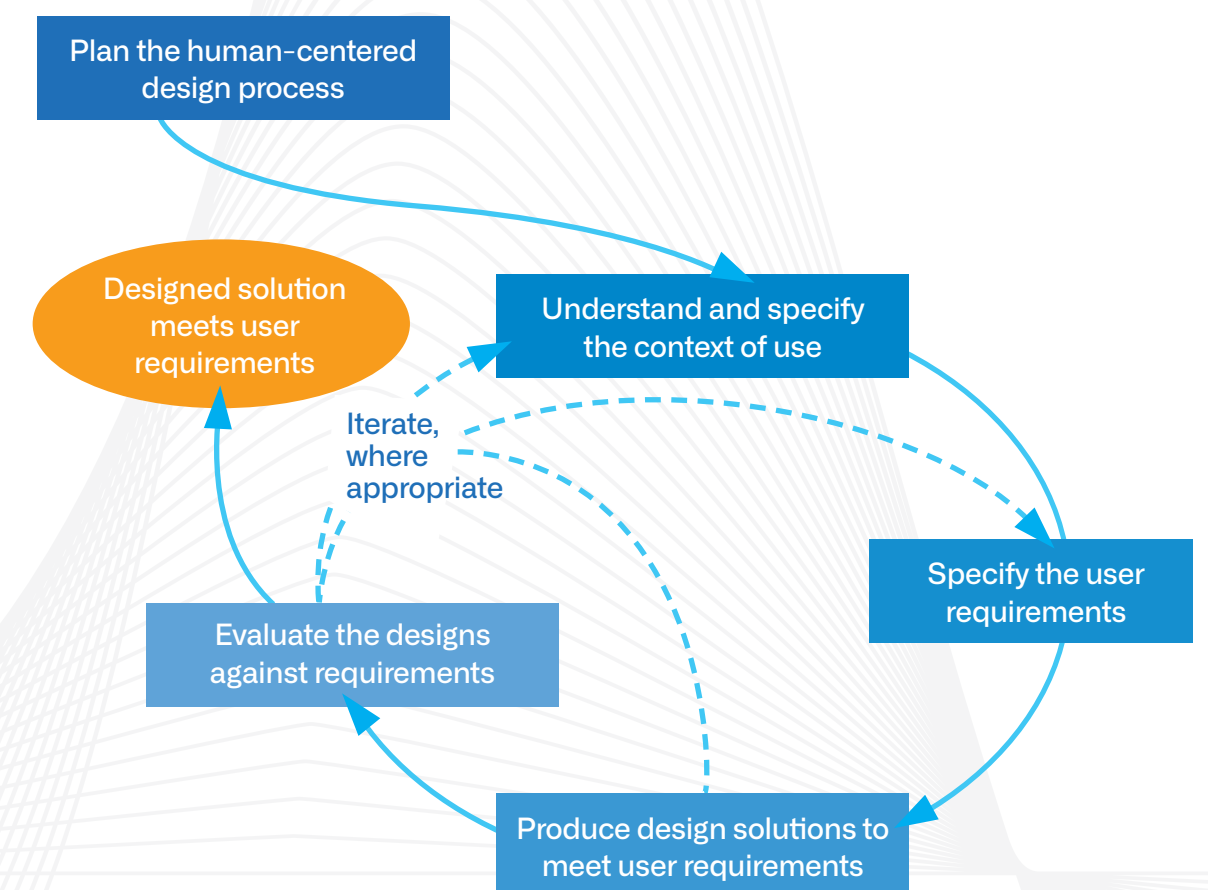
PEOPLE FIRST, TECHNOLOGY SECOND

The importance of user-oriented design in air traffic management

People are an integral part of safe Air Traffic Management (ATM) operations at all levels. While technological advancement is continuous as we develop more and more sophisticated systems and machines, users change relatively little over time. Moreover, when technology fails, human creativity and skills of improvisation still remain the last line of defence. This is why it is so important to understand users first, rather than technology.

Human Factors (HF) – the discipline supporting human performance – strives to ensure that the interrelationship between humans and machines can reach its full potential. At its core, it is a user-centred design process where the perspective of end-users provide both the starting point, and critical validation reference point throughout development. Human factors analysts (often with a background in psychology and user experience research) have the tools and expertise to identify and define these points.

At HungaroControl, our HF team applies a human-centred design approach (see Figure 1) throughout the lifecycle of projects to ensure that every ATM solution meets user requirements.



1. Figure: Human-centred design process ^[1]

DIFFERENT TECHNIQUES CAN BE APPLIED DEPENDING ON THE MATURITY OF THE EXAMINED CONCEPT. NONETHELESS, THE FOLLOWING USABILITY PRINCIPLES SHOULD BE ADHERED TO:

1. A DESIGN INSPIRED BY THE EXPLICIT UNDERSTANDING OF USERS, TASKS AND ENVIRONMENTS

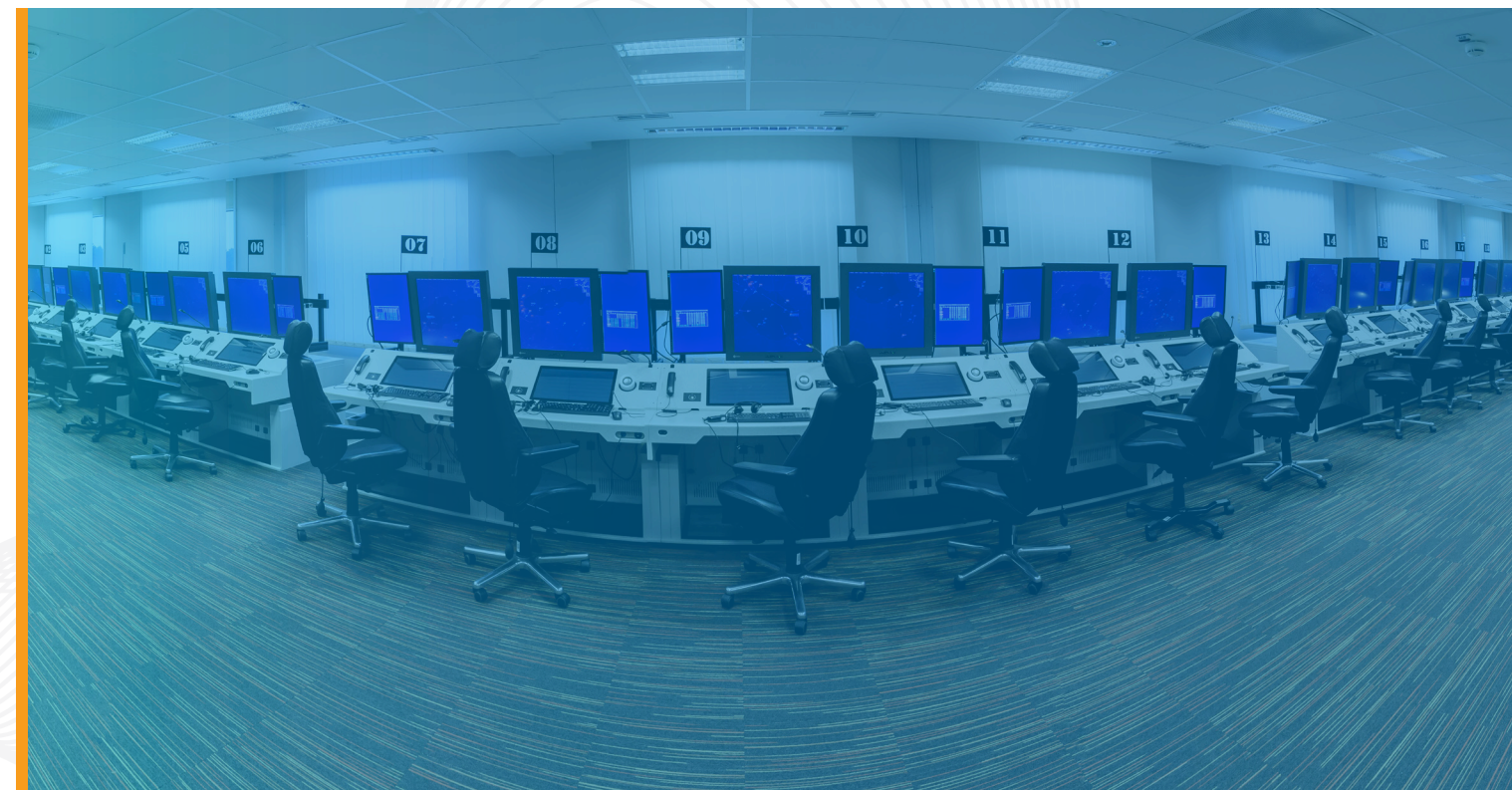
The starting point of any user research is to have a clear description of the users, tasks, equipment, physical and the social environments in which the new concept or system is used ^[2]. As projects often focus on system and user interface design, it is first important to understand the users impacted by new concepts or systems. Interestingly, it is not always as straightforward as it may seem at first glance – interviews and workshops with system designer-developers, air traffic controllers and safety experts can shed intriguing light on the variety of affected users. Site visits are also encouraged in order to have a strong grasp of user requirements in the context of the operating environment. Making observations and asking open questions in the operations room are crucial to understanding the context of use. Let us say that you are about to undertake a remote tower implementation project. Getting the context of use right can help with the placement of the Controller Working Positions (CWP) and their equipment within the operations room. Over the course of workshops and interviews with identified end-users, HF Analysts will define user requirements that the new concept or system has to meet. The consolidation of requirements should not be an isolated activity. Such discussions will ensure a common awareness and commitment to satisfy requirements at the later development stages, and may even identify emergent requirements.

2. USER INVOLVEMENT THROUGHOUT DESIGN AND DEVELOPMENT

Whatever concept that is being designed and tested, the aim is to always establish confidence and trust. This calls for end-users identified in the first step to be actively involved from start to finish. It is safe to say that all projects are rather unique – be it a custom-made ATM system or a new ATM operating concept – thus there is an opportunity to have a direct influence on the design as it evolves ^[1]. In every research and development (R&D) project there is a core group of end-users who participate in the concept definition and design phase. However, a wider and more representative stakeholder group should be involved to evaluate the solution and to propose recommendations. Such recommendations need to be accounted for and implemented as much as possible to ensure user acceptance and commitment. For HungaroControl, this is the path we followed with the introduction of the Hungarian Free Route Airspace (HUFRA) and our contingency remote tower operations project. Similarly this is our adopted approach in our participation of Single European Sky ATM Research (SESAR) 2020 activities.

3. THE DESIGN IS DRIVEN AND REFINED BY USER-CENTRED EVALUATION

Defining user requirements is not the end of the journey, in fact, proposed solutions have to also be tested by end-users. The evaluation should not be planned for the final acceptance phase, but rather it should be integrated in the design phase to minimise the risk of a concept or system not meeting user requirements ^[1]. At HungaroControl, we use various evaluation methods to test a concept or system depending on the maturity of the solution. At our radar simulator for validation activities – Simulation HUB (see Figure 2) – we ran human-in-the-loop simulations to validate Free Route Airspace and terminal airspace optimisation concepts. More recently, the SESAR 2020 Flight-centric Air Traffic Control (ATC) validation project was conducted together with experts from DLR and Frequentis. We are now preparing to conduct the usability research phase of a pseudo-pilot simulator interface design project for a major European air navigation service provider (ANSP). In this case, our end-users are pseudo pilots who have been actively involved in workshops to specify users' needs.



2. Figure: Simulation HUB at HungaroControl

4. THE PROCESS IS ITERATIVE

It is obvious that a new concept or system has to be tested prior to implementation. However, realising the perfect solution is rarely possible with only one iteration. This was a lesson that we learned from extensive experience in delivering various projects. Given ATM concepts and systems are traditionally complex, there is a high likelihood that many considerations are not taken into account during the specification phase. Remember that certain needs will inevitably emerge in the course of development; some system functionalities may not work yet in accordance with the usual ATC practices. System designers will gradually gain more understanding of the users' expectations based on their feedback, and subsequent iteration phases address identified gaps between the designed solution and user needs.

5. THE DESIGN ADDRESSES THE WHOLE USER EXPERIENCE

Designing an interface that is easy to use and assists users in achieving their task goals is only part of the story. User experience – the end-users' perceptions and emotions when using the system – is closely tied to usability. It is a factor that should not be neglected. As an example: we were in the process of defining user requirements for a new ATM subsystem, when some users mentioned the need for user manuals, support from the supplier and appropriate training to be comfortable working with the system. User requirements can be broad, but also specific. For example, colour coding of a human-machine interface to enhance situational awareness was an identified need that enhanced the experience of managing the system in one of our R&D projects. All these personal factors need to be considered to ensure user acceptance.

6. THE DESIGN TEAM IS MULTIDISCIPLINARY AND DIVERSE

Dedicated human-centred design teams are rather scarce at ANSPs. Nevertheless, the methodology to undertake effective research and design activities requires establishing a diverse and skilled team that represents all domain areas. At HungaroControl, operational experts, system designer-developers, flight procedure designers, ATM specialists, safety, human performance and simulation experts, and project managers with an extensive skills base work together. Such a multidisciplinary approach allows us to consider issues and benefits from a variety of perspectives, and at the same time, ensures that all design aspects have been addressed.

The methodology we use has proven to be an effective way to collaborate and integrate HF into concept and system designs. All that being said, HungaroControl continues to strive to remain innovative. A key part of this is our role in a major international R&D project which targets the further improvement of the human-centred design process in aviation and maritime. We strongly believe that the integration of HF analysis into ATM technology design and development is a priority for projects aiming to maximise human performance concurrent with technology implementation.

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² Drogoul, F. (2011). Support Material for Human Factors Case application. Edition Number: 3.0. European Organisation for the Safety of Air Navigation (EUROCONTROL)