Task Analysis Within The System Model – The Single Source Of Truth

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SUMMARY

Contemporary military platforms are designed within a Systems Engineering environment. This paper describes how the use of the System Model and HCI wire-framing are being utilised to replace the traditional tabular task analysis as the Single Source of Truth of vehicle's design.

KEYWORDS

Task Analysis, Systems Engineering, System Model

Introduction

The Task Analysis (TA), as illustrated by Kirwan & Ainsworth (1992), has been an inherent part of the system design process as highlighted by the often-used statement; *'design in accordance with the task analysis'*. Contemporary platform design and development occurs within the Systems Engineering multi-disciplinary approach to the realisation of complex systems as described in ISO 15288 (2015). Military vehicles are becoming increasingly complicated, with multiple systems being integrated into an effective capability. These vehicles are rarely completely bespoke designs, but rather a complex integration of commercial / modified-off-the-shelf sub-systems within the overall platform design, that is the responsibility of the System Integrator (or Prime Contractor). Furthermore, the requirement for compliance with a multitude of standards (including Human Factors), and the available budget/resources, restricts the design options open to a System Integrator's design engineers, leaving the resultant platform as an optimised compromise.

The TA can be a contractual requirement of UK MOD procurements where the system design is mandated to be in accordance with the TA. In the experience of the authors the TAs definition is typically based on the traditional tabular TA format. This can lead to an *unwieldy* TA, which for complex platforms can result in a TA that runs to over 10,000 lines. Such large impractical 'documents' lose their effectiveness in informing, driving, managing, validating and assuring the system design. Furthermore, while the intent of TA documents is to detail user tasks, they can lack insight into how the user is a part of the information processing system. The intent of this paper is to examine a model which better represents the role of the human within the system.

The design of military vehicles within the SysEng process is driven by the System Requirements (SR), and informed by the platforms intended Concept of Operations (CONOPS) / Concept Of Use (CONUSE). The SysEng process is described by the 'V-Model' (MOD JSP 912 Pt2, Figure 4) where the overarching SRs are decomposed into a vast array of detailed SRs, and divided up into specific domains, including the transversal HFI domain. This decomposition, from descriptions of the proposed operational battlefield day produces Operational Event Sequence Diagrams (OESD) which provide increasing operational granularity to inform the system design details. In addition to the requirements decomposition, understanding the crews part in delivering the platform's performance is also an essential consideration. This includes their Situation Awareness (SA) and subsequent decision making, with crew performance models being used to inform the design of the system. This allows for the design to consider the platform and its crew as working seamlessly together as a Joint Cognitive System (JCS) to deliver the required capability. By adopting the JCS perspective, this can influence the ability of the technology to effectively support the crew e.g. by presenting the required information (i.e. processed data) in an intuitive format to support their SA and decision making. The System Modelling Language (SysML) can provide the link between SysEng and HFI. The system model is the platform Single Source Of Truth (SSOT), as it defines all aspects of the design, e.g. Sub-System Specifications (SSS), sub-system interaction, and the human interaction. Effectively, the SysML takes the place of the TA, and via its activity and sequence diagrams illustrates the crew's tasks and their interaction with the system. Although the SysML is owned by the SysEng domain, it facilitates communication and cooperation between the domains (e.g. electronic architecture and HFI) so they can work in an integrated and coherent fashion. The HFI domain has a responsibility for the representation of the crew within the SysML, the components they interface with (e.g. displays and controls), and the human-system functionality required to deliver the system's capability. This means that as the design of the system undergoes the progressive assurance process to demonstrate compliance with the SRs, the SysML based TA concurrently demonstrates the crew interaction with the platform and its sub-systems.

Previous generations of vehicles were generally analogue in nature, with electrical and limited electronic systems. Contemporary vehicles are digitised with electronic systems that are integrated with multiple sensors and are network-enabled. Sequential/linear tasks (SysML use cases) can be straightforwardly described, but a digital capability allows users to perform multiple functions, in various orders, with the ability to switch between concurrent tasks. This means that there is an infinite number of task switching iterations that could be examined. Pragmatically, an impossible analysis task, particularly if utilising a list-based tabular TA that does not include the system / sub system functionality. The SysML activity and sequence diagrams are traditionally developed to a level of detail to support the SSSs and software development, but current design work requires an increased level of crewstation functional detail – e.g., their displays, control handles and control panels. The digital displays, designed in compliance with HF (DEFSTAN 00-251) and Generic Vehicle Architecture (GVA) (DEFSTAN 23-09 Pt2) standards, are developed using 'wireframing' techniques, e.g. using AXURE software, which allows the look, feel and functionality of the screens to be iteratively developed with the end-users, whilst ensuring that they remain aligned with the SysML SSOT. Therefore, the SysML and the wireframes together act as a contemporary TA, whilst providing a more nuanced level of functional detail that also supports the progressive assurance process demonstrating SR compliance. An example of the linking of the SysEng process, the SysML and the HFI / HCD process is described by Watson et al. (2017).

In conclusion, the development of the contemporary TA, based on the SysML SSOT and HCI wireframes, demonstrates a higher level of integration between the HF and SysEng domains when designing and assessing complicated platforms with multiple systems and sub-systems. As more experience is gained in the use of the SysML, and its development to better illustrate the details of the crew interaction, the more influence the HFI domain will have on the vehicle system design, including the Training, Safety and ILS domains which are also referenced to the SysML SSOT.

References

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