Setting the standard

Standards play a key role in making sure best practice is followed but applying them can be a balancing act, with budgets, schedules and constraints on the system you're designing all needing to be kept in mind. Victoria Valentinova outlines the steps taken to tailor a standard from the USA to help to create a new air traffic management system in Australia

Applying standards to system design and ensuring compliance with those standards is a common approach, not only in human factors but also more widely within systems engineering. Standards provide a structured and, arguably, rigorous way to ensure best practice principles are adhered to during the design phase.

This is of particular relevance when the system being designed is considered safety-critical, as optimising the design of the system is an essential enabler to achieving good human performance outcomes during the operations and maintenance phase. But how can we ensure rigorous and effective application of standards while balancing the constraints imposed on the system design and still being able to deliver programmes within budget and schedule?

This article describes an industry-based use case, illustrating how the USA's Federal Aviation Administration Human Factors Design Standard (FAA HFDS) was tailored to inform the design of a new air traffic management system which will replace the current independent civil and defence Australian air traffic management systems with an advanced integrated system known as the Civil Military Air Traffic Management System (CMATS).

So first of all, what is the FAA HFDS? Modelled on MIL-STD-1472, the FAA HFDS contains much of the guidance provided within the FAA Human Factors Design Guide (HFDG 1996).

The standard also refers to other standards and practices widely applied within the international HF community and includes more than 4,500 clauses. Given that not all of the FAA HFDS clauses may be applicable to every system, a key aspect to consider when applying it is the selection of appropriate clauses for a given project and then wording them into system-specific rules for the project. This is described as 'tailoring' of the standard. Much of the HFDS is

written at an implementation-specific level, and therefore requires a good knowledge of the intended system as well as detailed understanding of how this solution should fulfil the overall human and overall system performance needs.

In the introductory section of the standard, the FAA emphasises that the application of the total HFDS would likely result in a cost-prohibitive solution and that tailoring should be performed in a way that avoids unnecessary efforts, overly restrictive design, and exorbitant costs. The tailoring process includes selecting the appropriate clauses and modifying the clauses to ensure that there's an optimal balance between operational needs and costs. But the challenge lies in that there is no specific guidance on how to achieve this. In the particular case described here, undertaking tailoring of the FAA HFDS to inform the CMATS design was a contractual requirement for the human factors programme. A compliance matrix for the agreed clauses had to be provided as part of the programme deliverables, which had to:

1. Clearly indicate where a particular clause is met or not met;
2. Provide a description of how the intent of the clause is met; and
3. Where not met, provide justification for this.

In response to this programme requirement, a strategy for the application of the FAA HFDS needed to be developed. Strong focus was put on ensuring that the strategy was commensurate with the perceived level of human factors risk of the programme.

The strategy we developed consisted of five distinct phases, explained below:

Phase 1: Develop the classification framework to be used for the tailoring. We developed a classification framework that had two levels:

1. At the first level, the HFDS clauses were categorised between "Applicable", "Not Applicable" and "To be Determined". You may wonder >

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why the "To be Determined" category was needed. As previously stated, much of the HFDS is written in an implementation-specific manner. This categorisation was used for particular clauses for which applicability cannot be determined until the design solution attains greater maturity and are subject to further evaluation. An example of such clauses is HFDS-REQ-02624, stating: "A box should be drawn around a group of radio buttons to visually separate the group from other interface features." Before the system design has evolved to sufficient detail to determine if radio buttons are indeed used as part of the human-machine interface (HMI), it's not possible to determine if this clause (and all other clauses related to radio buttons) are applicable to the system or not.

2. A second level of classification was then applied. For applicable clauses, this second level classified them into "Derived into Requirements", "Detailed Design Guidelines" or "Satisfied by an Existing Contractual Requirement". For clauses categorised as not applicable, clauses were then classified between "Not Relevant", "Not in Scope", "Traded-off" or "Low Human Factors Value".

For each of these classifications, a definition was developed, and some examples were provided. The classification was also accompanied by a description of the treatment type, which ranged from formal compliance to be demonstrated to just the provision of justification for exclusion.

Phase 2: Application of the classification framework. This consisted of a long phase of desktop analysis, which culminated with the production of the HFDS compliance matrix, followed by a series of workshops with customer representatives, including human factors specialists and end-users, to ratify the proposed classification.

Phase 3: Establish the system constraints. Once the tailoring was completed, human factors requirements were developed for all applicable HFDS clauses classified as to be derived into human factors requirements. These requirements were included in the system specification and further derived into the subsystems' specifications at a later phase of the engineering lifecycle.

In addition, a human factors design philosophy was developed. In this document, the applicable HFDS clauses classified as Detailed Design Guidelines were organised by themes and explained in a way that allowed the rest of the engineering team to apply them to design. As part of this phase, we also embarked on another activity to assess their applicability to different subsystems that comprised the CMATS solution. This allowed us to refine the application of clauses even further by only targeting subsystems for which those clauses were of relevance.

Taking the example above, we concluded that radio buttons were used in most subsystems forming part of the CMATS solution, whereas clauses related to the physical location of equipment only applied to the infrastructure-related elements of the solution. This targeted application was another step undertaken to ensure this tailoring HFDS application was as efficient and effective as possible, minimising the cost associated with the subsequent phases of the activity and allowing HF resources to focus their efforts on the areas where their inputs were needed most.

Phase 4: Iterate at different phases of the engineering lifecycle. Several iterations had to be undertaken to re-classify all clauses initially assigned the To Be Determined category as the system design progressed and some of the uncertainties that prevented us from determining applicability were resolved. Updates to clauses previously categorised as Applicable or Not Applicable were also made where necessary. A simplified version of the diagram created to illustrate the tailoring methodology and its relationship to the engineering lifecycle is presented below.

Phase 5: Assess compliance. Once it was clear which clauses applied to the design of the system (and also which particular components or subsystems), human factors requirements followed the standard verification and validation lifecycle as part of the system specification. For the clauses classified as Detailed Design Guidelines and included in the human factors design philosophy, a combination of desktop analysis, end-user evaluations and assessment summary reports were used to assess and document compliance. For applicable clauses that were deemed satisfied by existing contractual requirement, a reference to the specific document demonstrating its application was provided.

The results obtained from the assessment of compliance phase were analysed by the human factors team in terms of the level of human factors risk associated and impacts on human performance. This provided a unique avenue to influencing the system design, with recommendations passed on to the designers to rectify the identified issues before progressing onto the next phase of human factors evaluations.

In conclusion, developing a methodology to tailor and apply the FAA HFDS to the design of the CMATS solution in a way that was rigorous and effective while also avoiding unnecessary efforts, overly restrictive design and exorbitant costs was undoubtedly one of the key challenges of the human factors programme. And while it's possible to argue that there are more effective or innovative ways to achieve good human factors design, this methodology allowed the human factors team to exercise a great amount of influence over design decisions that ultimately would influence human performance. ■

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