Security through Usability: a user-centered approach for balanced security policy requirements

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I. Motivation

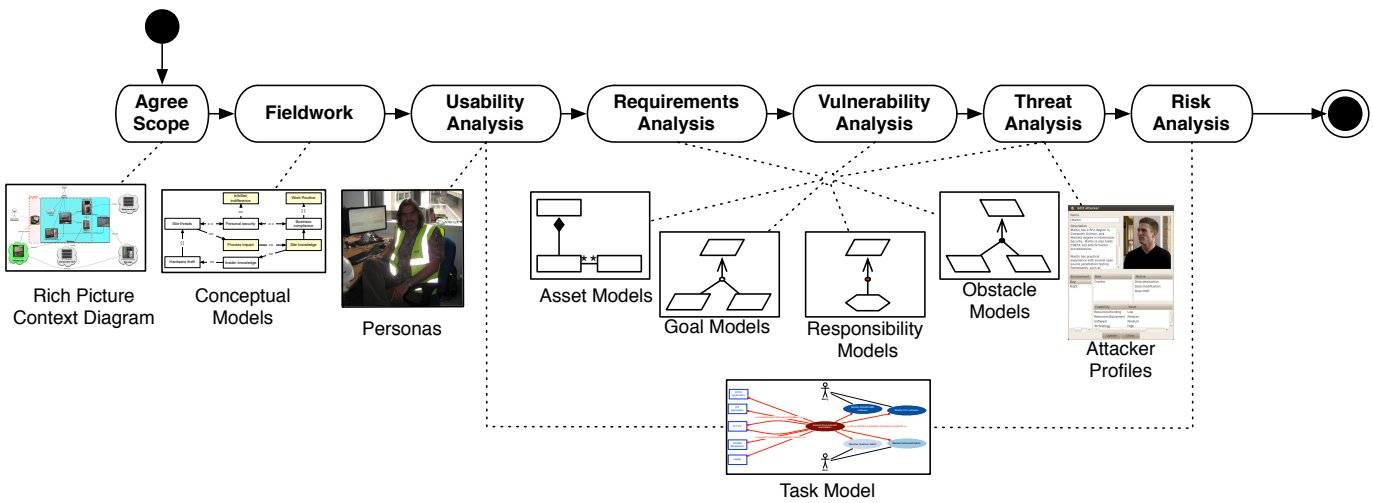
Security policy authors face a dilemma. On one hand, policies need to respond to a constantly evolving, well reported threat landscape, the consequences of which have heightened the security awareness of senior managers. On the other hand, the impact of policies extend beyond constraints on desktop computers and laptops; an overly constrained policy may compromise operations or stifle the freedom needed for staff to innovate. Because few people are fired for making a policy too secure, as long as usability continues to be treated as a trade-off quality together with functionality then policies will err on the side of constraint over freedom of action. Existing work [9] argues that balanced security can be achieved using Requirements Engineering best practice. Such approaches, however, treat usability as another class of quality requirement, and prescribed techniques fail to elicit or analyse empirical data with the same richness as those used by usability professionals. There is, therefore, a need to incorporates techniques from HCI into the task of specifying security, but without compromising Requirements Engineering practice. Recent work demonstrated how user-centered design and security requirements engineering techniques can be aligned [5], [6]; this approach was validated using a general system design project, where ample time was available to collect empirical data and run participatory requirements and risk workshops. The question remains whether such an approach scales for eliciting policy requirements where time is an imperative rather than a luxury.

II. Approach

We have devised a user-centered process for eliciting security policy requirements. Like the process in [6], it begins by agreeing the system scope and key roles with project stakeholders. This stage is followed by fieldwork and usability analysis. During the fieldwork stage, empirical data is collected about how users carry out their day-to-day work. This data is analysed and modelled using a qualitative data analysis methodology [3] to discover important user characteristics. This data is fed into the design of personas representing archetypical users [2], and task scenarios describing the activities they carry out.

Rather than undertaking lengthy participatory requirements and risk analysis workshops, the subsequent analysis is carried out exclusively by analysts in a number of stages. First, assets of value are modelled in UML based asset models. Second, the KAOS goal oriented requirements engineering methodology [4] is used to construct a goal tree of policy requirements. Leaf goals in these trees are assigned to specific roles. Goals may be obstructed using obstacles, which represent conditions

Fig. 1. Policy development process overview



preventing a goal from being achieved [8]. Although analysing goals may suggest possible vulnerabilities and threats, these are primarily defined from the empirical data used to define personas and tasks; previous work [6] found that fieldwork data can also be used to glean information about possible threats and vulnerabilities. Associated with each threat are attacker profiles; these are created using Open Source Intelligence, or published literature on related attacks. Where possible, policy requirements for mitigating these vulnerabilities and threats are elicited at this stage. The next stage involves specifying risks, where a single unmitigated threat exploits a single unmitigated vulnerability. Associated with each risk is a Misuse Case describing a scenario where the attacker carries out the activities necessary to realise the risk. Data from all stages are entered into a dedicated software tool [1], which structures the data, automatically visualises different models, and generates a DocBook policy requirements specification. This tool is described in more detail in [7].

The final stage involves a participatory workshop, where Misuse Cases are discussed by project stakeholders. Using Misuse Cases as boundary objects, this workshop aims to collectively elicit the remaining policy requirements mitigating these risks. Each Misuse Case is illustrated in a Task Model; this model contains the related attacker (or attackers), endangered assets, and personas and tasks related to these assets. Both the tasks and Misuse Cases are represented as coloured ellipses based on a quantitative usability and risk impact score generated by the software tool. When it has been agreed that a Misuse Case has been mitigated, the next Misuse Case is discussed.

III. Preliminary results and Future Work

We applied this approach to define the policy requirements for SCADA (Supervisory Control and Data Acquisition), Telemetry, and Control System software for plant operation staff at a UK water company. After agreeing the system scope and roles, we visited 4 different water treatment plants and, after subsequent usability analysis, one persona and 4 task scenarios were defined. During the initial requirements analysis, 102 policy goals were elicited, the leaf goals of which were assigned to 8 different roles. At an early stage, it was observed that IT support staff were responsible for a disproportionate number of policy goals, as opposed to plant operation and security staff. Based on the empirical data, 8 vulnerabilities, 8 threats, and 4 possible attackers were identified; 3 of these vulnerabilities were mitigated at an early stage. Eight risks were identified based on specific combinations of unmitigated threats and vulnerabilities. A participatory workshop was held to review the Misuse Cases associated with these risks; of these, two Misuse Cases were discussed in detail during the workshop. Based on the discussions, several additional policy requirements were elicited, while others were de-scoped from the study.

Preliminary results suggest that structuring risk analysis discussion around Misuse Case narratives helped ground the discussion about risk impact in the real world. One of the Misuse Cases explored the impact of a virus infecting SCADA workstations. Discussing the impact of policy decisions on the plant operator persona's work simplified policy requirements; in this specific case, the system attack surface was reduced by removing system functionality unused by the persona. Our results also indicate that this process can be completed comparatively quickly. The fieldwork and usability analysis stage was carried out in a little over a week, while the complete study took less than a month. Our results also re-affirm the usefulness of user-centered design techniques for providing supplemental data for security analysis. These techniques do, however, rely on the ability to carry out ethnographic research and qualitative data analysis, the results from which must be interpreted before personas and tasks can be built. We are currently exploring how argumentation structures can be used to build design rationale links between qualitative data and personas. This work potentially enables usability specialists to develop personas based on specific characteristics, which can be tracked back to its originating data.

IV. Acknowledgements

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References

[1] CAIRIS web site. http://www.comlab.ox.ac.uk/cairis (September 2010)
[2] Cooper, A.: The Inmates Are Running the Asylum: Why High Tech Products Drive Us Crazy and How to Restore the Sanity (2nd Edition). Pearson Higher Education (1999)
[3] Corbin, J.M., Strauss, A.L.: Basics of qualitative research : techniques and procedures for developing grounded theory. Sage Publications, Inc., 3rd edn. (2008)
[4] Dardenne, A., van Lamsweerde, A., Fickas, S.: Goal-directed requirements acquisition. Science of Computer Programming 20(1-2), 3 – 50 (1993), http://www.sciencedirect.com/science/article/B6V17-45FSTB2-10/2/605ddb5671131b8a28eb4d38d29cab5e
[5] Faily, S., Fléchais, I.: A Meta-Model for Usable Secure Requirements Engineering. In: Software Engineering for Secure Systems, 2010. SESS '10. ICSE Workshop on. pp. 126–135. IEEE Computer Society Press (May 2010)
[6] Faily, S., Fléchais, I.: Barry is not the weakest link: Eliciting Secure System Requirements with Personas. In: BCS HCI '10: Proceedings of the 2010 British Computer Society Conference on Human-Computer Interaction (2010)
[7] Faily, S., Fléchais, I.: Towards tool-support for Usable Secure Requirements Engineering with CAIRIS. International Journal of Secure Software Engineering 1(3), 56–70 (July-September 2010)
[8] van Lamsweerde, A., Letier, E.: Handling obstacles in goal-oriented requirements engineering. Software Engineering, IEEE Transactions on 26(10), 978–1005 (2000)
[9] Mead, N.R., Hough, E.D., Stehney II, Theodore R.: Security Quality Requirements Engineering (SQUARE) Methodology. Tech. Rep. CMU/SEI-2005-TR-009, Carnegie Mellon Software Engineering Institute (2005)