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PROJECT AT A GLANCE

Client:
Global electronic instrument manufacturer

Industry:
Oil and gas

Syncroness services:
- Project management
- Systems engineering
- Industrial design
- Manufacturing support

Objective:
- Modernize the graphical user interface of a sensor system to make it more user-friendly

RESULTS

By incorporating systems engineering into the product development process, Syncroness was able to help our client reduce the total field-testing time from six months to two months and decrease the number of testing sites by a third, ultimately minimizing costs and expediting speed-to-market.

INTEGRATING SYSTEMS ENGINEERING – HOW A DISCIPLINED ENGINEERING APPROACH DELIVERS RESULTS

To help our client develop a more user-friendly graphical user interface (GUI) for a sensor system used in the oil and gas industry, we integrated a systems engineering process that significantly enhanced their product development process.

AUTHORED BY JOHN GARDNER, SYNCRONESS

THE PROBLEM

The complex art of product development is often difficult to predict, frequently fraught with rework, and rarely repeatable. Changing requirements, late-stage redesign, errors due to lack of a common understanding of user needs, requirements arising during the verification/test stage, overdesigned products, and long field-testing (validation) periods can all increase costs and lengthen the development schedule. To overcome these challenges, we use systems engineering, a methodology used by the U.S. military, aerospace, and medical product development since the early 1950s.

EXECUTIVE SUMMARY

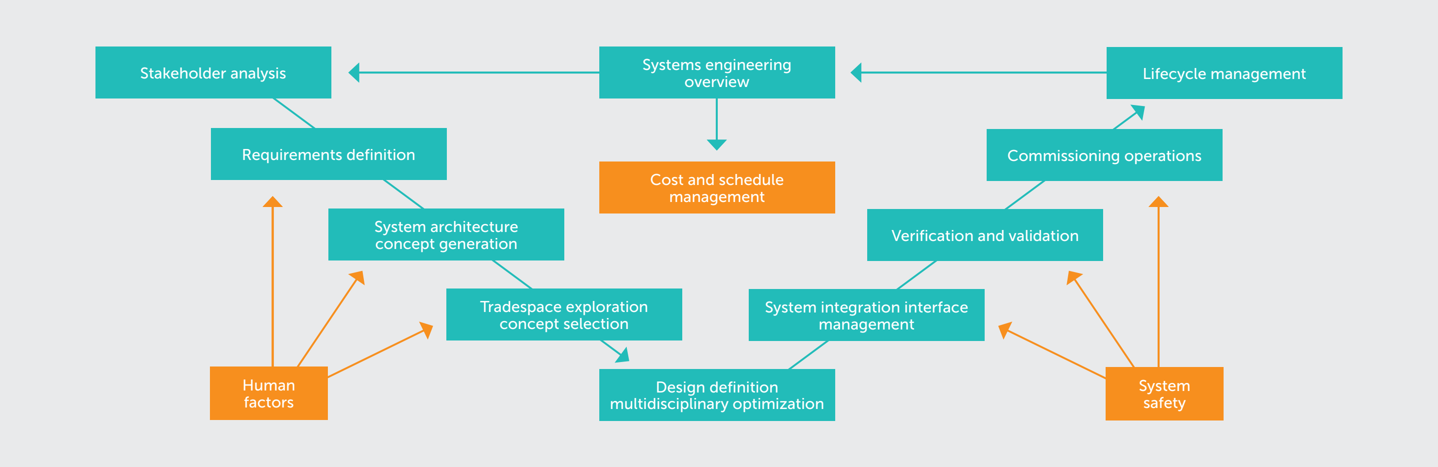
By incorporating the systems engineering process, we were able to help our client develop a better sensor system for use in the oil and gas industry – one that would offer ease-of-use and consistent performance across diverse locations. Adding systems engineering to the product development process allowed for early identification of requirements, thereby facilitating complete design with minimal downstream failures or new requirements added late in the process, which delay product launch.

THE APPROACH

Our systems engineering approach focuses on front-end planning, which enables us to ensure that product requirements are complete, unambiguous, and achievable. By building highly detailed specifications, improved use case definitions, and enhanced requirements traceability, we eliminate late-stage redesigns and the associated risks and costs. See Figure 1 for an overview of the fundamentals pertaining to systems engineering; Figure 2 details the systems engineering process.

FIGURE 1. FUNDAMENTALS OF SYSTEMS ENGINEERING

The components of systems engineering continuously consider stakeholder analysis, human factors, and system safety.



THE APPROACH

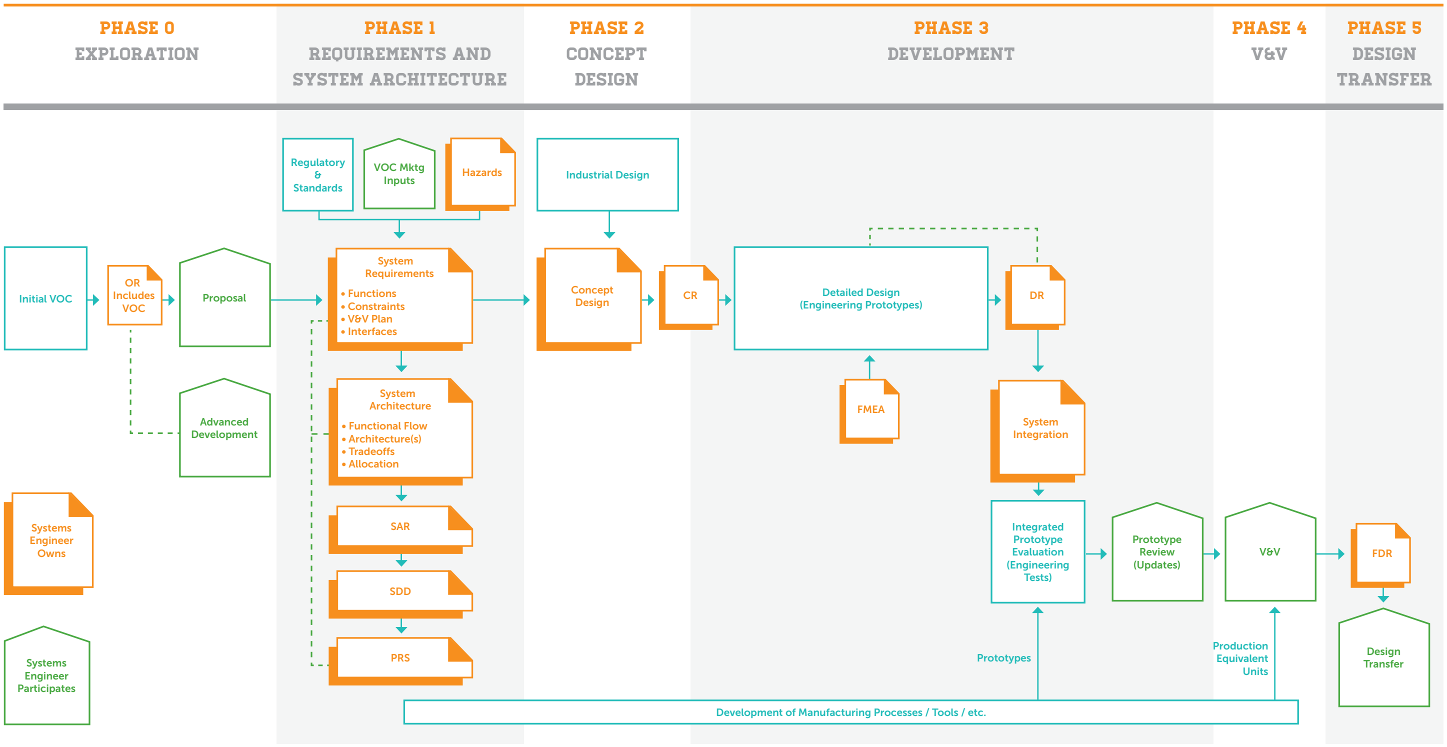
To help this global electronics manufacturer develop a better sensor system and get it to market faster, a Syncroness systems engineer was positioned onsite to lead the team through the product development process and assist with project planning and management. Next, we defined the use cases (see Figure 3), which explain how the product will be used and what the key user interactions will be. As with all of our projects, the use cases became a key part of the requirements and played a pivotal role in software design. After defining the use cases, we then outlined the product architecture, i.e., the major system components.

With the systems engineer at the whiteboard, we worked as a team to sketch typical scenarios. We initially found varied levels of understanding within the team but concluded with a series of flow diagrams that unified the team's understanding and formed the basis of the system performance requirements, which were eventually captured in the requirements document. Defining these elements reduced the probability of finding latent requirements and of discovering misunderstandings among team members later in the process, both of which result in schedule slip.

Next, we defined all of the "constraints," requirements that are not performance-based, such as thermal extremes, vibration, reliability, and manufacturing constraints. (For example, electrical components must be compliant with restriction of use of hazardous substances web requirements.) The systems engineer started the team discussion with a list of common constraints, defined during years of specification generation experience (military, medical, etc.). A big part of the process for the smart transmitter effort was to capture and integrate all of the requirements for hazardous location use (IEC 60079). By including these requirements and properly integrating them into the system model, we significantly increased the likelihood of quick downstream rating by a third party. Defining the system architecture was the next step, at which point we asked the team what major components (such as hardware, software, packaging, and literature) were needed to satisfy the now comprehensive requirements. In large, complex systems, it is recommended that this step be accomplished in parallel; with the smart transmitter project, we created the architecture as we defined the requirements. Upon conducting the requirements/architecture review, we were satisfied that both were complete. The smart transmitter architecture hierarchical view is depicted in Figure 4.

FIGURE 2. THE SYSTEMS ENGINEERING PROCESS

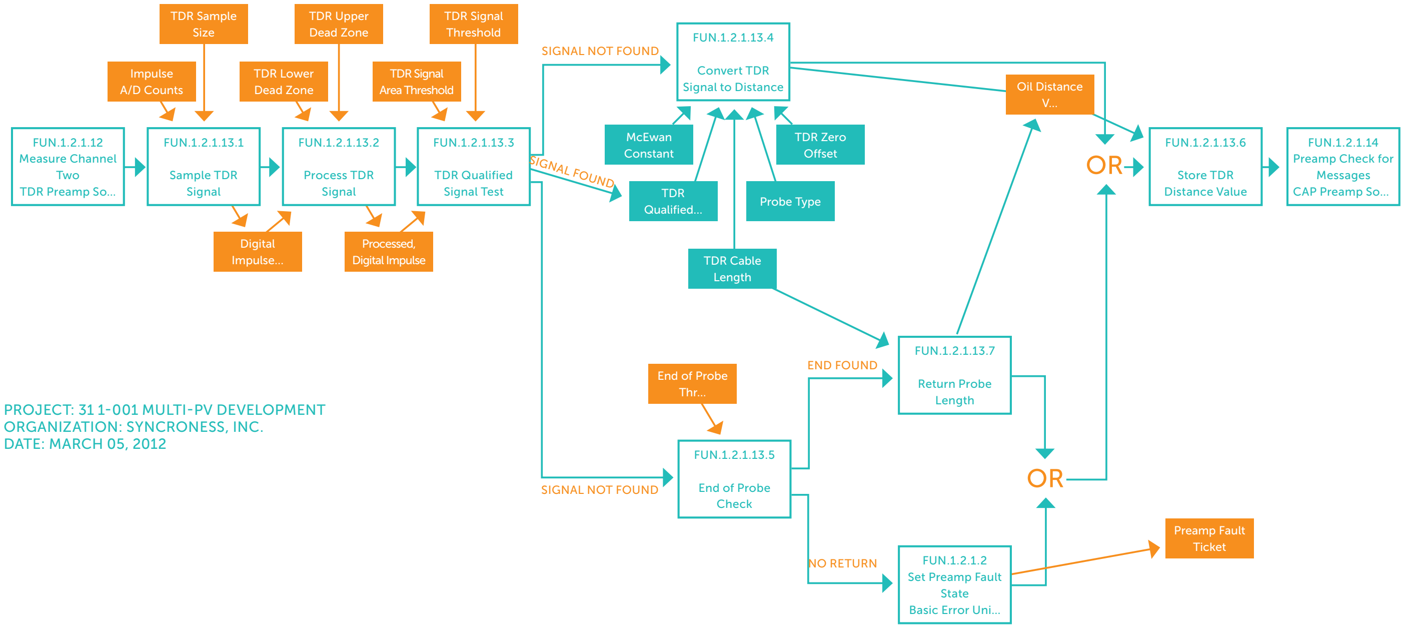
The systems engineering process offers deeper insight into procedural components. All members of the team come to agreement on the activities occurring in each phase.



THE APPROACH

FIGURE 3. EXAMPLE USE CASE FOR SMART TRANSMITTER

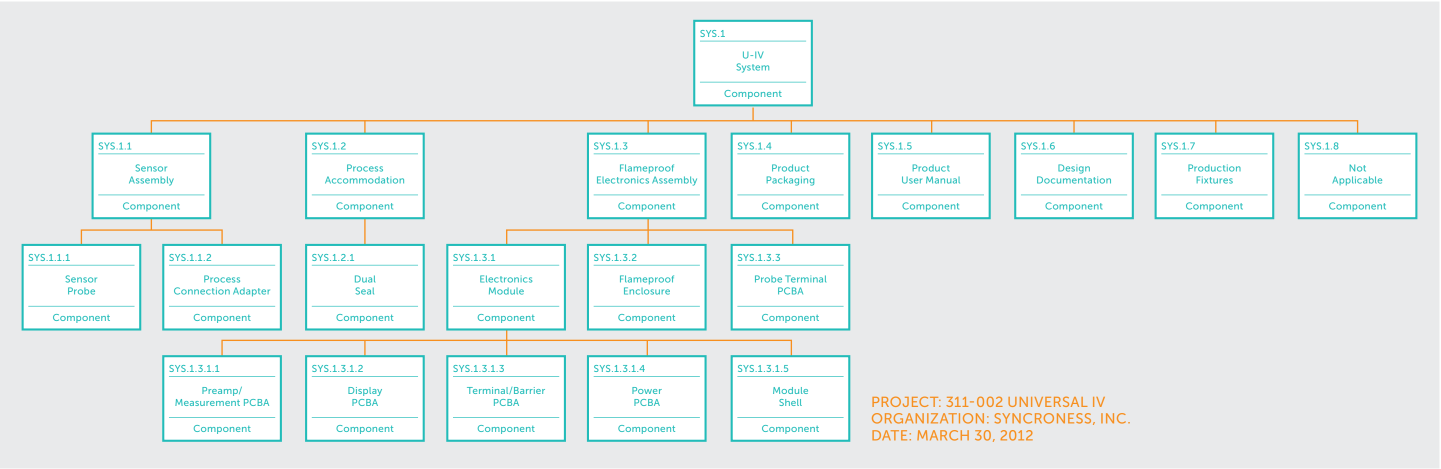
This use case for the TDR measurement component of the sensor system influenced the overall design, justified features, and provided background for requirements documentation.



PROJECT: 311-001 MULTI-PV DEVELOPMENT
ORGANIZATION: SYNCRONESS, INC.
DATE: MARCH 05, 2012

FIGURE 4. THE U-IV PHYSICAL ARCHITECTURE

System architecture is defined in parallel with use cases and other requirements. This optimizes the probability of collecting a complete set of design requirements and alignment of the team on product definition early in the process. This is captured in a form known as the “physical architecture.”



PROJECT: 311-002 UNIVERSAL IV
ORGANIZATION: SYNCRONESS, INC.
DATE: MARCH 30, 2012

THE RESULTS

Using the systems engineering approach, the team – some of whom were geographically dispersed from other team members – was then able to partition the remaining development work, something that had been attempted in the past but was not very successful, particularly with software. In essence, we took our approach down to the software development level, including requirements, functions, interfaces, and verification and validation (V&V). This allowed us to build the software and do the final system integration after all the pieces were available. The software and then the system, piece by piece, were assembled and tested, with minimal errors the first time.

Those members of the team responsible for V&V completed the project confident that we had appropriately “checked out” the system prior to launch. One free tool that’s available when we use systems engineering is traceability. When using a systems engineering tool, such as CORE, each requirement is traced (electronically linked) to its design implementation (architecture) and then to the verification method. We then created an Excel spreadsheet that showed the traceability of each V&V event to the actual results. A portion of the matrix appears in Figure 5.

Using these tools helped minimize the risk of finding post-launch issues. We did find areas for improvement, such as the bridge board that was not verified or tested as completely as we would have liked. Undoubtedly, trust will build with continued use of this process, and more complete V&V will be defined.

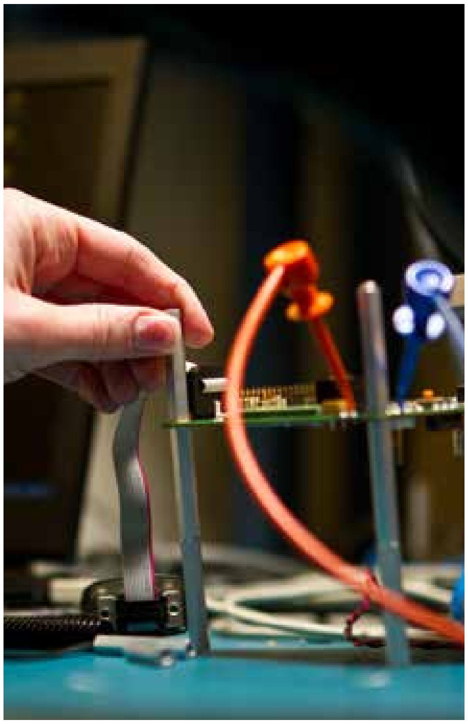


FIGURE 5. V&V EVENT TRACEABILITY EXAMPLE

This spreadsheet helped bring the design and V&V teams together, so everyone is aware of the test progress and results.

PRS #	SRS #	TEST NAME	TEST LOCATION	# UNITS	DURATION	UNIT	EQUIPMENT	OWNER
4.2.1	-	EN 61329-1:2001 EMI Test	Outside Testing Labs	3	1 week	?	None	V & V
-	6.2.4	Communications Protocol Test	Client Lab			Complete		Design/Engineering
-	-	Field Proving	Customers	10	8 weeks	Complete	None	Design/Engineering
-	6.2.9	Integrated Electronic Module Test	Client Lab			Complete		Design/Engineering
4.2.18	6.2.10	Boot Loader Test	Client Lab			Complete	None	Design/Engineering
4.2.22	6.2.11	Hart Protocol Test	Client Lab			Complete	Hartwin & Wincom Hart Handheld	V & V
4.2.24	-	Long Term Drift Test	Client Lab	3	12 months	Complete	TBD	V & V
4.2.29	-	Long Term UV Exposure Test	Client Lab	3	12 months	Complete	None	Design/Engineering
4.2.30	6.2.12	User Input Test	Client Lab	3	1 day	Complete	None	Design/Engineering
4.2.34	-	Response Time Test	Client Lab			Complete		Design/Engineering
4.2.38	-	Maximum Loop Resistance Test	Client Lab			Complete		Design/Engineering
4.2.12	-	High Storage Temperature Test	Client Lab	3	1 day	Core Func	Thermal Chamber	Design/Engineering
4.2.13	-	Low Storage Temperature Test	Client Lab	3	1 day	Core Func	Thermal Chamber	Design/Engineering
4.2.14	-	Unpackaged Vibration Test	Client Lab	3	1 day	Core Func	Vibe Table	Design/Engineering
4.2.15	-	Condensing Humidity Test	Client Lab	3	1 day	Core Func	Thermal Chamber w/Hum	Design/Engineering

THE RESULTS

REDUCED PRODUCT DEVELOPMENT RISK

Throughout our experience in developing sensor systems for a range of industrial applications including oil and gas, chemical, water, and power, we have often seen redesigns related to finding issues or unknown requirements after the initial field launch. Problematic from a customer credibility standpoint, this also causes redesign and retesting, which results in delayed revenue.

Adding the systems engineering process to this project increased the front-end labor hours a bit, but ultimately accounted for less than 10 percent of the total project labor. Incorporating systems engineering enabled us to identify and execute approximately 60 verification events, which reduced the total field-testing (or validation) time from about six months to two months and used only five sites rather than 15.

EXPEDITED TIME-TO-MARKET

Systems engineering gave the entire team confidence that as many of the requirements, architectural possibilities, and verification methods as possible were considered early in the project. Accomplishing this objective optimizes the project schedule and makes progress more efficient.

REDUCED PRODUCT COST

As engineers, we inherently drive to create and implement the best design, defined as “that design solution that achieves the customer need at the lowest possible cost.” A strong example of “best design” can be found in the electronics design that led to concern about signal ripple, which relates to a tolerance for acceptable background noise. Thanks to clearly defined requirements, there was no question as to how good was “good enough.”

In addition, the client plans to refine and reuse many of the hardware and software components developed in the smart transmitter product development process since they are now well-defined, specified, and tested. This benefit will also save considerable time on future projects.

CONCLUSIONS

By aligning team strengths, accomplishing swift closure on requirements, and developing cross-team cohesiveness, Syncroness was able to collaborate with our electronics manufacturing client to refine a new product development process that can release products with fewer resources and shorter development times.

Ultimately, we were able to define three new products to be developed, and we are confident in the predicted development cycle time. Communication within the team has improved considerably. Since the entire team is involved in systems engineering, there’s a much deeper understanding and definition of the product as well as greater team “buy in,” and we’ve taken steps toward establishing a requirements-driven design culture within our client’s teams. They are now migrating away from having one “guru” who knows the system and toward a system in which key knowledge is more widely distributed.

By meeting speed-to-market demands, our client was able to quickly respond to emerging markets and react to industry technological and market developments. The result is better profit, stronger metrics, and increased productivity.