

Systems Engineering

SYSTRA is a pioneer in the application of Systems Engineering practices to the transit industry. Our team is the transit industry leader in introducing and applying systems engineering tools, processes, and practices to all project life-cycle phases including project concept through design and implementation through operation and maintenance. SYSTRA has developed and refined a comprehensive, documented, and repeatable systems engineering methodology that is consistent with the international standard ISO/IEC 15288:2002(E), Systems engineering – System Life Cycle Processes, the latest industry standard IEEE Std 1220-2005, IEEE Standard for Application and Management of the Systems Engineering Process, and the International Council of Systems Engineering (INCOSE) recommended practices. SYSTRA's systems engineering discipline complies with the latest FAT System Safety and Security requirements and encompasses the following practices:

- Concept of Operations
- Requirements Engineering
- Systems Integration and Interface Management
- System Assurance including Reliability, Availability, Maintainability, Safety
- System Safety Certification & Independent Safety Assessor
- Verification & Validation
- Test and Commissioning
- Human Factors

The system engineering discipline as SYSTRA applies it to development of new and modified systems can be separated into two basic areas, the front-end SE that defines and documents the customer or stakeholder expectations and the SE that is exercised during construction. SYSTRA's SE capabilities have been successfully applied to both front end and construction phases of systems acquisition. Our SE process is an iterative, top down approach that closely correlates to the 6 life-cycle stages defined under ISO/IEC 15288. The SE activities that result in a system specification begin with definition of the system and decompose those needs into a set of functions and system requirements. Using studies of current technology, staffing and budget analysis, operations, environmental factors, and other areas of impact, significant decisions and options investigated are recorded. During construction the SE application controls and manages the life-cycle development of the product through traceability to requirements.

SYSTRA understands that the most important responsibility in development of a system is to fully and completely understand customer needs and define the system requirements to meet those needs. Our process requires working closely with each stakeholder, through many interviews and meetings, to define and refine the required functionality and the boundaries of the system early in the acquisition cycle. As part of this process, SYSTRA analyzes and reviews the impact of operational characteristics, environmental factors, and minimum acceptable functionality, and develops a concept suitable to meet all needs while considering cost and schedule. The Concept of Operations is developed early on in the project and generally follows the guidelines in IEEE 1362: Guide for Information Technology-System Definition-Concept of Operation (ConOps) Document. To best serve our clients, SYSTRA's engineers ensure that Concept of Operations is a user-oriented process, describing the product from the user's viewpoint, focusing on what the system must do, not how.

Engineering services at SYSTRA range from requirements analysis, specification development, bid phase support, and engineering services during construction. SYSTRA has developed an in-depth understanding and methodology for applying SE during construction through many years of experience. The key to SE is traceability and verification of each requirement to successive layers of the product as development progresses. Verification and validation that the design completely and technically fulfills the system requirements through design, implementation, test, and commissioning, is critical. Technical assessment of each life-cycle output is performed to assure



correct and complete tracing to the design, including interface, safety, reliability and maintainability, and performance assessments. This iterative process strives to uncover missing requirements early in development when it is least costly to correct. The goal is successful commissioning of a system on schedule and within budget; to achieve this each requirement must be managed individually through design, implementation, and verification.

Development of complex systems requires contribution from diverse technical disciplines. SE integrates these disciplines to ensure that performance and operation of the system ultimately meets requirements and expectations. Taking an interdisciplinary approach to SE is inherently complicated, requiring establishment of the capabilities and interactions between the component and the performance of the systems at the up front. SYSTRA engineers bring knowledge and direct experience with the latest industry system assurance specifications and technologies including RAMS (reliability, availability, maintainability, safety) analysis, system timing and performance analysis, EMI/EMC analysis, system threat assessment and security, and hazard analyses including FTA and FMECA. SYSTRA team members have been part of the development of pertinent industry standards, and are experts in implementing 49CFR236 Subpart H and Subpart I guidelines. Our experience includes assessment of levels of safety, availability, and reliability achieved in safety critical systems. Additionally, in compliance with the Rail Safety Act and PTC Regulations, we support railroad implementation of positive train control (PTC) systems to prevent train-to-train collisions, over-speed derailments, incursions into work zones, and movement of a train through a switch left in the wrong position.

SYSTRA's System Integration and Interface Management activities seek to ensure that all systems work interdependently and meet all standards, constraints, and design criteria. Using our system integration management methodology, we track and mitigate issues that affect seamless operation across different elements starting with the preliminary engineering and ending at the commissioning stage.

