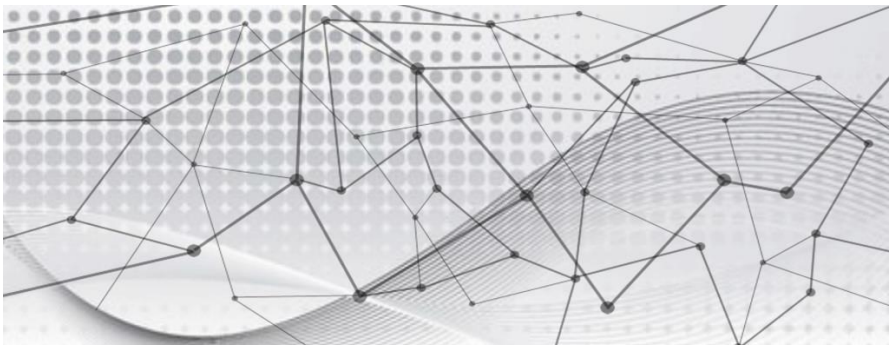
# The Value of a Holistic Systems Engineering Methodology for IoT Enabled Business Solutions

An Assess-IoT LLC Approach



**Assess-IoT, LLC**

www.AssessIoT.com

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# Abstract

This paper describes how Assess-IoT LLC, using a holistic technology-enabled business model, can assist you in identifying and implementing the right series of incremental changes to successfully adapt, compete and grow. Continuing success for any business involves positive transformation which can only be achieved by a series of (mostly) modest changes, cost-effectively implemented, that are closely aligned to your company's strategic business objectives.

Recent experience gained in partnering with diverse companies with similar goals and challenges has validated our approach based on three guiding principles:

1. **Business First**

   Ensure that transformational changes map to and are driven by your company's strategic objectives. All solution sets must meet this first principle.

2. **Holistic Approach to Problem Solving**

   Ability to deploy your advanced products/services and/or achievement of improved business outcomes depends on early holistic visualization of the problem set as a combination of symbiotic business and technology systems with multiple interdependencies and information flows. Identifying your most critical interdependencies to best business advantage can benefit from a holistic system engineering approach that integrates both business and technology perspectives.

3. **The Power of Internet of Things (IoT) Solutions**

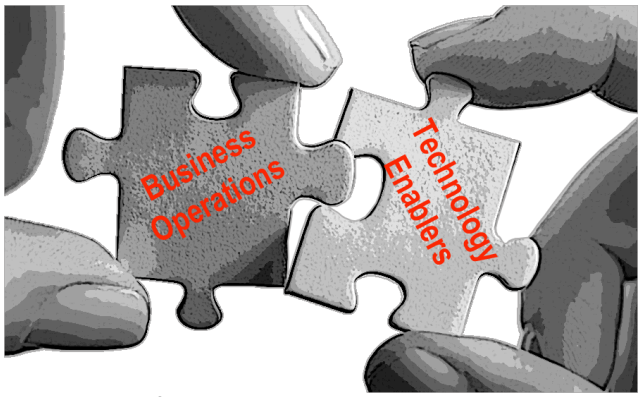
   Successful companies have found that the most powerful and cost-effective transformations are almost always enabled by appropriate technology that aids business decision-making, especially IoT enabled solutions that, for example, allow conversion of previously underutilized raw "data" into useful business information and intelligence with appropriate analytics.

# The Value of a Holistic Systems Engineering Methodology for IoT Enabled Business Solutions

**Assess-IoT LLC**

### The Assess-IoT Operating Premise

All new product/service offerings in development and successful business operations are examples of systems; if viewed holistically as a system of systems, they can both greatly benefit in execution from the best practices of Systems Engineering.



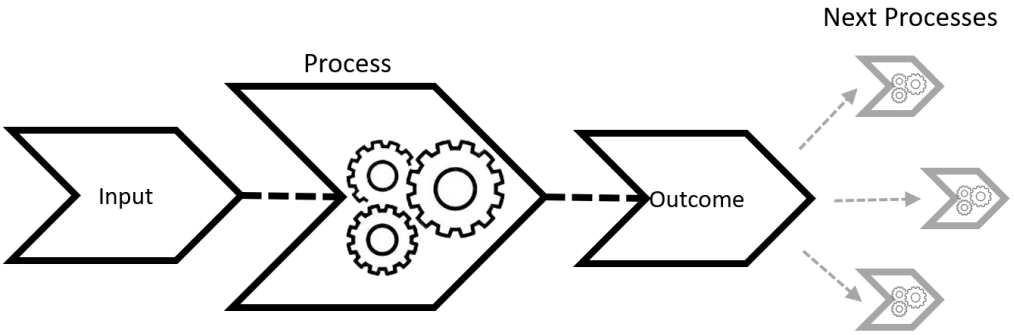

### What is a System?

In the marketplace environment, we consider a system as a group of interdependent components that form a unified and useful whole that may consist of:

- A set of components working together in a useful way, especially as an interconnected network (physical or virtual)
- A group of principles, procedures and behaviors by which business objectives are achieved
- Elements immersed in a greater ecosystem, much of it beyond immediate control of the business

### Common Attributes of Today's Systems and Their Deployment

- Are conceived and enhanced over time by a continuum of analysis and synthesis rather than single design-build-deploy cycle of previous eras
- Are usually driven by many competing interests (stakeholders)
- Are characterized by distinct User/Operational, Functional/Behavioral, and Technical/Physical Viewpoints
- Have significant interdependency among the parts
- Can be described by their structure, purpose and/or functioning
- Are influenced by their stakeholder, environmental, technical, regulatory, marketplace, financial, spatial / temporal boundaries
- The critical interactions that occur among the parts can be documented through interface descriptions
- Behavior of the individual parts usually follows the model:




- Behavior as a whole can differ significantly from the simple sum of their parts' behaviors
- System behaviors and outcomes can be tested or described against value-add standards such as efficiency, performance, cost or fitness for purpose.
- Have a definable life cycle (concept, design, construction, testing, deployment, maintenance, end-of life)
- Early business and product/service system development is almost always initially challenged by:
  - Deficits in critical business environment, enterprise or technical knowledge
  - Early forecasted demand for resources exceeds known or available
  - Inadequate understanding of interdependency of business objectives and technical capabilities

**Systems Engineering Methodology (Key Elements)**

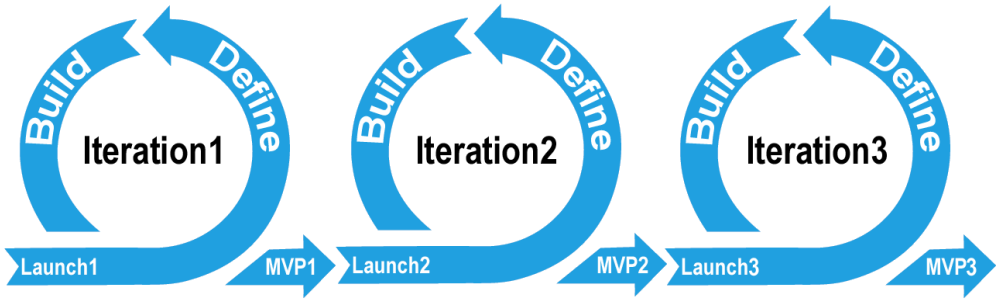
- An approach or discipline that develops solutions to complex business and technology objectives in a holistic rather than traditional linear/evolutionary fashion to maintain focus on "Business First" (The Why?)
- Provisionally identifies the essential functions necessary to achieve the primary objectives (The Why?)
- Starts by solidifying very high level requirements – What must the system do to meet the primary technical or business objective(s) (The How?)
- Creates a high-level specification/requirements working environment to harmonize the competing interests and constraints while maintaining persistent focus on the primary objective(s) (The Why?)
- Documents the emerging system design (the recipe) and any associated valuable intellectual property. (The Why?)
- Preserves flexibility for incorporation of new technologies, contemporary development models (i.e. AGILE) and incremental cost reduction opportunities (The How?)
- Recognizes and incorporates the viewpoints/interests of stakeholders as a "validity check" on the evolving system design (The How?)
- Establishes a system baseline (or reference model) where the effects of each design change can be readily evaluated as "better than" or "worse than" the baseline, accelerating design convergence to final product, business or technical outcome. (The How?)
- The methodology in the previous bullet point also creates a powerful decision-making space to optimize the many technical and business development tradeoffs; for example, helping to quantify the qualitative "better than"/"worse than" results that can enable earlier

estimates of performance, ROI, cost minimization, time-to-market, minimum viable product, etc. (The How?)

- Oversees successful handoff and continuing support of system requirements/functional descriptions to system designers, implementers and users. (The How?)

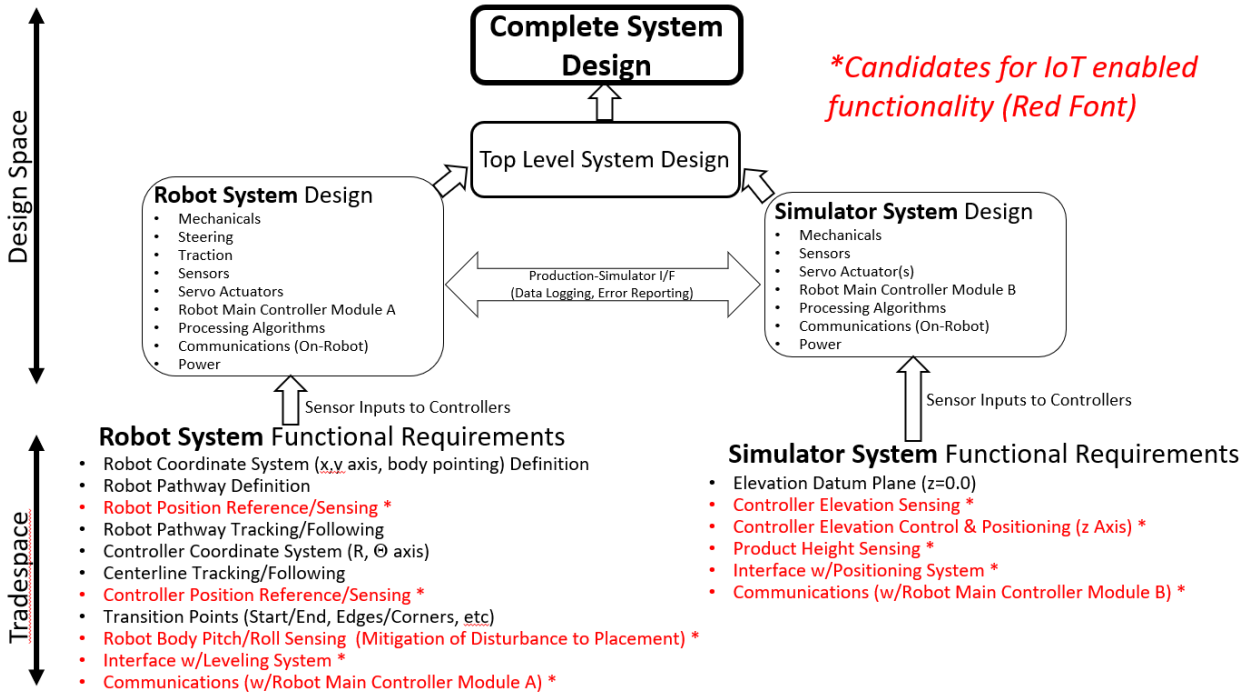
**Advantages of a Holistic System Engineering Approach**

- Achieves a successful system solution that meets the often-conflicting business, technical, user, and other stakeholder objectives.
- Adaptable in the face of increasingly complex systems; allows for "parsing" the final end product or business outcome into iterations where one or more intermediate minimum viable products (MVP's) or business outcomes can be delivered incrementally before the design requirements are finalized and resources are fully committed for next iteration. This method can significantly lower risk to full deployment as well providing progressively more valuable interim products and business outcomes since each MVP will be fully tested and validated.



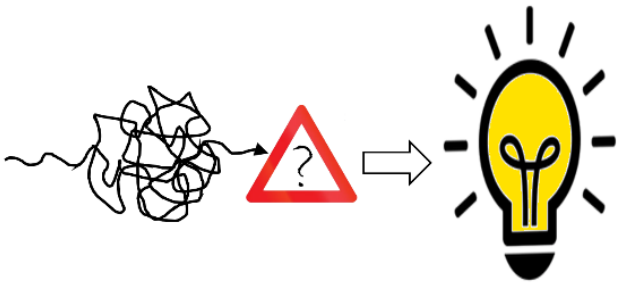

- Identifies the key interfaces between system parts and between organizational units
- Illuminates the major risks and critical paths before commitment to design or implementation.
- Defines the major design and procedural tradeoff variables early in the process; helps avoid "technology myopia", the fascination with a particular technical solution or the "next big thing" when current or mature technology will do the job. The figure below is a simplified example of a model set up to begin the requirements definition and tradeoff analysis design ("Define") Iteration1 for an advanced production line robot and companion simulator for employee training and production process optimization:

## Production Line Robot + Simulator Tradespace Model




- Can yield single “optimum” tradeoff decisions for a particular use case or conversely highlight specific tradeoffs necessary to optimize for multiple use cases
- Allows for early detection and mitigation of solutions that may technically meet the specification but are not sufficiently cost-effective or optimal for intended purpose
- Due to the early and formal establishment of the system concept and associated constraints, stakeholder interests and essential functions, the holistic system engineering approach assures a much higher probability of meeting end product or business outcome expectations.
- Enables flexible and proactive risk management, especially where information deficits and uncertainty exist by applying techniques such as:
    - Forming interim solutions as fast as possible (but not necessarily with pure quality) to test them in practice faster.

- Recognizing failures as unavoidable, yielding valuable insights if perceived as opportunities:



- In case of failure, understand the root cause, find a new solution, generate changes, and merge with next $MVP_X$ iteration.
- Work in parallel, verifying and coordinating intermediate results.
- The schedule might be corrected and updated but should not be jeopardized by improper execution.
- Wherever possible, prototype and test the most critical and most questionable solutions first.
- Start from pilot area and then expand to address remaining scope.

**Proof of Concept**

How can this holistic systems engineering methodology be applied in practice? Additional articles in this series introduce a growing library of mini-case studies generalized from recent Assess-IoT LLC work with partner companies that highlight the application of this model to achieve the desired transformation and meet the strategic business objectives. These articles can be reached at following links:

Customer Use Case – Enhancing the Omni-channel Experience Using a Branded IoT Solution

Customer Use Case – IoT Enabled Commercial Construction Using Robotic 3D Printing