What is ISO/IEC 15288?
(A Concise Introduction)

What if all or the majority of the people of an organization (independent of their personal background and role) held a shared view concerning:

- what systems are,
- how systems are formed and
- how systems are life cycle managed?

The potential in person to person, project to project, management to and from personnel communications improvement is significant.

This is possible with the proper utilization of the new international standard ISO/IEC 15288 System Life Cycle Processes [ISO/IEC 15288]. This standard has been under conceptualization and development since 1996, was ratified as an International Standard in June 2002 and was published in November 2002. Amongst a variety of translations, a combined English-Swedish version became a Swedish standard in June 2003; namely SS-ISO/IEC 15288.

The primary goal specified for the standard is:

“**To provide a basis for international trade in system products and services.**”

The implication of this primary goal is the radical improvement in communication both within and amongst trading partners. In order to meet this goal, ISO/IEC 15288 provides guidance for the following:

- Defining the structure of systems
- Defining the boundaries of systems
- Structuring life cycles for systems
- Processes for the enterprise management of systems
- Processes for making acquisition and supply agreements for system activities, products and services
- Processes for the management of projects used in performing system related work
- Processes for performing the “technical” work on systems

The architecture of ISO/IEC 15288 describes a unique collection of system life cycle processes based on a fundamental set of system principles and concepts that govern their application. **The standard can be applied to any type of man-made system.** The English version of the standard is 62 pages in length. When the principles and concepts are understood and applied, the standard provides “mental capital” to its users who learn to view all systems in a systematic manner.

The standard is well positioned to have a major impact upon business management [Arnold and Lawson, 2004] as indicated in a news release on the ISO’s website [www.iso.ch]:

“The next ‘standards phenomenon’ for implementation by businesses worldwide?

The designation of ISO/IEC 15288 may hide a new standards phenomenon whose combination of timeliness and applicability to organizations in all sectors could give it a considerable impact on the world of business, in the wake of standards like ISO 9000. Just as the ISO 9000 standards have distilled the essential characteristics of quality management into a set of generic requirements that any organization can use to its benefit, ISO/IEC 15288, Systems engineering - System life cycle processes, offers a portfolio of generic processes for the optimal management of all stages in the life of any product or service, in any sector......”
Multi-Disciplinary View Of Systems

Systems, of diverse nature are the assets that an organization and their enterprises utilize in achieving their purpose, missions, and goals, as illustrated in Figure 1.

![Figure 1: Achieving Purpose, Missions and Goals](image)

Thus, achievement of purpose, missions, and goals is dependent upon the organization and its enterprises keeping a system focus. The system assets include the systems provided as value-added products and/or services to “customers” as well as the systems used in enabling product and/or service realization. Thus, all forms of management systems as well as resource related systems belong to this enabling category with respect to the system products and/or services produced by the organization.

The term system is used in many speciality contexts to refer to something essential that fulfills some form of need. Thus, a system is always defined “in the eyes of the beholder(s)”. To be able to extract the common denominators for managing systems (as done in the ISO/IEC 15288 standard) it is important to recognize the multi-disciplinary nature of systems and the wide variety of system elements from which they are composed. Regardless of the type of system involved, a system is defined to fulfill a need, provide a potential set of services, and when used in an operational context, provides effect as illustrated in Figure 2.

![Figure 2: System Structure: Need, Services and Effect](image)

As noted in the figure, the system upon which focus is placed is called in ISO/IEC 15288 terms, the system-of-interest. The system-of-interest is designed to provide services to one or more “users” and when the system is deployed, it delivers effect.
In ISO/IEC 15288 the constituents of a system-of-interest are identified as system elements. The system elements, in this case E1, E2, or E3, are integrated in expectation that they will contribute to meeting the need to be provided by the system-of-interest. Each of the system elements can deliver one or more services to the system-of-interest and when interacting with the other elements can collectively provide the system service(s).

Implicit in Figure 2, are the central system related notions of structure and behavior. That is, the system-of-interest portrayed has a structure that is defined by the set of system elements it contains as well as the relationships defined between the elements. The services that can be provided are the potential behavior of the system. When an instance of the system is used in operation to meet a need it produces effect that is the actual behavior of the system.

It is important to note that the effect delivered (i.e. behavior) for the system is not simply the individual behaviors of the system elements. The behavior that results from the operation of the interacting elements of the system is thus called the emergent behavior.

Humans in general can have a variety of relationships to systems. They can be stakeholders in a system and thus expect that a system-of-interest provide services and deliver effect that is in their interest. Humans can operate a system-of-interest and thus be an element in that system. Finally, they can be part of an operational environment in which they interact with one or more systems; that is, they are consumers of services provided by systems and/or supply services to other systems.

As stated above, the ISO/IEC 15288 standard has been developed to assist in the life cycle management of any type of man-made system. Thus the system elements of a system-of-interest may be a various types exemplified by the following:

- Hardware – mechanical, electronic
- Software – system software, firmware, application, utilities
- Humans – operators
- Data – individual items and sets of data providing information
- Processes – business, political, system management
- Procedures – operating instructions, activities
- Facilities – containers, buildings, instruments, tools
- Documents – policy, standards, legal, regulatory, patents, contracts, agreements
- Natural elements – water, gas, air, organisms, minerals, etc.

Systems can be composed of system elements of the same type or of heterogeneous types of elements. In all cases, however, the set of elements that are integrated into a system must always be designed to meet a need, provide required services and when deployed deliver effect as denoted in Figure 2. The ISO/IEC 15288 standard truly provides a multi-disciplinary view of systems and their life cycle management.

**System Life Cycles**

ISO/IEC 15288 requires that a life cycle model be developed for each system-of-interest for which the standard is to be applied. The standard describes the structure of a single stage in terms of its purpose and its expected outcomes. From this stage specification, a multi-stage model representing the needs of the type of system involved is to be defined and utilized as a management instrument for establishing projects to perform system related work and in reviewing the progress of a system through its life cycle.

While the ISO/IEC 15288 standard does not require, nor advocate a specific life cycle model, for guidance purposes, an annex contains a description of a common life cycle model structure composed of the stages as portrayed in Figure 3. This representation is not to be interpreted as a sequence of stages. It is quite possible, and for many types of systems, necessary to iterate amongst the stages in...
refining the system definition and/or in producing improvements to or variants of system products and/or services. However, as portrayed Figure 3, the Utilization and Support Stages are operated in parallel.

Bounding of Systems

In the previous sections, two of the central system related concepts of ISO/IEC 15288 have been presented, namely, that a system as a system-of-interest is composed of system elements and the that each system-of-interest requires a life cycle model composed of stages.

What makes the ISO/IEC 15288 standard powerful from a systems perspective is that it can be re-applied for any type of system, regardless of where the system sits in a system hierarchy. Further that systems used as enablers during the life cycle of a system-of-interest can in their own right be treated as a system-of-interest and thus are handled in a consistent manner by the standard. These two aspects provide for a holistic bounding of systems.

Recursive System Composition

The holistic scope of a system-of-interest arises from the causal interrelationships between all systems elements from which it is composed. Each system element can be considered a system in its own right and this gives rise to the recursive application of the ISO/IEC 15288 standard at successive levels of system structural detail.

This recursive ‘downward’ application of the processes leads to an even finer level of detail in a system’s structure. This decomposition is the primary mechanism by which system complexity can be reduced to comprehensible and manageable proportions. Conversely, the route to synthesizing novel, overall system-of-interest properties from a set of dissimilar system elements is performed by applying processes recursively ‘upward’ to achieve a fully integrated entity. These two directions of recursive application are apparent in Figure 4.

A level of ever decreasing system detail is reached down any path of decomposition that is no longer of undue concern. For each path, this level is defined in terms of a judgment that balances risk and benefit. That is, a level of system detail is ultimately reached at which the provision of a system element, having specified performance characteristics and necessary implementation constraints, can be delegated to advantage to another party. Such a system element may already exist, or it may need to be designed and built. Thus, a system element, as viewed by one party, can be a system-of-interest when viewed by another party.
Enabling Systems

ISO/IEC 15288 identifies system-of-interest interactions with other systems that are essential to it’s progress through its life cycle but are not part of the operational environment in which the system-of-interest’s services are required. These systems, although necessary, are ancillary to the purpose of the system-of-interest and are viewed as enabling systems.

ISO/IEC 15288 recognizes the purpose of a man-made system as meeting the needs of and delivering services to users. Any system that aids transition of the system-of-interest through states other than its own service delivery is viewed as an enabling system, e.g. a test system used during development or manufacturing, a simulation system used during conception or development, a logistic system used in maintenance. These enabling systems are essential to the provision of the services provided by the system-of-interest. Although they lie outside the boundary of the system-of-interest, just as systems in the immediate operational environment do, they interact with it in very purposeful ways. They are thus not only purposefully influenced by the system-of-interest but typically will reflect back influence on it, sometimes in constraining and unavoidably restrictive ways. This is particularly evident in the case where enabling systems pre-exist the system-of-interest, e.g. a production line influencing a new member of an evolving family of products.

The standard can be applied to an enabling system when, in its own right, it becomes a system-of-interest. In this way, the labyrinthine complexity of layers of system-of-interest/enabling system interdependencies can be encapsulated in a clearly structured hierarchy of organizational responsibilities. The larger organization re-applies the standard wherever it elects to create, operate and manage the enabling system services in-house, whether within or outside the responsibility of the system-of-interest project. For the smaller organization, that may not possess the enabling system assets and needs to acquire these services from third parties, this approach enables it to apply the standard in a simpler, more focused way.
Providing for Organizational Needs

All organizations exist in order to provide some form of added value in the form of products and/or services to their “customers”. In organizing their operations to provide added value, the organization management often defines one or more enterprises that are charged with business goals of value added provision. In accomplishing these goals, the organization and its enterprises utilize fundamental relationships between the organizational elements as portrayed in Figure 5.

The enterprise (which may be identical with the organization) establishes agreements in its supply chain role as a supplier of value-added products and/or services as well as an acquirer of activities, products and services from supplier organizations. The enterprise authorizes, supports and monitors projects (and line organizations as well) to perform system related work. Line organizations most typically have responsibility for continual operation activities whereas projects most are directed to perform system related work using technical processes and their activities within discrete time periods.

The ISO/IEC 15288 has been designed and developed to meet these fundamental organizational needs by providing appropriate processes in each category as portrayed in Figure 6.

Figure 5: Fundamental Organizational Elements and their Relationships

Figure 6: The ISO/IEC 15288 Processes [ISO/IEC 15288]
### Summary of the Process Categories

The details of these processes are ISO/IEC proprietary cannot be provided in this paper. However, in order to understand the context of the various categories of processes, the following summary is provided.

**Enterprise Processes**

These processes are provided to manage an organization’s capability to acquire and supply system products or services through the initiation, support and control of projects. They provide the resources and infrastructure necessary to support projects and ensure the satisfaction of organizational objectives and established agreements.

**Agreement Processes**

The processes define the activities necessary to establish an agreement between two organizations (enterprises). The Acquisition Process provides the means for conducting business with a supplier of system products that are supplied for use as an operational system, of services in support of an operational system, or of elements of a system being developed by a project. The Supply Process provides the means for conducting a project in which the result is a system product or service that is delivered to the acquirer.

**Project Processes**

These processes are utilized to establish and evolve project plans, to assess actual achievement and progress against the plans and to control execution of the project through to fulfilment. The processes collectively or individually may be invoked at any time in the life cycle and at any level in a hierarchy of projects, as required by project plans or unforeseen events. The processes are to be applied with a level of rigour and formality that is dependent upon the risk and complexity of the project.

*Note:* The project processes provide a basis for the utilization of the Shewhart-Deming quality management cycle Plan, Do, Check, Act (PDCA). While ISO/IEC 15288 has a defined project-orientation, a line organization will also benefit by selecting and implementing appropriate processes needed to provide continual operational capability.

**Technical Processes**

These processes are utilized to:

- define the requirements for a system,
- to transform the requirements into an effective systems product,
- to permit consistent reproduction of the product where necessary,
- to use the product to provide the required services,
- to sustain the provision of those services and
- to dispose of the product when it is retired from service.

The processes define the activities that enable enterprise and project functions to optimize the benefits and reduce the risks that arise from technical decisions and actions. These activities enable products and services to possess the timeliness and availability, the cost effectiveness, and the functionality, reliability, maintainability, producibility, usability and other qualities required by acquiring and supplying organizations. They also enable products and services to conform to the expectations or legislated requirements of society, including health, safety, security and environmental factors.

*Note:* There is only one process in the set of Technical Processes that is not dedicated to system properties; that is the Implementation Process. This process is used in multiple instances in order to provide system elements that will be integrated into the system-of-interest. Thus, this can imply the...
invocation of another standard such as ISO/IEC 12207 Software-Life-Cycle Processes [ISO/IEC 12207] for software system elements, another specialty standard for material or immaterial elements, or the application of best-practice guidance within a specialty. For example, in implementing software system elements, the Rational Unified Process or the ITIL (Information Technology Infrastructure Library) best practice may be applied. Remember as described earlier, that the system element to be implemented can well be a system-of-interest at the next lowest level in which case, it can be appropriate to reutilize the ISO/IEC 15288 standard recursively applied at that level.

**Tailoring of Processes**

In addition to the processes portrayed in Figure 6, the ISO/IEC 15288 standard defines a Tailoring Process which is to be utilized in order to guide organizations, enterprises and projects in their adaptation of the standard to their environment and for meeting their specific requirements and needs. Adaptation can be required in order to satisfy an agreement, to influence a project that is required meet an agreement based upon use of the standard, and in order to reflect the needs of an organization in supplying system products and/or services.

The result of tailoring can be modified or new system life cycle processes, the definition of individual stages that influence an agreement or a life cycle model defined in terms of stages and processes that define the contributions they make to the system.

In practice, it makes sense for an organization to define generic sets of life cycle models and processes, as system assets in their own right, that are intended to provide guidance for the developing concrete life cycle models and process sets for specific agreements and/or specific projects.

**Applying the Standard in Practice**

Regardless of the type of man-made system for which ISO/IEC 15288 is to be utilized, there are three fundamental categories of life cycle stages as portrayed in Figure 7. This generic model illustrates that one or more actual stages may exists for a particular life cycle model and that the goal is to produce a system-of-interest as a product or service. Further the model portrays the system of interest that is integrated from system elements where the elements have a defined relationship.

![Diagram](image.png)

**Figure 7: The Generic T-Model**
The generic T-Model is used to illustrate how stakeholder requirements are distributed from the early stages of the system life cycle to the processes and activities of the various stages as well as to the system product or service to be produced. The product or service evolves during the early stages in the form of a system description where the system elements and their relationships are established.

![Diagram of T-Model]

**Figure 8: Allocating Requirements to Activities, Products and Services**

In practice, the evolution of a system-of-interest is the result of successive refinement of the system. Thus, the stages of the life cycle are often re-iterated as knowledge is gained in transforming stakeholder requirements in the required products and services.

The means to verifying that the stakeholder requirements have been met for any particular system product or service can be conveniently accomplished by incorporating Verification processes in each relevant stage as portrayed in Figure 9. Further, in order to validate that the produced product and/or service actually satisfies the customer, a Validation process is also included in the Utilization stage. Note that the use of Verification processes in the later stages applies to the verification of maintenance or disposal requirements.

![Diagram of Verification and Validation]

**Figure 9: Verification and Validation**

Via the distribution of requirements into life cycles, their verification and validation for customer satisfaction, the framework of ISO/IEC 15288 provides an expedient mechanism for taking account of
all forms of stakeholder requirements. Thus requirements from other standards that are to be applied, such as ISO 9001 [ISO 9001] and ISO 14001 [ISO 14001] can be conveniently accommodated.

Continual management review of the achievement of requirements is provided in stage decision gates. Further, when the stages of the life cycle are iterated in the refinement of a system product or service or in producing new versions, the framework continues to provide decision points so that quality and/or environmental requirements remain in focus.

Conclusions

In summary, ISO/IEC 15288 provides a set system technical processes in the context of an organization’s business processes that can be applied throughout the life cycle of a system. ISO/IEC 15288 thus builds a process picture, centered on systems technical processes, that more effectively coordinates technical contributions by diverse organizational functions at different stages of the life cycle [Arnold and Lawson, 2004].

Via the proper implementation and introduction of the ISO/IEC 15288 standard, organizations and their enterprises can build the type of shared “mental capital” required to make significant improvements in their capabilities to manage and exploit their system assets.

References


