Service Life Management

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Product and service life management deals with the overall life cycle planning and support of a system. The life of a product or service spans a considerably longer period of time than the time required to design and develop the system. Systems engineers need to understand and apply the principles of life management throughout the life cycle of the system. (See Life Cycle Models for a general discussion of life cycles.) Specifically, this knowledge area (KA) focuses on changes to a system after deployment, including extension, modernization, disposal, and retirement.

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Contents

Topics

Each part of the SEBoK is divided into knowledge areas (KAs), which are groupings of information with a related theme. The KAs in turn are divided into topics. This KA contains the following topics:

- Service Life Extension
- Capability Updates, Upgrades, and Modernization
- Disposal and Retirement

See the article Matrix of Implementation Examples for a mapping of case studies and vignettes included in Part 7 to topics covered in Part 3.

Overview

Product and service life management is also referred to as *system sustainment*. Sustainment involves the supportability of operational systems from the initial procurement to disposal. Sustainment is a key task for systems engineering that influences product and service performance and support costs for the entire life of the program.

Sustainment activities include: design for maintainability, application of built-in test, diagnostics, prognostics and other condition-based maintenance techniques, implementation of logistics footprint reduction strategies, identification of technology insertion opportunities, identification of operations and support cost reduction opportunities, and monitoring of key support metrics. Life cycle sustainment plans should be created for large, complex systems (DAU 2010). Product and service life management applies to both commercial systems (e.g. energy generation and distribution systems, information management systems, the Internet, and health industries) and government systems (e.g. defense systems, transportation systems, water-handling systems, and government services).

It is critical that the planning for system life management occur during the requirements phase of system development. (See System Requirements and System Definition). The requirements phase includes the analysis of life cycle cost alternatives, as well as gaining the understanding of how the system will be sustained and modified once it is operational.

The body of knowledge associated with product and service life management includes the following areas:

1. Service Life Extension - Systems engineers need to understand the principles of service life extension, the challenges that occur during system modifications,

and issues involved with the disposal and retirement after a system has reached the end of its useful life.

2. Modernization and Upgrades - Managing service life extension uses the engineering change management process with an understanding of the design life constraints of the system. Modernizing existing legacy systems requires special attention and understanding of the legacy requirements and the importance of having a complete inventory of all the system interfaces and technical drawings.
3. Disposal and Retirement - Disposal and retirement of a product after reaching its useful life requires attention to environmental concerns, special handling of hazardous waste, and concurrent operation of a replacement system as the existing system is being retired.

Principles and Standards

The principles of product and service life management apply to different types of systems and domains. The type of system (commercial or government) should be used to select the correct body of knowledge and best practices that exist in different domains. For example, U.S. military systems would rely on sustainment references and best practices from the Department of Defense (DoD) (e.g., military services, Defense Acquisition University (DAU), etc.) and military standardization bodies (e.g., the American Institute of Aeronautics and Astronautics (AIAA), the Society of Automotive Engineers (SAE), the Society of Logistics Engineers (SOLE), the Open Geospatial Consortium (OGC), etc.).

Commercial aviation, power distribution, transportation, water-handling systems, the Internet, and health industries would rely on system life management references and best practices from a combination of government agencies, local municipalities, and commercial standardization bodies and associations (e.g., in the U.S.- the Department of Transportation (DOT), State of Michigan, International Organization for Standardization (ISO), Institute of Electrical and Electronics Engineers (IEEE), International Council on Systems Engineering (INCOSE), etc.).

Some standardization bodies have developed system life management practices that bridge both military and commercial systems (e.g., INCOSE, SOLE, ISO, IEEE, etc.). There are multiple commercial associations involved with defining engineering policies, best practices, and requirements for commercial product and service life management. Each commercial association has a specific focus for the market or domain area where the product is used. Examples of such commercial associations in the U.S. include: American Society of Hospital Engineering (ASHE); Association of Computing Machinery (ACM); American Society of Mechanical Engineers (ASME); American Society for Testing & Materials (ASTM) International; National Association of Home Builders (NAHB); and Internet Society (ISOC), including Internet Engineering Task Force (IETF), and SAE.

In addition, there are several specific resources which provide useful information on product and service life management:

- The *INCOSE Systems Engineering Handbook*, version 3.2.2, identifies several relevant points regarding product and service life management (2011).
- The *Systems Engineering Guidebook for Intelligent Transportation Systems (ITS)*, version 1.1, provides guidance on product changes and system retirement (Caltrans and USDOT 2005).
- *Systems Engineering and Analysis* emphasizes design for supportability and provides a framework for product and service supportability and planning for system retirement (Blanchard and Fabrycky 2006).
- *Modernizing Legacy Systems* identifies strategies for product and service modernization (Seacord, Plakosh, and Lewis 2003).
- "Logistics and Materiel Readiness" (http://www.acq.osd.mil/log/) provides online policies, procedures, and planning references for product service life extension, modernization, and retirement (OUSD(AT&L) 2011).
- *A Multidisciplinary Framework for Resilience to Disasters and Disruptions* provides insight into architecting a system for extended service life (Jackson 2007).

Good Practices

Major pitfalls associated with systems engineering (SE) after the deployment of products and services can be avoided if the systems engineer:

- Recognizes that the systems engineering process does not stop when the product or service becomes operational.
- Understands that certain life management functions and organizations, especially in the post-delivery phase of the life cycle, are part of the systems engineering process.
- Identifies that modifications need to comply with the system requirements.
- Considers that the users must be able to continue the maintenance activities drawn up during the system requirement phase after an upgrade or modification to the system is made.
- Accounts for changing user requirements over the system life cycle.
- Adapts the support concepts drawn up during development throughout the system life cycle.
- Applies engineering change management to the total system.

Not addressing these areas of concern early in development and throughout the product or service's life cycle can have dire consequences.

References

Works Cited

Blanchard, B.S. and W.J. Fabrycky. 2011. *Systems Engineering and Analysis,* 5th ed. Prentice-Hall International series in Industrial and Systems Engineering. Englewood Cliffs, NJ, USA: Prentice-Hall.

Caltrans and USDOT. 2005. *Systems Engineering Guidebook for Intelligent Transportation Systems (ITS),* version 1.1. Sacramento, CA, USA: California Department of Transportation (Caltrans) Division of Research & Innovation/U.S. Department of Transportation (USDOT), SEG for ITS 1.1.

DAU. 2010. "Acquisition Community Connection (ACC): Where the DoD AT&L workforce meets to share knowledge." Ft. Belvoir, VA, USA: Defense Acquisition University (DAU)/US Department of Defense (DoD). https://acc.dau.mil.

INCOSE. 2012. *Systems Engineering Handbook: A Guide* *for System Life Cycle Processes and Activities,* version 3.2.2. San Diego, CA, USA: International Council on Systems Engineering (INCOSE), INCOSE-TP-2003-002-03.2.2.

Jackson. 2007. “A Multidisciplinary Framework for Resilience to Disasters and Disruptions.” *Journal of Integrated Design and Process Science.* 11(2).

OUSD(AT&L). 2011. “Logistics and Materiel Readiness On-line policies, procedures, and planning references.” Arlington, VA, USA: Office of the Under Secretary of Defense for Aquisition, Transportation and Logistics (OUSD(AT&L)). http://www.acq.osd.mil/log/.

Seacord, R.C., D. Plakosh, and G.A. Lewis. 2003. *Modernizing Legacy Systems: Software Technologies, Engineering Processes, and Business Practices*. Boston, MA, USA: Pearson Education.

Primary References

Blanchard, B.S. and W.J. Fabrycky. 2011. *Systems Engineering and Analysis,* 5th ed. Prentice-Hall International series in Industrial and Systems Engineering. Englewood Cliffs, NJ, USA: Prentice-Hall.

Caltrans and USDOT. 2005. *Systems Engineering Guidebook for Intelligent Transportation Systems (ITS),* ver 1.1. Sacramento, CA, USA: California Department of Transportation (Caltrans) Division of Research and Innovation and U.S. Department of Transportation (USDOT), SEG for ITS 1.1.

INCOSE. 2012. *Systems Engineering Handbook: A Guide for System Life Cycle Processes and Activities*, version 3.2.2. San Diego, CA, USA: International Council on Systems Engineering (INCOSE), INCOSE-TP-2003-002-03.2.2.

Jackson, S. 2007. “A Multidisciplinary Framework for Resilience to Disasters and Disruptions.” *Journal of Integrated Design and Process Science.* 11(2).

OUSD(AT&L). 2011. “Logistics and Materiel Readiness On-line policies, procedures, and planning references.” Arlington, VA, USA: Office of the Under Secretary of Defense for Acquisition, Transportation and Logistics (OUSD(AT&L). http://www.acq.osd.mil/log/.

Seacord, R.C., D. Plakosh, and G.A. Lewis. 2003. *Modernizing Legacy Systems: Software Technologies,* *Engineering Processes, and Business Practices*. Boston, MA, USA: Pearson Education.

Additional References

Blanchard, B.S. 2010. *Logistics engineering and management,* 5th ed. Englewood Cliffs, NJ, USA: Prentice Hall: 341-342.

Braunstein, A. 2007. “Balancing Hardware End-of-Life Costs and Responsibilities.” Westport, CT, USA: Experture Group, ETS 07-12-18.

Brown, M., R. Weyers, and M. Sprinkel. 2006. “Service Life Extension of Virginia Bridge Decks afforded by Epoxy-Coated Reinforcement.” *Journal of ASTM International (JAI).* 3(2): 13.

DLA. 2010. “Defense logistics agency disposition services.” In Defense Logistics Agency (DLA)/U.S. Department of Defense [database online]. Battle Creek, MI, USA, accessed June 19 2010: 5. Available at: http://www.dtc.dla.mil.

EPA. 2010. “Wastes In U.S. Environmental Protection Agency (EPA)." Washington, D.C. Available at: http://www.epa.gov/epawaste/index.htm.

Finlayson, B. and B. Herdlick. 2008. *Systems Engineering of Deployed Systems.* Baltimore, MD, USA: Johns Hopkins University: 28.

FSA. 2010. “Template for 'System Retirement Plan' and 'System Disposal Plan'.” In Federal Student Aid (FSA)/U.S. Department of Eduation (DoEd). Washington, DC, USA. Accessed August 5, 2010. Available at: http://federalstudentaid.ed.gov/business/lcm.html.

Gehring, G., D. Lindemuth, and W.T. Young. 2004. “Break Reduction/Life extension Program for CAST and Ductile Iron Water Mains.” Paper presented at NO-DIG 2004, Conference of the North American Society for Trenchless Technology (NASTT), March 22-24, New Orleans, LA, USA.

Hovinga, M.N., and G.J. Nakoneczny. 2000. “Standard Recommendations for Pressure Part Inspection during a Boiler Life Extension Program.” Paper presented at ICOLM (International Conference on Life Management and Life Extension of Power Plant), May, Xi’an, P.R. China.

IEC. 2007. *Obsolescence Management - Application Guide*, ed 1.0. Geneva, Switzerland: International Electrotechnical Commission, IEC 62302.

ISO/IEC/IEEE. 2015. *Systems and Software Engineering -- System Life Cycle Processes*. Geneva, Switzerland: International Organisation for Standardisation / International Electrotechnical Commissions / Institute of Electrical and Electronics Engineers. ISO/IEC/IEEE 15288:2015.

Ihii, K., C.F. Eubanks, and P. Di Marco. 1994. “Design for Product Retirement and Material Life-Cycle.” *Materials & Design.* 15(4): 225-33.

INCOSE UK Chapter. 2010. *Applying Systems Engineering to In-Service Systems: Supplementary Guidance to the INCOSE Systems Engineering Handbook,* version 3.2, issue 1.0. Foresgate, UK: International Council on Systems Engineering (INCOSE) UK Chapter: 10, 13, 23.

Institute of Engineers Singapore. 2009. *Systems Engineering Body of Knowledge, provisional,* version 2.0. Singapore.

Jackson, S. 1997. *Systems Engineering for Commercial Aircraft*. Surrey, UK: Ashgate Publishing, Ltd.

Koopman, P. 1999. “Life Cycle Considerations.” Pittsburgh, PA, USA: Carnegie Mellon. Accessed August 5, 2010. Available at: http://www.ece.cmu.edu/~koopman/des_s99/life_cycle/index.html.

L3 Communications. 2010. “Service Life Extension Program (SLEP).” Newport News, VA, USA: L3 Communications, Flight International Aviation LLC.

Livingston, H. 2010. “GEB1: Diminishing Manufacturing Sources and Material Shortages (DMSMS) Management Practices.” McClellan, CA, USA: Defense MicroElectronics Activity (DMEA)/U.S. Department of Defense (DoD).

Minneapolis-St. Paul Chapter of SOLE. 2003. "Systems Engineering in Systems Deployment and Retirement, presented to INCOSE." Minneapolis-St. Paul, MN, USA: International Society of Logistics (SOLE), Minneapolis-St. Paul Chapter.

NAS. 2006. *National Airspace System (NAS) System Engineering Manual,* version 3.1 (volumes 1-3).

Washington, D.C.: Air Traffic Organization (ATO)/U.S. Federal Aviation Administration (FAA), NAS SEM 3.1.

NASA. 2007. *Systems Engineering Handbook.* Washington, DC, USA: National Aeronautics and Space Administration (NASA), NASA/SP-2007-6105, December 2007.

Nguyen, L. 2006. “Adapting the Vee Model to Accomplish Systems Engineering on Change Projects.” Paper presented at 9th Annual National Defense Industrial Association (NDIA) Systems Engineering Conference, San Diego, CA, USA.

Office of Natural Gas and Oil Technology. 1999. *Reservoir LIFE Extension Program: Encouraging Production of Remaining Oil and Gas*. Washington, DC, USA: U.S. Department of Energy (DoE).

Paks Nuclear Power Plant. 2010. “Paks Nuclear Power Plant: Service Life Extension.” In Paks Nuclear Power Plant, Ltd.. Hungary, accessed August 5, 2010. Available at: http://paksnuclearpowerplant.com/service-life-extension.

Ryen, E. 2008. *Overview of the Systems Engineering Process*. Bismarck, ND, USA: North Dakota Department of Transportation (NDDOT).

SAE International. 2010. “Standards: Commercial Vehicle--Maintenance and Aftermarket.” Warrendale, PA, USA: Society of Automotive Engineers (SAE) International.

SAE International. 2010. “Standards: Maintenance and Aftermarket.” Warrendale, PA, USA: Society of Automotive Engineers (SAE) International.

Sukamto, S. 2003. “Plant Aging and Life Extension Program at Arun LNG Plant Lhokseumawe, North Aceh, Indonesia.” Paper presented at 22nd Annual World Gas Conference, June 1-5, Tokyo, Japan.

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