System Disposal and Retirement

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Product or service disposal and retirement is an important part of system life management. At some point, any deployed system will become one of the following: uneconomical to maintain; obsolete; or unrepairable. A comprehensive systems engineering process includes an anticipated equipment phase-out period and takes disposal into account in the design and life cycle cost assessment. (See other knowledge areas in Part 3 for discussion on life cycle metrics and assessment.)

A public focus on sustaining a clean environment encourages contemporary systems engineering (SE) design to consider recycling, reuse, and responsible disposal techniques. (See Systems Engineering and Environmental Engineering for additional discussion.)

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Topic Overview

According to the INCOSE Systems Engineering Handbook (2012), “The purpose of the disposal process is to remove a system element from the operation environment with the intent of permanently terminating its use; and to deal with any hazardous or toxic materials or waste products in accordance with the applicable guidance, policy, regulation, and statutes." In addition to technological and economical factors, the system-of-interest (SoI) must be compatible, acceptable, and ultimately address the design of a system for the environment in terms of ecological, political, and social considerations.

Ecological considerations associated with system disposal or retirement are of prime importance. The most concerning problems associated with waste management include:

- Air Pollution and Control,
- Water Pollution and Control,
- Noise Pollution and Control,
- Radiation, and
- Solid Waste.

In the US, the Environmental Protection Agency (EPA) and the Occupational Safety and Health Administration (OSHA) govern disposal and retirement of commercial systems. Similar organizations perform this function in other countries. OSHA addresses hazardous materials under the 1910-119A List of Highly Hazardous Chemicals, Toxics, and Reactives (OSHA 2010). System disposal and retirement spans both commercial and government developed products and services. While both the commercial and government sectors have common goals, methods differ during the disposition of materials associated with military systems.

US DoD Directive 4160.21-M, *Defense Material Disposition Manual* (1997) outlines the requirements of the Federal Property Management Regulation (FPMR) and other laws and regulations as appropriate regarding the disposition of excess, surplus, and foreign excess personal property (FEPP). Military system disposal activities must be compliant with EPA and OSHA requirements.

Application to Product Systems

Product system retirement may include system disposal activities or preservation activities (e.g., mothballing) if there is a chance the system may be called upon for use at a later time.

Systems Engineering and Analysis has several chapters that discuss the topics of design for goals such as "green engineering," reliability, maintainability, logistics, supportability, producibility, disposability, and sustainability. Chapter 16 provides a succinct discussion of green engineering considerations and ecology-based manufacturing. Chapter 17 discusses life cycle costing and the inclusion of system disposal and retirement costs (Blanchard and Fabrycky 2011).

Some disposal of a system's components occurs during the system's operational life. This happens when the components fail and are replaced. As a result, the tasks and resources needed to remove them from the system need to be planned well before a demand for disposal exists.

Transportation of failed items, handling equipment, special training requirements for personnel, facilities, technical procedures, technical documentation updates, hazardous material (HAZMAT) remediation, all associated costs, and reclamation or salvage value for precious metals and recyclable components are important considerations during system planning. Phase-out and disposal planning addresses when disposal should take place, the economic feasibility of the disposal methods used, and what the effects on the inventory and support infrastructure, safety, environmental requirements, and impact to the environment will be (Blanchard 2010).

Disposal is the least efficient and least desirable alternative for the processing of waste material (Finlayson and Herdlick 2008).

The EPA collects information regarding the generation, management and final disposition of hazardous wastes regulated under the Resource Conservation and Recovery Act of 1976 (RCRA). EPA waste management regulations are codified at 40 C.F.R., parts 239-282. Regulations regarding management of hazardous wastes begin at 40 C.F.R. part 260. Most states have enacted laws and promulgated regulations that are at least as stringent as federal regulations.

Due to the extensive tracking of the life of hazardous waste, the overall process has become known as the "cradle-to-grave system". Stringent bookkeeping and reporting requirements have been levied on generators, transporters, and operators of treatment, storage, and disposal facilities that handle hazardous waste.

Unfortunately, disposability has a lower priority compared to other activities associated with product development. This is due to the fact that typically, the disposal process is viewed as an external activity to the entity that is in custody of the system at the time. Reasons behind this view include:

- There is no direct revenue associated with the disposal process and the majority of the cost associated with the disposal process is initially hidden.
- Typically, someone outside of SE performs the disposal activities. For example, neither a car manufacturer nor the car's first buyer may be concerned about a car's disposal since the car will usually be sold before disposal.

The European Union’s Registration, Evaluation, Authorization, and Restriction of Chemicals (REACH) regulation requires manufacturers and importers of chemicals and products to register and disclose substances in products when specific thresholds and criteria are met (European Parliament 2007). The European Chemicals Agency (ECHA) manages REACH processes. Numerous substances will be added to the list of substances already restricted under European legislation; a new regulation emerged when the Restriction on Hazardous Substances (RoHS) in electrical and electronic equipment was adopted in 2003.

Requirements for substance use and availability are changing across the globe. Identifying the use of materials in the supply chain that may face restriction is an important part of system life management. System disposal and retirement requires upfront planning and the development of a disposal plan to manage the activities. An important consideration during system retirement is the proper planning required to update the facilities needed to support the system during retirement, as explained in the *California Department of Transportation Systems Engineering Guidebook* (2005).

Disposal needs to account for environmental and personal risks associated with the decommissioning of a system and all hazardous materials involved. The decommissioning of a nuclear power plant is a prime example of hazardous material control and exemplifies the need for properly handling and transporting residual materials resulting from the retirement of certain systems.

The US Defense Logistics Agency (DLA) is the lead military agency responsible for providing guidance for worldwide reuse, recycling, and disposal of military products. A critical responsibility of the military services and defense agencies is demilitarization prior to disposal.

Application to Service Systems

An important consideration during service system retirement or disposal is the proper continuation of services for the consumers of the system. As an existing service system is decommissioned, a plan should be adopted to bring new systems online that operate in parallel with the existing system so that service interruption is kept to a minimum. This parallel operation needs to be carefully scheduled and can occur over a significant period of time.

Examples of parallel operation include phasing in new Air Traffic Control (ATC) systems (FAA 2006), the migration from analog television to new digital television modulation (FCC 2009), the transition to Internet protocol version 6 (IPv6), maintaining water handling systems, and maintaining large commercial transportation systems, such as rail and shipping vessels.

The *Systems Engineering Guidebook for Intelligent Transportation Systems (ITS)* provides planning guidance for the retirement and replacement of large transportation systems. Chapter 4.7 identifies several factors which can shorten the useful life of a transportation system and lead to early retirement, such as the lack of proper documentation, the lack of effective configuration management processes, and the lack of an adequate operations and maintenance budget (Caltrans, and USDOT 2005).

Application to Enterprises

The disposal and retirement of large enterprise systems requires a phased approach, with capital planning being implemented in stages. As in the case of service systems, an enterprise system's disposal and retirement require parallel operation of the replacement system along with the existing (older) system to prevent loss of functionality for the user.

Other Topics

See the OSHA standard (1996) and EPA (2010) website for references that provide listings of hazardous materials. See the DLA Disposal Services website for disposal services sites and additional information on hazardous materials.

Practical Considerations

A prime objective of systems engineering is to design a product or service such that its components can be recycled after the system has been retired. The recycling process should not cause any detrimental effects to the environment.

One of the latest movements in the industry is green engineering. According to the EPA, green engineering is the design, commercialization, and use of processes and products that are technically and economically feasible while minimizing:

- the generation of pollutants at the source; and
- the risks to human health and the environment.

See Environmental Engineering for additional information.

References

Works Cited

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

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 and Innovation and U.S. Department of Transportation (USDOT), SEG for ITS 1.1.

DoD. 1997. *Defense Materiel Disposition Manual.* Arlington, VA, USA: US Department of Defense, DoD 4160.21 -M.

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.

ECHA. 2010. “European Chemicals Agency (ECHA).” In European Chemicals Agency (ECHA). Helsinki, Finland. Available at: http://echa.europa.edu/home_en.asp.

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

European Parliament. 2007. Regulation (EC) no 1907/2006 of the European parliament and of the council of 18 December 2006 concerning the registration, evaluation, authorisation and restriction of chemicals (REACH), establishing a European chemicals agency, amending directive 1999/45/EC and repealing council regulation (EEC) no 793/93 and commission regulation (EC) no 1488/94 as well as council directive 76/769/EEC and commission directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC. Official Journal of the European Union 29 (5): 136/3,136/280.

FAA. 2006. "Section 4.1" in “Systems Engineering Manual.” Washington, DC, USA: US Federal Aviation Administration (FAA).

FCC. 2009. “Radio and Television Broadcast Rules.” Washington, DC, USA: US Federal Communications Commission (FCC), 47 CFR Part 73, FCC Rule 09-19: 11299-11318.

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

OSHA. 1996. “Hazardous Materials: Appendix A: List of Highly Hazardous Chemicals, Toxics and Reactives.” Washington, DC, USA: Occupational Safety and Health Administration (OSHA)/U.S. Department of Labor (DoL), 1910.119(a).

Resource Conservation and Recovery Act of 1976, 42 U.S.C. §6901 et seq. (1976)

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),* version 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.

Casetta, E. 2001. *Transportation Systems Engineering: Theory and methods*. New York, NY, USA: Kluwer Publishers Academic, Springer.

DAU. 2010. "Acquisition community connection (ACC): Where the DoD AT&L workforce meets to share knowledge." In Defense Acquisition University (DAU)/US

Department of Defense (DoD). Ft. Belvoir, VA, USA, accessed August 5, 2010. https://acc.dau.mil/.

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.

ECHA. 2010. “European Chemicals Agency (ECHA).” In European Chemicals Agency (ECHA). Helsinki, Finland. Available at: http://echa.europa.edu/home_en.asp.

Elliot, T., K. Chen, and R.C. Swanekamp. 1998. "Section 6.5" in *Standard Handbook of Powerplant Engineering.* New York, NY, USA: McGraw Hill.

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

European Parliament. 2007. Regulation (EC) no 1907/2006 of the European parliament and of the council of 18 December 2006 concerning the registration, evaluation, authorisation and restriction of chemicals (REACH), establishing a European chemicals agency, amending directive 1999/45/EC and repealing council regulation (EEC) no 793/93 and commission regulation (EC) no 1488/94 as well as council directive 76/769/EEC and commission directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC. Official Journal of the European Union 29 (5): 136/3,136/280.

FAA. 2006. "Section 4.1" in “Systems Engineering Manual.” Washington, DC, USA: US Federal Aviation Administration (FAA).

FCC. 2009. “Radio and Television Broadcast Rules.” Washington, DC, USA: US Federal Communications Commission (FCC), 47 CFR Part 73, FCC Rule 09-19: 11299-11318.

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 Education (DoEd). Washington, DC, USA. Accessed August 5, 2010. Available at: http://federalstudentaid.ed.gov/business/lcm.html.

IEEE 2005. *IEEE Standard for Software Configuration Management Plans*. New York, NY, USA: Institute of Electrical and Electronics Engineers (IEEE), IEEE 828.

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. 2010. “In-service systems working group.” San Diego, CA, USA: International Council on Systems Engineering (INCOSE).

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: Institute of Engineers Singapore.

Mays, L. (ed). 2000. "Chapter 3" in *Water Distribution Systems Handbook.* New York, NY, USA: McGraw-Hill Book Company.

MDIT. 2008. *System Maintenance Guidebook (SMG),* version 1.1: A companion to the systems engineering methodology (SEM) of the state unified information technology environment (SUITE). MI, USA: Michigan Department of Information Technology (MDIT), DOE G 200: 38.

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., USA: 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.

OSHA. 1996. “Hazardous Materials: Appendix A: List of Highly Hazardous Chemicals, Toxics and Reactives.”

Washington, DC, USA: Occupational Safety and Health Administration (OSHA)/U.S. Department of Labor (DoL), 1910.119(a).

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

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

Schafer, D.L. 2003. “Keeping Pace With Technology Advances When Funding Resources Are Diminished.” Paper presented at Auto Test Con. IEEE Systems Readiness Technology Conference, Anaheim, CA, USA: 584.

SOLE. 2009. “Applications Divisons.” In The International Society of Logistics (SOLE). Hyattsville, MD, USA, accessed August 5, 2010. http://www.sole.org/appdiv.asp.

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