

Systems Engineering Body of Knowledge  
(SEBoK)  
Wiki Approach

SEBoK Workshop in Toulouse  
October 13-14, 2010

BKCASE Semantic Wiki Team  
Presented by Hans Peter de Koning

# Agenda

- Background/Motivation
- Initial Findings/Exploration
- SEBoK Wiki Use Cases
- Proposed SEBoK Wiki Transition Plan

# Background

- Splinter Content Management WG established at INCOSE IW in Feb '2010
  - Explore approach to SEBoK content capture and management using Wiki and Modeling technologies
  - Make recommendations to SEBoK Team
- Participants – BKCASE Semantic Wiki Team
  - Sanford Friedenthal (Lockheed Martin)
  - Hans-Peter de Koning (European Space Agency)
  - Steve Jenkins (Jet Propulsion Lab)
  - David Lempia (Rockwell Collins)
  - Paola Di Maio (Advanced Knowledge Lab)
  - Art Pyster (Stevens Institute of Technology)

# Wiki Motivation

- Systems Engineering Body of Knowledge is an aggregation of knowledge
  - across a broad field
  - with many authors
  - will continue to evolve over time
- Need mechanism to effectively capture and manage knowledge content over time
  - Consistent
  - Unambiguous
  - Completeness relative to scope
  - Shareable and controlled environment
- Need effective navigation and search mechanisms for inter-related content
- Soft copy documents are inadequate
- Wiki and modeling technologies offer potential solution

# Initial Results from Exploration

- Current Systems Engineering Wiki's exists
  - Wikipedia
  - SE Handbook on INCOSE Connect
- Semantic Wiki Technology build on top of MediaWiki OSS used in Wikipedia can be used to manage SEBoK content
- Some semantic modeling technology can be applied
  - E.g. definition of controlled terms/concepts and references
  - Full conceptual modeling requires too much effort
  - Can further evolve in future releases of SEBoK
- Recommend transitioning to Wiki environment

# Results from Exploration

## Wiki-Based Prototype Technology

- Uses MediaWiki, the open source software that runs Wikipedia
  - See <http://www.mediawiki.org>
- And Semantic MediaWiki (SMW) extension
  - Helps to search, organize, tag, browse, evaluate, and share the wiki's content
  - "While traditional wikis contain only text which computers can neither understand nor evaluate, SMW adds semantic annotations that let you easily publish Semantic Web content, and allow the wiki to function as a collaborative database."
  - Free open source with active developer community
  - See <http://www.semantic-mediawiki.org>

# Semantic Wiki-Based Prototype Platform

- Hosted on <http://www.referata.com/>
  - Small New York based service company, active participant in SMW open source development
- Created experimentation account
  - [http://sesandbox.referata.com/wiki/BKCASE\\_SE\\_BoK\\_Prototype\\_Wiki](http://sesandbox.referata.com/wiki/BKCASE_SE_BoK_Prototype_Wiki)
  - Managed by Hans Peter de Koning (ESA)
  - Access only through specifically created user accounts
  - Small monthly fee (~20 USD)

# Wiki-Based Prototype Status

- 2010 March-July
  - Original experimental content using material from INCOSE SE Handbook v3.2
  - Very easy and quick to set-up and manage
  - Appealing / easy interfaces for users and developers
- 2010 September-October
  - Parts from SEBoK v0.25 loaded into (traditional) wiki
    - From MS Word source, via OpenOffice, to MediaWiki text
    - Some manual cleanup required
  - Semantic wiki of controlled terms / concepts and references

# SEBoK v0.25 Wiki Demo – Chapter 1

The screenshot shows a Mozilla Firefox browser window with the address bar displaying `http://sesandbox.referata.com/wiki/SEBoK_v0.25_Chapter_1`. The page title is "SEBoK v0.25 Chapter 1 - Systems Engineering Sandbox - Mozilla Firefox". The browser's address bar shows the URL and search engines like Google. The page content includes a navigation menu on the left, a main content area with a table of contents, and an introduction section.

**Navigation**

- Main page
- BKCASE Prototype
- SEBoK v0.25 Demo
- Recent changes
- Browse data
- Add data
- Add new term
- Add new concept
- Special
- Properties
- Templates
- Forms
- Categories
- Help
- Help
- Referata help

**Page Discussion**

SEBoK v0.25 Chapter 1

This is the approved revision of this page, as well as being the most recent.

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  - 1.2 Origins of the SEBoK
  - 1.3 SEBoK Users and Uses
  - 1.4 Domain-Dependent Knowledge
  - 1.5 Entangled Disciplines
  - 1.6 Guidance for the Construction of the SEBoK
  - 1.7 Structure of SEBoK Version 0.25
  - 1.8 Next Steps
  - 1.9 References
  - 1.10 Glossary
    - 1.10.1 Acronyms
    - 1.10.2 Terminology

**Introduction** [\[edit\]](#)

**Purpose and Value of the SEBoK** [\[edit\]](#)

As a discipline, systems engineering (SE) is perhaps sixty or seventy years old. The term **systems engineering** (SE) arose in the 1940s to enable the development of large telecommunications systems in the

Done

# SEBoK v0.25 Wiki Demo – Chapter 1

SEBoK v0.25 Chapter 1 - Systems Engineering Sandbox - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://sesandbox.referata.com/wiki/SEBoK\_v0.25\_Chapter\_1

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File:SEBoK-0.25-Figure-06.png - Syste... SEBoK v0.25 Chapter 1 - Systems... Help:Contents - Referata Semantic MediaWiki - semantic-mediawi... Help:Images - MediaWiki

Help [edit]

## Introduction

Help Referata help

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## Purpose and Value of the SEBoK

[edit]

As a discipline, systems engineering (SE) is perhaps sixty or seventy years old. The term **systems engineering** (SE) arose in the 1940s to enable the development of large telecommunications systems in the United States (Buede2009). Today, SE is recognized worldwide for its importance in enabling the development, deployment, operation, and evolution of systems with such varied scale, complexity, and purpose as a mobile phone (a product), express package shipping (a service), air traffic control (a system of systems (SOS)), and a department or ministry of a national government (an enterprise). The authors of the SEBoK have taken a broad view of the terms system and systems engineering. One useful definition of **system** comes from Aslaksen2004:

A **system** consists of three related sets:

- a set of elements;
- a set of **internal interactions** between the elements; and
- a set of **external interactions** between one or more elements and the external world; i.e. interactions that can be observed from outside the system.

The International Council on Systems Engineering (INCOSE) defines systems engineering as (INCOSE 2010):

*An interdisciplinary approach and means to enable the realization of successful systems. It focuses on defining customer needs and required functionality early in the development cycle, documenting requirements, then proceeding with design synthesis and system validation while considering the complete problem:*

- Operations
- Performance
- Test
- Manufacturing
- Cost & Schedule
- Training & Support
- Disposal

*Systems engineering integrates all the disciplines and specialty groups into a team effort forming a structured development process that proceeds from concept to production to operation. Systems engineering considers both the business and the technical needs of all customers with the goal of providing a quality product that meets the user needs.*

Chapter 2: *Systems Concepts and Systems Thinking* and Chapter 3: *Systems Engineering Fundamentals* elaborate on those two definitions, providing the context for the rest of the SEBoK.

There are several hallmarks for the maturing of a discipline. One of the most important is an agreement by the professional community on what knowledge is included in the discipline and how that knowledge should be captured and organized to facilitate its use by practitioners, researchers, and educators; i.e., a guide to its body of knowledge. Without a recognized body of knowledge, each practitioner has no community-accepted framework to structure his understanding of the field, a university that launches a SE program is largely on its own in deciding what students should know upon graduation, and each organization that certifies practicing SE professionals and guides career development does so without the benefit of community-accepted standards. The boundaries of the discipline itself will be poorly defined and agreement on

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# SEBoK v0.25 Wiki Demo – Chapter 2

SEBoK v0.25 Chapter 2 - Systems Engineering Sandbox - Mozilla Firefox

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http://sesandbox.referata.com/wiki/SEBoK\_v0.25\_Chapter\_2

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File:SEBOK-0.25-Figure-06.png - Syste... SEBoK v0.25 Chapter 2 - Systems... Help:Contents - Referata Semantic MediaWiki - semantic-mediawiki Help:Images - MediaWiki

Complex behaviors and for structuring the engineering and life cycle management of complex systems, there is a richness that must not be over-simplified.

- **Disorganized complexity** occurs when there are many variables that exhibit a high level of random behavior. It can also represent the product of not having adequate control over the structure of heterogeneous complex systems that have evolved due to inadequate architectural control over the system life cycle (complexity creep).
- **People-related complexity** where the perception of any system fosters a feeling of complexity. In this context, humans become "observing systems." We could also relate this category to systems in which people are elements and can well contribute to organized simplicity, organized complexity, or disorganized complexity. The rational or irrational behavior of individuals in particular situations is of course a vital factor with respect to complexity.
- **Complex adaptive** where the individual elements act independently but jointly behave according to common constraints and goals. In the natural world a flock of geese is a complex adaptive system (CAS). Human-intensive systems are complex adaptive systems, since each human in the system is independent.

Other categorizations and characterizations of complexity can be found throughout the literature.

## Roles of Systems [\[edit\]](#)

An organization's systems portfolio consists of the value-added system products or services that a public, private or non-profit organization supplies, as well as their enabling infrastructure assets. Examples of the infrastructure assets include human resource, production, marketing, supply chain, and information processing systems. These systems are the essence of their existence; thus a system focus is required as portrayed in Figure 4. It is through the utilization of instances of the system assets that the purpose, goals, and missions are achieved.

Figure 4. Achieving Organization Purpose, Goals and Missions via System Assets (Source: [Lawson2010], Permission Pending)

These institutionalized system assets must be properly **sustained** over varying periods of time, in order to be in such condition that when put into operation (instantiated), they are ready to deliver the desired effect. The provisioning of value-added products and services such as aircraft, telecommunication equipment, banking services, health care, social welfare, etc. requires a long sustained life cycle. Typically the provisioning of such sustained systems result in product or service families. Therefore, from a generic system definition, variant products and services are produced, each one of which must be life cycle managed. As mentioned earlier in regards to system perspectives, systems can arise as a **situation** that may be short-term but may have a long longevity. The situation may be thought of and even described in terms of a network of contributing elements and relationships, as illustrated in the terrorist action described earlier. In order to meet or counteract the situation that has arisen, a **respondent** system is created and put into operation. For example, consider as a respondent system a fire brigade that is assembled from elements (equipment, consumables (water, chemicals, etc.), and personnel) in order to bring a fire under control. Another example of a respondent system is the assembly of a military force in order to pursue a course of action to meet a situation that has arisen. Such system services are composed from available assets

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# SEBoK v0.25 Wiki Demo – Concepts

The screenshot shows a Mozilla Firefox browser window with the address bar at <http://sesandbox.referata.com/wiki/Category:Concepts>. The page title is "Category:Concepts - Systems Engineering Sandbox - Mozilla Firefox". The browser's toolbar includes navigation buttons (back, forward, home, search), a search engine (Google), and a list of bookmarks such as "Most Visited", "Latest Headlines", "RSS feeds", "Wikipedia", "ESA Intranet", "CDF-MetaFrameXP", "Webmail", "Worldclock", "Gmail", "pde-announce Admin", "HPdk's TiddlyWiki", "ESA VPN", "NASA TV", "TEC-M", "Getting Started", and "MyOnlinePool.com".

The page content includes a navigation sidebar on the left with links like "Main page", "BKCASE Prototype", "SEBoK v0.25 Demo", "Recent changes", "Browse data", "Add data", "Add new term", "Add new concept", "Special", "Properties", "Templates", "Forms", "Categories", "Help", and "Referata help".

The main content area features a "Category:Concepts" header with tabs for "Category" and "Discussion". Below the header, it states "This category uses the form [Concept](#)." and provides navigation links "(previous 200) (next 200)". The section "Pages in category 'Concepts'" indicates that there are 200 pages in this category out of a total of 399. The pages are listed in three columns under the headings "A", "D cont.", and "F cont.", with "G" and "H" sections partially visible. The "A" column lists terms like "Acceptance criteria", "Acquirer", "Acquirer identification", "Acquisition plan", "Acquisition strategy", "Actual", "Agile", "Agile development", "Agility", "Agreement", "Agreement process", "Alignment", "Analysis", "Application domain", "Architecting", and "Architecture". The "D cont." column lists terms like "Decision criteria", "Decision gate", "Decision management", "Decision theory", "Decommissioning review", "Delphi technique", "Demilitarization", "Demonstration", "Deployment", "Derived function", "Derived measure", "Derived requirement", "Design constraint", "Design life", "Designed abstract systems", and "Designed physical system". The "F cont." column lists terms like "Fixed-price redetermination", "Flexibility", "Form, fit, function, and interface", "Function", "Functional architecture", "Functional organization", and "Functional requirement". The "G" column lists "Global functional architecture", "Governance", "Governmental service enterprise", and "Green engineering". The "H" column lists "Hard system" and "Hazardous material".

At the bottom of the browser window, there is a search bar with the text "Find: image" and navigation buttons for "Next", "Previous", "Highlight all", and "Match case". The status bar at the very bottom shows "Done".

# SEBoK v0.25 Wiki Demo – Concept example

The screenshot shows a Mozilla Firefox browser window with the address bar at `http://sesandbox.referata.com/wiki/Agile_development`. The page title is "Agile development" and it is part of the "BKCASE WIKI". The page content includes a table with the following information:

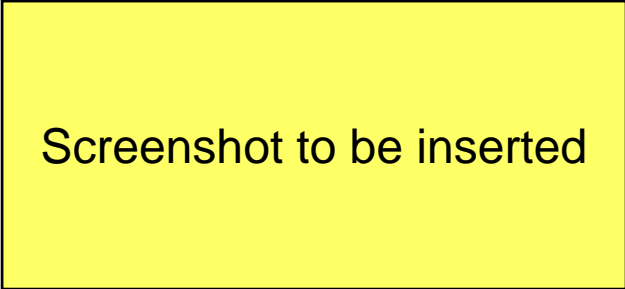
<b>definition</b>	Agile development approach provides a tailoring framework, based on an opportunity to simplify control methods and to assess the risks in so doing. The extent of tailoring is determined by whether the opportunity to shorten the project cycle is worth the risk of doing development steps out of sequence or in parallel. ⚠
<b>acronym</b>	
<b>reference</b>	
<b>is adaptation</b>	No

Below the table, the category is listed as "Concepts". There is a section titled "Facts about Agile development" with the following properties:

- Is adaptation: false
- Is defined as: ⚠

The page footer includes a copyright notice: "This page was last modified on 2010-10-12, at 04:29:11. Content is available under INCOSE © 2010 - All rights reserved." and links for "Privacy policy", "About Systems Engineering Sandbox", and "Disclaimers". The browser's search bar at the bottom contains the text "image".

# SEBoK v0.25 Wiki Demo – References



Screenshot to be inserted

# First Test

## with Automatic Text Extraction (ATX) Tools

- Steps
  - Parsed Chapter 2 using different generic tools (OpenCalais, Alchemy)
  - Compared the output with the glossary created manually by the editors with the output of ATX
- Overview of results
  - ATX yields more granular results and in some cases provides some categories (structure) to the terms
- Recommendations
  - Editors of the glossary could benefit from taking into account the additional granularity and categorization structure (in addition to the manual glossary)
  - New ad hoc categories for SE could be created
  - Categories could serve as metadata and could be encoded using SKOS or other suitable supporting schema
- More Info at <http://tinyurl.com/2vwq5wh>

(Performed by Paola di Maio)

# ATX Example:

## "Industry Terms" found by OpenCalais

abstract systems  
adaptive systems  
bodies defining systems  
certain human activity systems  
chemical impurities  
chemical interaction  
chemicals  
civil infrastructure  
component systems  
computational applications  
concept systems  
conceptual systems  
cultural systems  
dangerous network  
defined physical systems  
discussion  
disruptive technology  
educational systems  
energy  
financial systems  
form first systems  
government systems

hard and soft systems  
heterogeneous complex systems  
Human activity systems  
human systems  
human-intensive systems  
human-made systems  
idea systems  
information processing systems  
introduction to systems  
large-scale physical systems  
law enforcement system  
life cycle management  
man-made and natural systems  
man-made systems  
mechanical systems  
modified system product  
Natural systems  
ordered conscious product  
physical network  
physical systems  
political systems  
politico-technical systems  
possible systems  
process systems

respondent systems  
situation systems  
social systems  
socio-ecological systems  
socio-technical systems  
soft systems  
Software systems  
static systems  
storage systems  
structured social and political systems  
supply chain  
sustained systems  
system services  
technology dependent  
telecommunication equipment  
telecommunications  
transport systems  
transportation media  
transportation systems  
variant products  
version that focuses upon business systems  
web-site [www.systems-thinking.org](http://www.systems-thinking.org)

# SEBoK v0.25 Wiki Demo – Findings 1/4

- Loading from v0.25 MS Word into Semantic Wiki worked reasonably well
  - Load in OpenOffice – Export to MediaWiki text format
  - Still quite some manual cleanup needed
    - In particular inconsistent use of styles in MS Word source
    - A lot of "cosmetic" formatting, using e.g. bold or italics with implied "meaning" that is author dependant
    - Glossary of Terms and References do not follow standard structure
- In general the source should be written as clean as possible without any specific (manual) formatting and only follow a small set of structural rules

## SEBoK v0.25 Wiki Demo – Findings 2/4

- Was possible to bulk load all controlled terms and a number of references
  - This needed some massaging through text editor and Excel
  - Wrote a number of Python scripts for data manipulation
- Maintenance/adaptation of the semantic data structures behind the demo is not so straightforward
  - First creation is easy
  - Subsequent modifications necessitate a number of manual actions to keep Templates / Forms / Properties in sync

# SEBoK v0.25 Wiki Demo – Findings 3/4

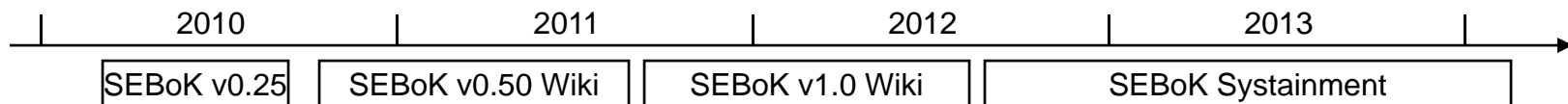
- Estimated effort to convert whole of SEBoK (~600 pages) is 3 to 5 person.week
  - Including basic semantical clean-up and consistency check
- The [www.referata.com](http://www.referata.com) prototype environment is not good enough for BKCASE production
  - Reliability/availability of the wiki environment is insufficient
  - Have not tested multi-user concurrent usage
- Since SEBoK is conceived as a traditional book it is not so obvious how to transform it into a network of wiki articles
  - Should value and honour original authorship
  - Content would need to be adapted to non-sequential reading

# SEBoK v0.25 Wiki Demo – Findings 4/4

- Option is to keep a sequential book narrative
  - Wiki would still bring:
    - Structure for controlled terms/concepts
    - Structure for references, acronyms, hyperlinking
    - Strong support for community authoring and review
  - Could potentially be done with the basic MediaWiki engine without Semantic extensions
    - MediaWiki supports Categories, Templates and Forms
  - Stepping stone to move to a "real" semantic SEBoK
  - Reduced risk

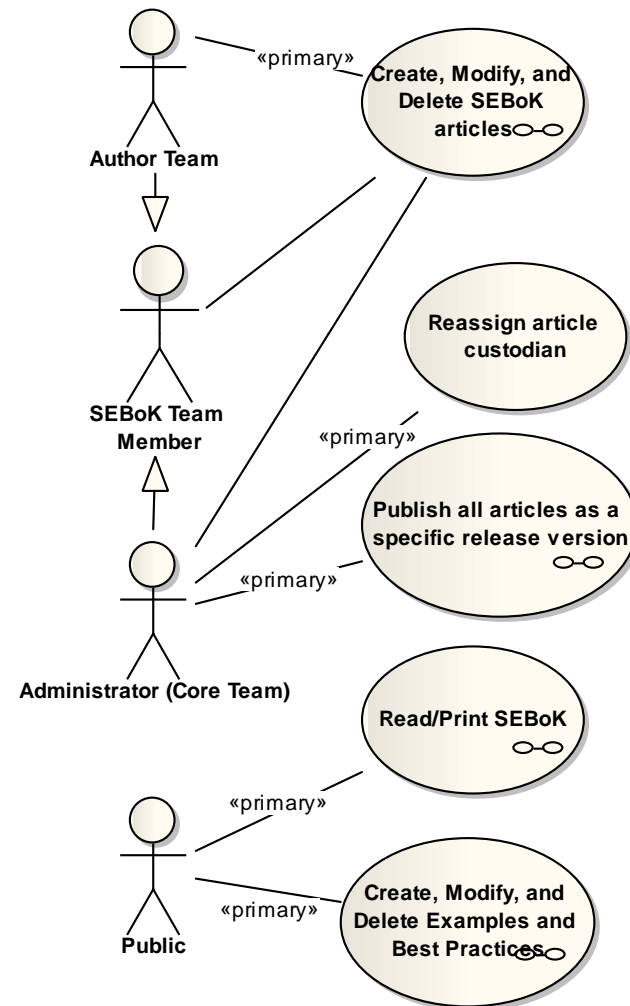
# Possible SEBoK WIKI Development

- Purpose
  - To capture and share the SEBoK in a collaborative environment
  - To provide the option to move to a more open business process model for future SEBoK evolution
  - Maximize SEBoK visibility in the public domain
- SEBoK Charter
  - <http://www.bkcase.org/about-bkcase/project-charter>
- Tentative Schedule as of Sept 2010
  - September 2010 - Version 0.25 SEBoK released
  - September 2011 - Version 0.5 SEBoK
  - September 2012 - Version 1.0 SEBoK
  - **Sustainment**



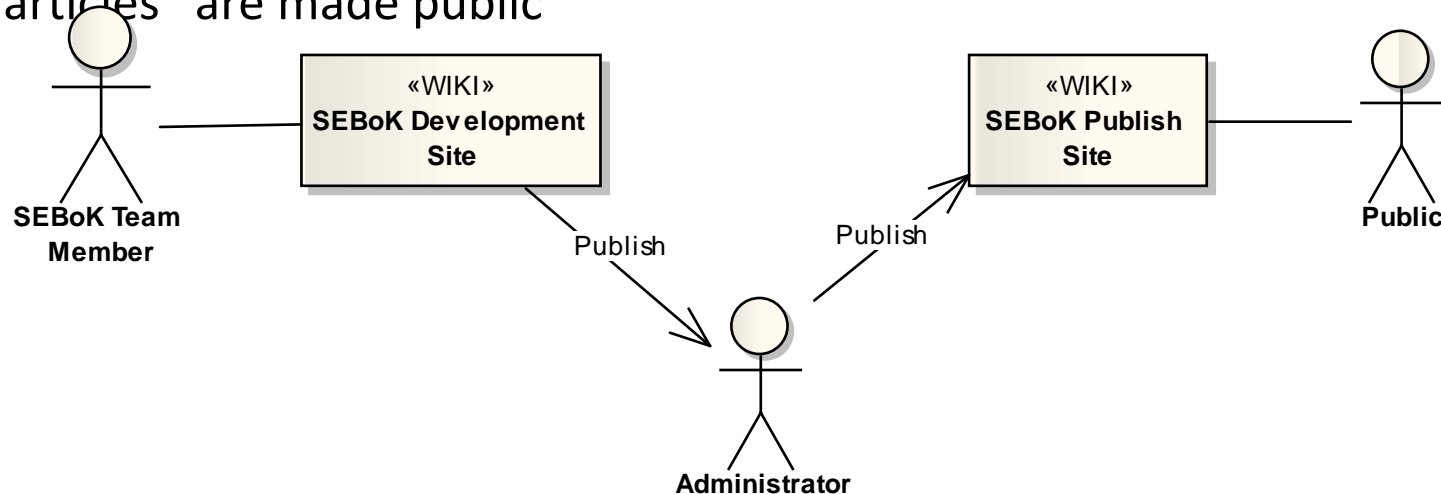
# SEBoK Use Cases

- SEBoK Team Member
  - Any person that has access to SEBoK development
  - Role: Review and modify articles
- Author Team
  - A specialized SEBoK team member
  - Role: Author new and existing SEBoK articles; give additional authors ability to modify their articles
- Administrator (Core Team)
  - A specialized SEBoK team member
  - Role: Setup and backup the wiki; publish and restore SEBoK information; re-assign access privileges for articles; manage Wiki
- Public
  - Any person that discovers and wants to read or print the published version of the SEBoK; provide comments, examples, and/or best practices through child pages (decision point)



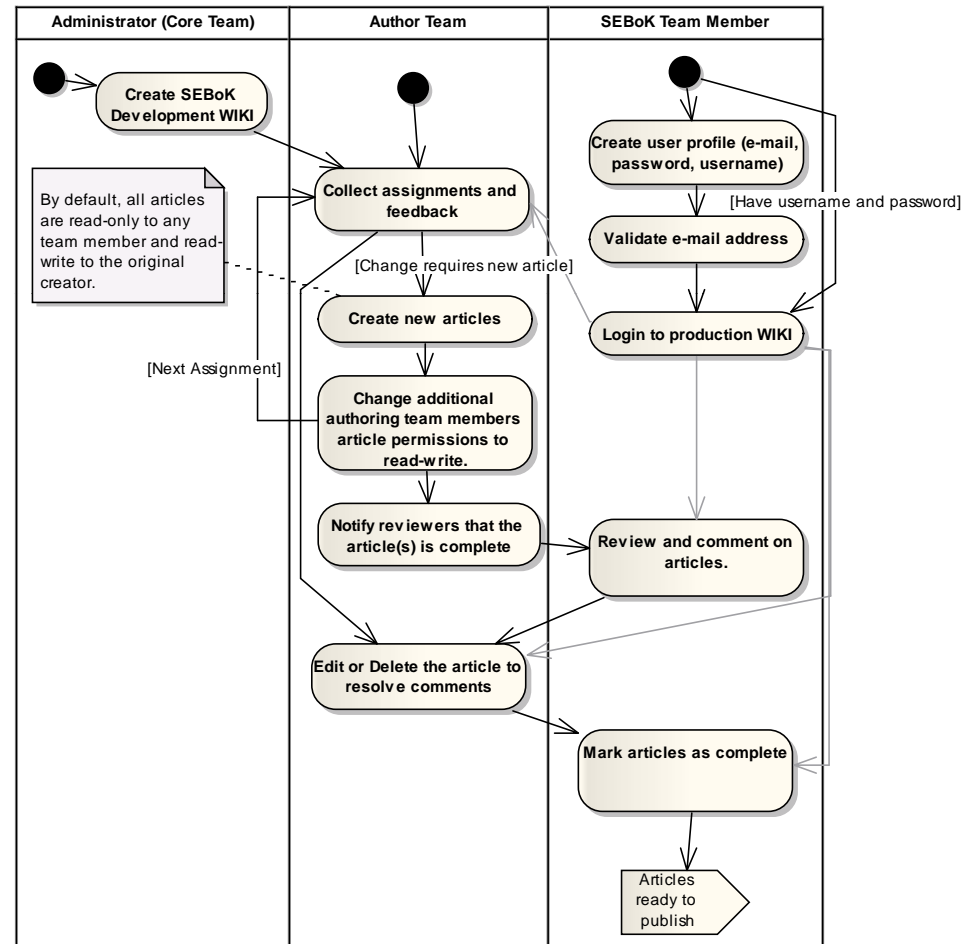
# SEBoK Assumptions (development or pre v1.0)

- SEBoK v0.25 will be imported with additional development for SEBoK v0.5 completed in the WIKI
- Development edits are only visible to SEBoK team members
- Published (released) information developed by SEBoK team members is read-only to the Public with comments accepted (decision point)
- The public can add examples and best practices as children articles to published articles (decision point)
- Development is hidden from the public; only approved/published “articles” are made public



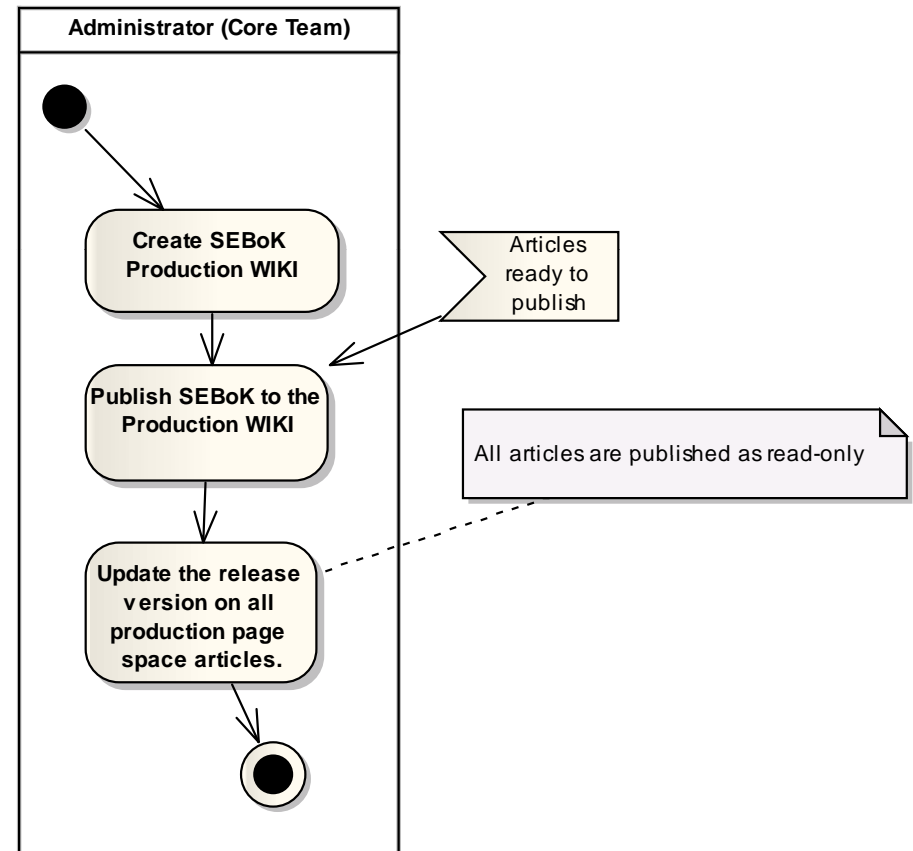
# Create, modify, or delete SEBoK articles

- Each major release starts on the Development WIKI.
- Only SEBoK team members can see items on the Development WIKI
- The initial content of the Development WIKI is a import of the original document (release 0.25)
- At the end of this use case, the articles have been created or edited with new updates. All articles are complete and ready to publish.
- Future SEBoK development is done on the Development WIKI



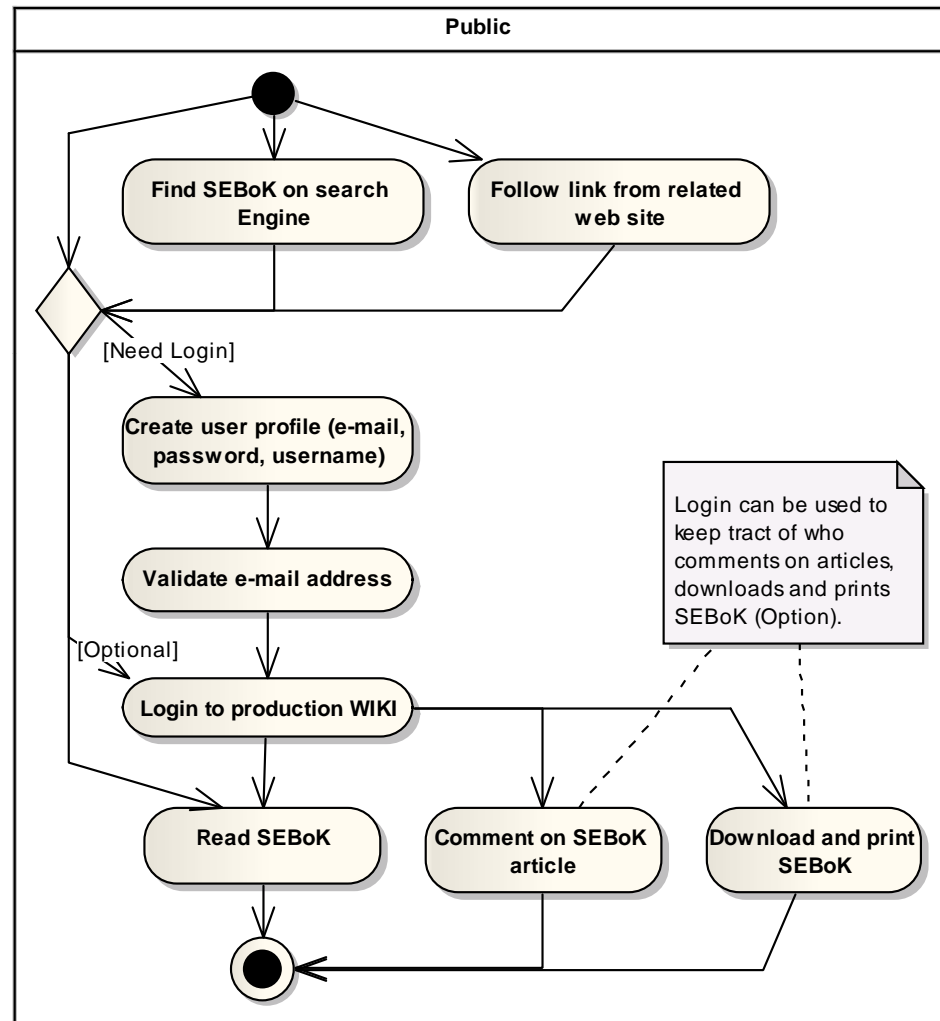
# Publish all articles as a specific release version

- Publishing moves the completed development WIKI articles into the Production WIKI
- All new articles are approved for release to the Production WIKI
- At the end of this use case, the Development WIKI material is moved to the Production WIKI



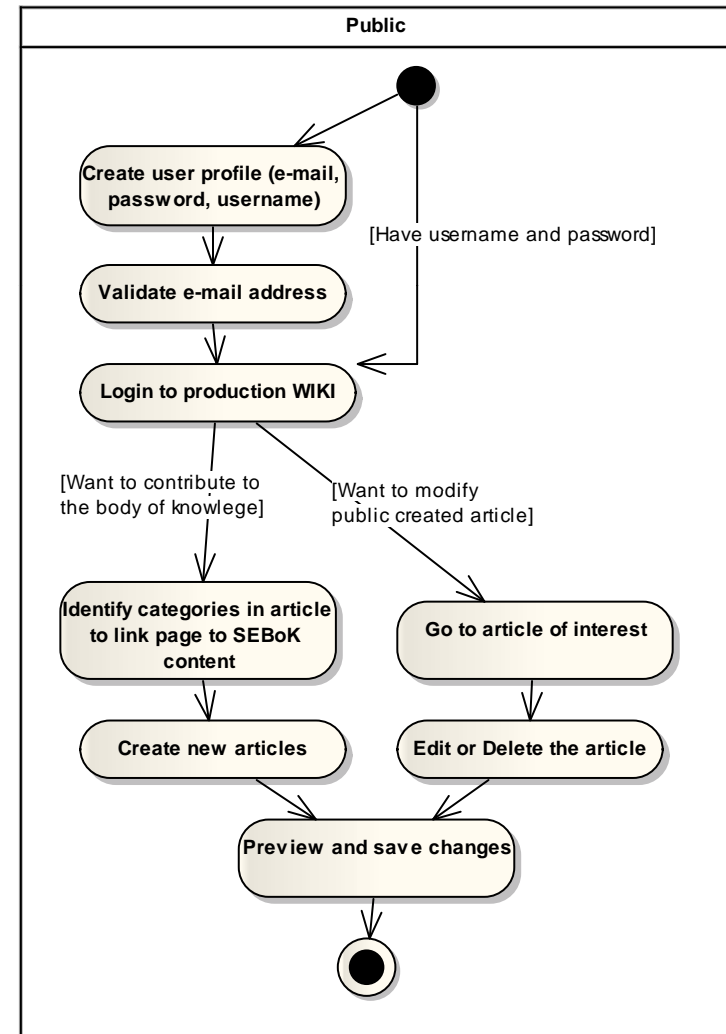
# Read/Print SEBoK

- Anybody on the internet can find the SEBoK through search, following links from any web site, or any other means.
- The Wiki (community defined option) can log users that comment on articles, download, view and/or printout the SEBoK.



# Create, Modify, and Delete Examples and Best Practices

- A person contributes examples and best practices to extend the body of SE knowledge
- SEBoK WIKI articles are available to summarize the industry examples and best practices.
- At the end of this use case, a member of the public has a new or modified article linked into the SEBoK



# Development versus Sustainment Phases

- Up to the V1.0 Release (Development)
  - The WIKI Administrator will setup and backup the wiki; publish and restore SEBoK information; re-assign access privileges for articles; manage Wiki
  - Author Team will author new and existing SEBoK articles; give additional authors ability to modify their articles.
- Post V1.0 Release (Sustainment)
  - Choice 1 – Publish model. Maintain the development and publish wiki. Select authors make edits to the SEBoK articles on the development wiki and publish them to the publish wiki.
  - Choice 2 – Wiki model. The SEBoK articles are opened for editing by the public. Authors monitor, arbitrate, and organize SEBoK article development.

# Conclusions

- Future SEBoK governance during sustainment is flexible
  - Article write permission can be opened for anyone to modify, can remain locked, or could be allowed with a moderator
- SEBoK v0.25 is released in MS Word format
  - This can be used to populate an initial version for v0.50
  - Would be very beneficial to issue a number of editing guidelines (stick to predefined styles) so as to minimize manual rework
  - Additional development could be conducted in Wiki environment
- A decision needs to be made on how to manage content of the SEBoK post v1.0 release – sustainment phase
- Given the approach taken in v0.25 the option to use a "classical" (non-semantic) Wiki should be considered as a low risk approach