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KNOWLEDGE MANAGEMENT AND THE INTEGRATED WORKFLOW PROJECT

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This talk will provide an overview of the IWF, and how the project supports confidence in Computational Simulation analyses using graphical workflows that provide artifact traceability, execution repeatability, and ease of workflow evolution to illuminate contextualized knowledge.

As a part of "Data Days", we contend that data is a subordinate component of knowledge. To move from data to knowledge, the use of graphical workflows to capture and contextualize knowledge is critical to address the challenges of knowledge, as opposed to data, management.

INTRODUCTION

Starting with a workflow provides the greatest benefits

Utilizing a "Workflow First Approach" maximizes the ability to manage knowledge.

A workflow provides the process, context, and exploration capabilities that allow knowledge to be extracted.

Knowledge ≠ Information

- Builds upon information
- Requires a process to extract and transform information

Knowledge is Contextual

- Must be contextually situated
- Context is developed through processes that transform information into knowledge

Knowledge is Expansive

- Sharing
- Sparks investigation
- Web of links
- Evolves

Graphical workflows manage processes to generate contextualized, sharable knowledge

WHAT IS KNOWLEDGE?

Can you manage what you cannot define?

The question of the nature of knowledge is extremely challenging. Although philosophers have been discussing the issue for several hundred years, the search for a formal definition continues (Emery, 1997). There is neither agreement nor clarity on what, exactly, constitutes the concerted effort to capture, organize, share and transform [...] knowledge (Despres, 1999).

Hundreds of years, thousands of philosophers, and no real consensus

Did not stop an entire academic journal from being founded – "Journal of Knowledge Management"

Knowledge is the only resource that provides sustainable competitive advantage, and, therefore, [...] attention and decision making should focus primarily on knowledge and the competitive capabilities derived from it (Roberts, 1998).

KNOWLEDGE

Not just a pyramid...

Traditionally, in information theory, knowledge has been distinguished by its place on a hierarchical ladder that locates data on the bottom rung, the next belonging to information, then knowledge, and finally wisdom at the top.



Note: Information in this context here is not directly leveraging Shannon's information theory.



KNOWLEDGE

"Knowledge" is not merely an object that can be "placed," nor should it be confused with representations of knowledge in documents, databases, etc., but it can be seen as a collection of processes that allow learning to occur and knowing to be internalized...



STAGES OF KNOWLEDGE MANAGEMENT

Information transformed through a process placing it in context is knowledge



• Next, individuals assimilate the contextual information and transform it into knowledge.

KNOWLEDGE EVENT CHAIN

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Each stage has expansive opportunities for specialization





Knowledge is process-driven transformation of information

WORKFLOW PLATFORM

Graphically define, communicate, and execute ModSim process: the workflow IS the model

Intuitive and graphical

• Institutional knowledge capture, training, share best practices

Composable to accurately express hierarchical workflow through nesting

• Agile model development by multiple analysts

Supports analysis credibility evidence/communication

- All computational steps documented from input parameters to responses
- Committed in repository

Delivered in SAW (Sandia Analysis Workbench) and in open source

- Integrated with Sandia model development tools (meshing, solution, postprocessing, etc.)
- Available to all analysts without license burden; supporting Trilab and beyond
- Can be executed by iterators (e.g. Dakota optimization, sensitivity and uncertainty quantification methods)

All CompSim activities comprising a model are repeatable, documented, efficiently communicated and executed

WORKFLOW EVOLUTIONS, HISTORY, DOCUMENTATION

Graphically modeling and storing the evolving workflow supports:

- Confidence in conclusions
 - Assumptions captured
- Contextualization of the steps
- Repeatable execution
- Leveraging different expertise in a team

Not just capture and storage of data, but the "management of the workflow representing the evolution of the analysis" (Schweinsberg et al., 2021).

WORKFLOWS & VISUAL CONTEXT

User understands at a glance

- Preconditions
- Tools used
- Hardware used
- Data products
- Process status

Spatial memory helps with

- Recall
- Understanding
- Knowledge transfer
 - Person-to-person
 - Workflow-to-workflow

Workflow provides a visual context for knowledge creation

WORKFLOWS & SHARING

ADVANTAGES OF NEXT-GEN WORKFLOW

Repeatable and robust

Sandia infrastructure

Secure and scalable

Graphical presentation

Flexible "Glue" that works with everything

Fast, easy customization

Integrated with

Introspection and traceability

CASE STUDY INFORMATION

Design exploration workflow for a critical component involving structural dynamics and visualization with significant pre and post processing.

- Original manual process
 - Single evaluation took a week or more to complete
 - Could only be executed by subject-matter expert
- Translated to automated workflow
 - Runs in 1-2 hours
 - Can be executed by anyone
- Composed into ensemble study
 - Multiple cases covered in less than a day
- Migrating from SNL capacity clusters to ATS-2 LLNL

OTHER QUOTES ON KNOWLEDGE

ADDITIONAL QUOTES ON KNOWLEDGE

Information and Knowledge Differentiation

The ambiguity of the distinction between information and knowledge has been a major source of difficulty and, in many articles, the distinction between information and knowledge is not clearly articulated (Mårtensson, 2000, p. 213).

Knowledge is often used as something similar to information, but information and knowledge are far from synonymous. Tacit knowledge might have begun as information, but because it is processed by the human mind, it can be translated into explicit knowledge. Explicit knowledge is identical to information; it can be easily stored outside the human mind (e.g. in databases), but nonetheless it cannot be described as knowledge until it has been processed (Mårtensson, 2000, p. 213).

Information has little value and will not become knowledge until it is processed by the human mind (Ash, 1998).

All strategic contributions on knowledge emphasize two essential features: the way knowledge is created and the way it is leveraged into value (Mårtensson, 2000, p. 214).

Knowledge is dynamic (McInerney, 2002, p. 1009).

APPROACH KNOWLEDGE THROUGH QUALITIES/CHARACTERISTICS

Knowledge is messy
 It is self-organizing
 It seeks community
 It travels on language
 It is slippery
 It likes looseness

7. It experiments
8. It does not grow forever
9. It is a social phenomenon
10. It evolves organically
11. It is multi-modal
12. It is multi-dimensional

APPROACH KNOWLEDGE THROUGH QUALITIES/CHARACTERISTICS

Knowledge cannot easily be stored (Gopal and Gagnon, 1995).

Knowledge is something that resides in people's minds rather than in computers (The Banker, 1997).

Unlike raw material, knowledge usually is not coded, audited, inventoried, and stacked in a warehouse for employees to use as needed. It is scattered, messy, and easy to lose (Galagan, 1997).

Knowledge should be studied in context. Knowledge is information combined with experience, context, interpretation, reflection, and perspective.

A study by the American Productivity and Quality Center shows that 89 per cent of the participants in the study said that the core goal for knowledge management is to capture and transfer knowledge and best practices (Allerton, 1998).

TACIT AND EXPLICIT KNOWLEDGE

Tacit vs. Explicit Knowledge: Explicit knowledge is documented and public; structured, fixed-content, externalised, and conscious (Duffy, 2000). Explicit knowledge is what can be captured and shared through information technology.

Tacit knowledge resides in the human mind, behaviour, and perception (Duffy, 2000). Tacit knowledge evolves from people's interactions and requires skill and practice.

Organisations are beginning to recognise that technology-based competitive advantages are transient and that the only sustainable competitive advantages they have are their employees (Black and Synan, 1997).

Knowledge is ineffectual if not used (Martensson, 2000, p. 209).

The process of creating knowledge results in a spiralling of knowledge acquisition (Martensson, 2000, p. 209).

IWF/NGW ADDITIONAL SLIDES

NEXT-GEN WORKFLOW ARCHITECTURE

Architecture based on fully independent components anticipates change

Graphical Workflow Editor

"Firewalled" from workflow engine

Open Workflow Document Format

REFERENCES

REFERENCES

Allerton, H. E. (1998). News you can use. *Training & Development*, *52*(2), 9-10.

Ash, J. (1998). Managing Knowledge Gives Power. Communication World - San Francisco, 15(3), 23-26.

The Banker. (1997). CSFI Knowledge Bank. The Banker, 147(862).

Davenport, T. H., De Long, D. W., & Beers, M. C. (1998). Successful knowledge management projects. *MIT Sloan Management Review*, 39(2), 43-57.

Despres, C., & Chauvel, D. (1999). Knowledge management (s). *Journal of knowledge Management*, 3(2), 110-123.

Duffy, J. (2000). Knowledge management: to be or not to be? Information Management Journal, 34(1), 64-67.

Galagan, P. (1997). Smart companies. *Training & Development*, *51*(12), 20-25.

Gopal, C., & Gagnon, J. (1995). Knowledge, information, learning and the IS manager. *Computerworld*, 29(25), 1-7.

Infield, N. (1997). Capitalising on knowledge. Information World Review, 130(22).

Mårtensson, M. (2000). A critical review of knowledge management as a management tool. Journal of knowledge Management, 4(3), 204-216.

REFERENCES

Mayo, A. (1998). Memory bankers. People Management, 4(2), 34-38.

McInerney, C. (2002). Knowledge management and the dynamic nature of knowledge. *Journal of the American Society for Information Science and Technology*, *53*(12), 1009-1018.

Schaefer, M. (1998). ``Eight things communicators should know and do about knowledge management". *Communication World*, 15(2), 26.

Schweinsberg, M., Feldman, M., Staub, N., van den Akker, O. R., van Aert, R. C., Van Assen, M. A., Liu, Y., Althoff, T., Heer, J., & Kale, A. (2021). Same data, different conclusions: Radical dispersion in empirical results when independent analysts operationalize and test the same hypothesis. Organizational Behavior and Human Decision Processes, 165, 228-249. <u>https://doi.org/https://doi.org/10.1016/j.obhdp.2021.02.003</u>

Warren, L. (1999). Knowledge management: just another office in the executive suite? *Accountancy Ireland*, *31*(6), 20-22.

Note: several articles sourced from Mårtensson (2000).