Question 4: Suppose we define a generalized memory sub-system as that part of a system that helps that system bring the past to bear on the present and future. List as many examples of such sub-systems that we learned about in this course as you can, very briefly describing for each the generalized memory sub-system, and the system it serves. Choose three from your list to describe in more detail. Then compare and contrast these three.

Memory systems and subsystems

- Archival systems and museums give durability to created artifacts. These serve the memory function of the larger historical contextualization system of events and societies [1].
- Organizational practices and routines encode the tacit knowledge of social groups. These serve the larger system of durable organizational function and viability [2, 3].
- Codification of meaningful words in language preserves the efforts in creating shared meaning. This serves the system of coordinated activity in groups, vital to sustainability and cooperation [4-6].
- Library classification systems preserve the memory of how ideas are related within a standardized structure. This serves the larger system of knowledge preservation, and makes information more accessible for the creation of new knowledge [7].
- Archived online conversations preserve memory in collaborative efforts, such as in the interface of the UARC. This serves the larger system of collaboratory innovation efforts and knowledge sharing [8, 9].
- Inverted indices in information retrieval systems preserve the memory concept and keyword location within a corpus of documents. This serves the larger system of efficiency in organizing document for effective reuse [10].
- Bayesian methods in economic modeling preserve the memory of earlier transactions and decisions through defining priors. These serve the general system of effective decision making, bringing past decisions to bear on present and posterior probabilities [11].
- Transactive memory within working groups preserves not specific information to be applied, but knowledge about where the information resides. This serves the larger system of organizational efficiency through specialization [12].
- Routinization of task decomposition serves as temporary memory within work processes (such as Dennett's example of the two watch makers.) This serves the larger system of protracted problem solving processes, preserving the efforts and memory of processes, and mitigating against interruption [13].
- Neural subsystems, embedded in larger brain structures, allow recall of past experienced information to construct appropriate responses to new stimuli. These serve the larger system of the body in maintaining viability in evolutionary processes [14-16].
- Semiotic associations are an efficient memory compression serving as a subsystem for cognitive processes. They serve the larger system of fast approximations for recall in determining context of new situations [7].
- The practice of legitimate peripheral participation serves as a subsystem for transmitting experience and memory anecdotally from one generation of a community

to the next. This serves the larger system of organizational memory, and preserves traditions and tacit knowledge through indoctrination and mentorship [17-19].
- Representations of various networks are a memory subsystem capturing both the nature of agents within a larger system, as well as the relationships through which resources, physical or informational, can and do travel. This serves the larger system of understanding the network effects of phenomena as they shift through levels of aggregation [16, 20-23].
- Information artifacts and tools can be created to serve larger, distributed systems of cognition in complex tasks. These serve various larger systems working toward specific goals, for example, flight instrumentation can serve transient memory functions in the larger system of operating an airplane [24].
- Physical arrangement of office function can be a memory subsystem, centralizing or streamlining organizational function. This serves the larger system of a multi-departmental organization in maintaining compatible workflows [25].

For comparison, I choose three of these memory subsystems for more explanation: transactive memory in work groups [12], inverted indices in information retrieval systems [10], and culture in organizations [2]. Transactive memory describes the tacit knowledge and working memory of an established group. Individuals in work groups have different expertise, and this specialization promotes efficiency or lack of redundancy in skill sets. Over time, group members become aware of efficient problem solving methods by quickly identifying the group member with the most appropriate knowledge for a task. The transactive memory serves as a subsystem for the distributed cognitive abilities of the group in completing work. Inverted indices are lists of keywords and terms within a corpus of documents, effectively allowing users to navigate to locations within the corpus for relevant information. The lists are the memory of previous expenditure of cognitive resources to locate such information and serve the larger system of information retrieval tasks in variable contexts. Organizational culture refers to the complex sets of norms, routines, practices, infrastructures, and hierarchies that describe an organization's behavior, ranging from the individual to the organic whole. Argote describes several modes in which this memory can be codified, including social, technological, and decision-making systems. They all come together to serve the economic and social viability of the organization to evolve, profit, and provide for the organization members.

To contrast on one critical dimension, it is apparent that these three memory subsystems use different modalities to encode information and knowledge. Transactive memory is a purely implicit or tacit memory function, specific to the individuals in the group, and derived solely from experience in that group. Studies of work groups have shown that the memory is highly specific to the individuals within the group; thus, the memory is not particularly durable. Inverted indices in IR systems, on the other hand, and completely explicit, even of the files from which they are derived. This quality gives them a high level of durability; however, as documents are added or deleted from the corpus, re-indexing is necessary, and dynamic information may be difficult to make tacit on a moment-to-moment basis. Culture in organizations is a middle ground between these two. Some aspects, such as shared history, informal communication patterns, company loyalty, and location of specific resources (especially tacit) are uncodified and are

transmitted to new employees through participation, observation, norm enforcement, and mentoring. Other aspects, such as formal procedure, dress codes, hierarchies of command, and processes surrounding capital are usually standardized and codified, typically in procedure and employee manuals. In each of these three cases, mechanisms effectively preserve the memory of the system to ensure the survival and viability of the larger system; however, the mechanisms are enacted in highly variable modalities, contextualized to the media and systems they serve.

(1003 words)

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