Knowledge Preservation for Design of Rocket Systems

Summary of Research

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The Knowledge Preservation Project at Southern University

An engineer at NASA Lewis RC presented a challenge to us at Southern University. Our response to that challenge, stated circa 1993, has evolved into the Knowledge Preservation Project which is here reported. The stated problem was to capture some of the knowledge of retiring NASA engineers and make it useful to younger engineers via computers.

We evolved that initial challenge to this - design a system of tools such that, with this system, people might efficiently capture and make available via commonplace computers, deep knowledge of retiring NASA engineers. In the process of proving some of the concepts of this system, we would (and did) capture knowledge from some specific engineers and, so, meet the original challenge along the way to meeting the new. Some of the specific knowledge acquired, particularly that on the RL-10 engine, was directly relevant to design of rocket engines.

We considered and rejected some of the techniques popular in the days we began - specifically "expert systems" and "oral histories." We judged that these old methods had too high a cost per sentence preserved. That cost could be measured in hours of labor of a "knowledge professional." We did spend, particularly in the grant preceding this one, some time creating a couple of "concept maps", one of the latest ideas of the day, but judged this also to be costly in time of a specially trained knowledge-professional.

We reasoned that the cost in specialized labor could be lowered if less time were spent being selective about sentences from the engineers and in crafting replacements for those sentences. The trade-off would seem to be that our set of sentences would be less dense in information, but we found a computer-based way around this seeming defect.

Our plan, details of which we have been carrying out, was to find methods of extracting information from experts which would be capable of gaining cooperation, and interest, of senior engineers and using their time in a way they would find worthy (and, so, they would give more of their time and recruit time of other engineers as well).

We studied these four ways of creating text:
1) the old way, via interviews and discussions - one of our team working with one expert,
2) a group-discussion led by one of the experts themselves and on a topic which inspires interaction of the experts,
3) a spoken dissertation by one expert practiced in giving talks,
4) expropriating, and modifying for our system, some existing reports (such as "oral histories" from the Smithsonian Institution).

Having text documents, each of these would be processed in turn by our software product, created under this grant, called NetAuthor. The text document would be transformed, via a few clicks at a computer, into a netbook. Specifications, in a preliminary form, for netbooks were created or advanced under this grant. A netbook is an HTML document which has special tags allowing it to be accessed in special ways by our BookReader. This BookReader was also created or advanced under this grant. BookReader consists of computer code which can be executed by web browsers.

BookReader, software running in a personal computer, presents a netbook via a web browser, which we realized would be commonplace (they were not when we began this work on an earlier grant) throughout NASA. BookReader is, technically, itself an HTML document, but one consisting, not of text but, of a kind of code written in a computer language which is "understood" by web browsers. We used the language JavaScript, thinking it to be common to all likely web browsers.

We evolved a Plan which we have reported to various people, inside and outside of NASA, whom we thought might be interested in participating. The Plan involves creating a Committee to establish, via tools begun in this project at Southern University, and then to grow and to maintain a NASA-wide Library of Netbooks.

In addition to creating some of the initial ideas of components of the Plan, including social components for the generation of books, our team based at Southern University would create and did create
1) first demo versions of software tools - to make efficient these three activities: acquiring knowledge, preparing specially formatted documents, and accessing those documents containing the especially valuable preserved knowledge, and
2) some netbooks to serve as examples for other people who might join the Plan to build the Library of computer-based netbooks.

Please note that it was not in our part of the Plan to produce a long series of notebooks. Rather, we planned to, and did to some extent, produce tools for a small army of people to use in creating notebooks.

We worked on some netbooks related to design of rocket engines. We produced one on the RL-10 engines and studied the probable cost of scanning an entire, large and famous, rocket-design manual into our system.

The software tools we have created include
      NetAuthor and BookReader
and these ran successfully in many demonstrations. But, these were not sufficient to insure that a Library of Netbooks would be used, even if created. To be used, the Library must not only contain knowledge of interest but also be efficient for

people seeking knowledge of the sorts contained. This efficiency was not in the sentences of the netbooks (not in all of the books) because to more rapidly gather knowledge we sacrificed, for some books, the selectivity and re-writing of earlier methods. The desired efficiency for users is to come from that tool of the World Wide Web called a "search engine." Using a search engine, the entire NASA Library of Netbooks could be rapidly searched by users anywhere within NASA.

Perceiving a specially designed Search Engine as essential to success of the Plan, we have tested our own ideas of how to help technically-minded people find technical information. We have considered that, in the future, we might subcontract out the task of producing the engine. We have discussed the search-engine problem with the CEO of a small firm which designed its own search engine for special uses.

Designing a technically-oriented search engine has led us into collaboration with a lab at Marshall Space Flight Center which seemed likely to soon require such software for a smaller "library" created just within that lab.

Netbooks and concept maps we have created include
    1) "RL-10 Rocket Engine–Lessons Learned," the words of Pratt & Whitney's Bob Faust, former project manager for the RL-10,
    2) "Failure Analysis" netbook based on transcribed audio recordings wherein five very senior rocket engineers use telemetry data to puzzle out probable causes of mission failures (also a digital recording will be playable in quasi-synchrony with scrolling text),
    3) some netbooks based on oral histories of NASA managers, histories which had been put online by the Smithsonian Institution (as a demonstration, we downloaded them and ran them through NetAuthor which turned them into netbooks), and.
    4) "Centaur Systems Integration", a concept map of wisdom of NASA's widely known and respected engineer Bill Tabata. This was one of a couple of concept maps produced for us by our subcontractor John Coffey at the Institute for Human and Machine Cognition (in Pensacola).

Related to search engine work, we created experimental software for creating indexes that allow complex searches, in JavaScript.

A more complete description of NetAuthor is this: a computer-program which enables one, though not knowing special tools such as HTML or Javascript, to combine transcripts, pictures, digital audio recordings into a netbook in such a few easy steps. Using NetAuthor, content-authors anywhere can produce their own netbooks.

The Plan for how to create a Library of Netbooks can lead to spin-offs into organizations outside of NASA. We have found some interest (though we lacked

time to pursue this) in the Corps of Engineers. We have been told that there is some concern about loss of knowledge of retiring, "Baby Boomer" chemists at Exxon Research.

Our travels seeking and imparting information on knowledge preservation have taken us to conferences in Austin, Huntsville, and Cleveland. We have, on this grant project, had a long meeting with the Chief Historian of NASA and a number os shorter meetings with another in this office and in the Smithsonian Institution, and we have talked with historians in Cleveland, Auburn (Alabama), Austin, and talked by phone with professional historians of government in Georgia and in Arizona. We have had more than one meeting with a knowledge preservation project at NASA Johnson and we have discussed knowledge preservation with engineers at NASA Marshall.

We have, on this grant project, interviewed senior NASA engineers in Cleveland (GlennRC), Florida (a retiree from Kennedy), and Denver (an office at Lockheed-Martin).

This report was written by Douglas Moreman at Southern University.