REFLECTIONS ON DESCRIPTIVE PSYCHOLOGY - NASA, MEDIA & TECHNOLOGY, OBSERVATION

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IMPLEMENTATION OF COMPUTER-BASED INFORMATION MODELS USING DESCRIPTIVE PSYCHOLOGY METHODOLOGY

At NASA, we have used methods of Descriptive Psychology (DP) to solve problems in several areas:

- Simulation of proposed Lunar/Mars missions at high level to assess feasibility and needs in the robotics and automation areas
- How we would go about making a "person-like" robot
- Design and implementation of Systems Engineering practices on behalf of future projects with emphasis on interoperability
- Design of a Question and Answer dialog system to handle student questions about Advanced Life Support (ALS) systems – students learn biology by applying it to ALS projects
- Others

These projects have been described in reports presented at the 19th and 20th SDP Conferences in 1997 and 1998.

These projects feature the creation and utilization of Process Descriptions in the State of Affairs (SA) component of the DP Person Concept, with augmentations (to be described) from the Intentional Action (IA) component.

Process Descriptions in the SA system are basically descriptions of performances and achievements.

Others in the Society have been engaged in technical applications of DP. We will list those that we know of, including ours, from the viewpoint of Process Description implementation issues.

There is a terminology issue which we will mention now: whereas I (Pat) talk about the use of an Intentional Action (IA) system to drive the SA system, others talk about Social Practice Descriptions, which are augmented SA Process Descriptions incorporating skills and knowledge (IA system) issues. For example, eligibility constraints, which restrict the set of individuals eligible to play a role in a process (usually based upon skill and knowledge considerations) are the purview of the IA system.

1. In "What Actually Happens", Dr. Ossorio (Pete) introduces templates for objects, processes, and states of affairs. Transition rules relating objects, processes, events, relations, and states of affairs have already been introduced.

   In “Meaning and Symbolism”, Pete describes the Intentional Action Component of the Person Concept , as well as the Language Component.

2. In the 1980s, Pete develops a computerized process description for scheduling support for a client using a new system called the "Knowledge Dictionary System" (KDS) developed by Lowell Schneider and his intrepid programming crew. He has a military project.
   Pete mentions that the "contingencies" are driving the complexity of the project – e.g. "run this stage-option only at night".
   The implementation methodology is Lowell's concept of relational data base practices plus a few of his own, e.g. "second order relations such as joins". These are included in KDS.

   The programming language of KDS (later called C-Lite - either because is was said to be a proper subset of C or in honor of Coors Lite) is interpreted, not compiled. Today's Perl reminds me of C-Lite.

3. Tony Putman and Joel Jeffrey (1970s) develop the Mentor system at AT&T's Indian Hill facility. This system is designed to let a new employee know exactly what to do in carrying out his/her job.

   Specifically, it tells a person how to make changes in computer code, starting with the top level stage “fixing a bug”.

   Mentor was written in C.

   Versions of an Aide de Camp system were developed (mid 1970s – mid 1980s). These systems involved social practice descriptions. Tony, Joel, and Paul Zeiger were involved in the final version through Management Support Technology (1983 – 1987). These were developed in PC-based Pascal.

   An interesting feature of Aide de Camp was that, in the loan application case, the program could produce a document which the user did not necessarily understand – a finished document ready to go to the loan committee.

Lessons learned are said to include

- Make sure all team members share a common view on writing social practice descriptions, especially handling eligibility rules

- Think hard about creating designs which lead to facilitated computer implementations

4. Pat (1989) gives a talk at UH/CLC on requirements wherein he mentions DP, SA, KDS, and factor space indexing. Next, Jon Erickson/NASA requests Pat to work on Lunar/Mars mission analysis and to acquire KDS and use it.
Pat solicits Pete's help in setting up the process description methodology, and Pete relates some prior experiences. He also suggests that Pat contact Joel re the Mentor system. Pat becomes the analyst and programmer for the Mission Analysis and Simulation System (MSAT) using KDS. This version of KDS is a beta version. MSAT is a great success; Pat is able to generate mission sims quickly and effectively.

5. Pat uses the new Ellery Open Systems (EOS) product, a distributed processing and X-Windows version of KDS. MSAT is modified to accommodate EOS. Pete's outfit is about five years ahead of the SOA with EOS (Kerberos, server wraps "a Unix file is just a string of bits, so what's the big deal with wrapping it?"), etc.

6. Pete and the gang have been developing the Astrophysical Data System (ADS) since 1989. It features distributed processing and data scattered all over hell's half acre. It even has an evolving capability for the use of factor space indexing.
But the world is not interested in distributed processing nor the other benefits of ADS, Pete is years ahead in the state of the practice.

7. Pete's company decides to stop supporting EOS. They make a brief stab at object orientation, but never release a version of it. Tee Roberts introduces Pat and Simon Tan to the new world of Web-based conferencing and about a hundred other topics, including Motif programming (much to Simon's delight).
Pete eases Pat's depression over so much computer stuff by taking Pat, Simon, and Tee on a drive through the mountains (Boulder to Nederland to Estes Park and back to Boulder).

8. Without EOS, Pat decides the time has come to rethink methodology. He remembers Joel's comment that "the relational model is good for a few relations with thousands of entries, but not so good for hundreds of relations with a few entries each (as we see in SA applications)". Pat develops a new model unfettered by relational database models and object orientation. He develops a Web-based prototype using Perl, Java, and C which pleases him greatly. This prototype has incorporated about four technical innovations.

It is important to consider that any process description has two possible uses:

* display (SA system only)
* run as a computer-based simulation (an IA system working with the SA system)

Pat's current model needs a driver to run it in simulation; Pat will provide it. It is interesting to note that a driver is actually an implementation of a subset of an IA system which uses the SA system just described.

The advantages of Pat's approach are:

- handles the problem of relating names (which persons love) to numbers (which computers love)
- breaks the templates up into basic (canonical) parts; each part has a type (there are 49 types used so far) so that information can be more readily handled by persons and computers alike
- the idea of using types of relations to describe the part-whole nature of information modeling is more general than the class notion of C++.
- We have no ties to any implementation schemes, except the general one that we will use digital computers
- the IA system (could be just a person in the simplest case) can readily review the accuracy and degree of completeness of stored information.

Where are we heading with this? Some observations come to mind:

- computer languages are evolving rapidly, but they aren't up to the natural language requirements implicit in the use of DP

- we need graphic capabilities beyond VRML in order to do any of this easily.

Apropos to the media section to follow:

- botanists complaining about how hard it is to describe plants in words

- it's hard to describe a bucket in words, but it's easy to describe how to make a bucket

- As we go down from top level, the data handling issue overwhelmes the development effort. Needed are clever ways of handling this. However, as of this time in history, there probably is no substitute for time and funding. Look at what SAP does at the nuts and bolts level.

  Pete's ADS effort included several sizeable organizations with large data bases and wrapping methodologies. As mentioned, this was more of an object configuration system than process description. An attempt was made to incorporate Factor Space Indexing; this would have provided some of the information needed to migrate to Process or Social Practice descriptions.

  Of course, we now have the Web with hot links. We as well as many others have investigated how to get a handle on this powerful new capability.

Technical notes:

- In the 1980s, Brachman published a paper delineating the various ways that the "is-a" relation was being used in the AI world – there were about eleven distinct ways. To relieve the confusion, Sathi, Fox, and Greenberg separated the various interpretations by defining the following relations – is-a, instance of, subset of, member of, elaboration of , part of, and revision of. This was done on behalf of the SRL language and its commercial counterpart CRL, from Carnegie Group. By way of contrast, we have been devising a far more elaborate and useful set of relations which go far beyond the "is-a" issue.

- In any ongoing set of processes, there are objects which are used and there are objects which are acted upon (loading, deploying, etc.). A sanity check for process descriptions is to make sure that any object to be used is first deployed and later stored or maintained as appropriate.

3. WHAT HAPPENED OR COULD HAPPEN – THE OBSERVER'S PERSPECTIVE

Normally, we observe objects directly and/or observe processes as they are happening.

We also make observations on behalf of designing processes which we might later undertake or on behalf of creating possible descriptions for processes which have already occurred or which could occur.

We will give two examples for the case where we are trying to construct processes which involve us and physical objects (e.g. auto repair), and one where we are trying to reconstruct the story of the behavior of persons (archaeology).

A prime consideration is the methodology used in observation – we need to decide what to observe and how to observe it. In the case of robotics, we invariably find that we are not making enough of the right kind of measurements.

WARNING – IF YOU AREN'T COMFORTABLE WITH PHYSICS, SKIP THIS FIRST EXAMPLE!

1. The first example is the measurement of the length of a moving rod from a fixed inertial frame. You may recognize this as an issue in special relativity. Here, we must acquire a signal (usually light) from both ends of the moving rod at the same time. Assuming that the speed of light is constant and independent of the speed of its source (the usual assumption in wave-like phenomena) we compute that the rod appears to be shorter than it is when we bring it to rest.

WARNING – SKIP THIS IF YOU'RE NOT INTO CAR REPAIR

2. The second example is concerned with replacing the upper control arm bushings in a 1977 Ford.

We have a process description from the Chilton repair manual, but it involves more work than we want to do. Can we find a simpler procedure?

To make a long story short, we laboriously made the following observations over a period of a few weeks:

- Can we get the retaining nuts off without disturbing the upper arms? Yes, using a 15/16" box end wrench. It will barely fit the openings.

- Do we need to use a spring compressor?
  No, the springs do not contact the upper control arms. We only need to jack up the lower control arms slightly, as well as the car frame, to get most of the load off the bushings.

- Do we have a way of getting the old bushings out? The shaft will stop us from using a cylindrical bushing remover. Mechanics tell us that they have to destroy the bushings in order to get them out.

  We do have a possibility which will destroy the old bushings; that is, access to an electric air heater – heating the control arm at the bushing site will cause the arm to swell and may allow us to pound the bushings out from a 45 degree angle.
  But we can't be sure.

We conclude that we do have a process, but that bushing removal time could be excessive. Now we have to decide whether or not to proceed. Is it worth it to keep trying to do this job ourselves?

3. The third example is illustrated by Discovery Channel detective stories showing how DNA, hair, and/or fiber sample analysis can be used by forensic scientists to tie an individual to a murder scene.

Of course, the issues faced by archaeologists are the most challenging. There are no eye witnesses, physical evidence may be in poor condition, there may not be a written record, and perhaps no-one has had a lineage such that he/she can speak the language or understand the symbols of his/her ancestors.

Let's paraphrase what Pete had to say.

We cite the research proposal in "Meaning and Symbolism", whereby an observation is made of an individual performing a process and we ask what larger process this could be a part of (a stage-option of).

We are clearly starting off with trying to determine part-whole relations.

Careful note is made of the objects and environment constituents in the observed process. We collect resources using factor spaces to enable substitution of resources in the construction of the larger process – the relations used can be property or attribute, means-end, category, etc.

If we can answer the question "which process could this be a stage-option of" we are on our way. Both deduction and induction (concept formation) are invoked.

The larger process we come up with is a tentative conclusion or working hypothesis, not an observation.

Another research idea comes from Lowell Schneider. Paraphrasing:

Ordinary database models are good at dealing with the small-scale structures you find in distributed data such as two catalogs of the same objects. But they are not good at delineating the large-scale structures such as the set of relations we can discover between the two catalogs themselves.

The large scale relationship between these objects is only apparent when you combine the catalogs with the measurement instrumentation properties, the mission plan, and even the results of other research.

It's a part-whole problem; you have to keep adding information until it makes sense. But the resolution is not one of pattern matching. Factor Space Indexing gives us a way of delineating "all" the ways that objects can be similar to or different from each other. It gives us a way of implementing the mathematical idea that one way to describe a complex situation is to add dimensions.
We can bring in ancillary information in the form of insights on the part of experts which isn't even in the catalogs. Quoting from W. Kent, "Data and Reality", North Holland Publishing, 1978:

> "Things exist in a knowledge base because they exist in peoples' minds independent of any physical evidence. Therefore, we have to deal with the issue that concepts may exist differently in different peoples' minds."

Comment: This can be seen in the stock market. A model by George Soros has a dynamic set up by the interaction of "underlying trends" e.g. fundamentals such as earnings per share, robustness of a company, vs. "participant bias" – what an investor is willing to do in response to a stock.

Bias is rampant in the accounts of the Spanish regarding the native Indians. The Spanish had major agendas on their hands.

Another bias syndrome exists between archaeologists and historians In academia.

Now for an archaeology example. This example reflects our experiences during a field trip last New Years conducted by the Houston Museum of Natural Science.

Monte Alban in the state of Oaxaca furnishes our archaeological example. About 2000 years ago, people believed to be Zapatec constructed this site. It was used for ceremonial purposes, not general habitation. Can we get an idea of the social practices of these people? What happened?

Another question: can we construct a strawman paradigm case based upon paradigm cases for other pre-history groups, where we can proceed along the lines of similarities and differences?

What do we have to go on? At top level:

- The Zapatecs scraped off the top of the mountain to make the flat Monte Alban site.
- It seems certain that the site was used for ceremonial events and to office some of the nobles, and not for ordinary habitation.
- There are carvings and paintings of Danzantes, nobles whose genitalia had been removed.
- There were "ball courts" where a game using a rubber ball two feet in diameter was played. Of all the games we know about, this game resembles soccer the most. A game went on for several hours; the losers could be put to death.
- Another indigenous group, the Mixtecs, seem to have had little effect on the Zapatecs – the reason may have been that they averaged four feet in height compared to five feet seven inches for the Zapatecs.
- There is a newly-discovered painted tomb with a stele nearby at Huitzo. Perhaps the code will be broken as was the case for the Mayans. But it will be necessary to find Zapatecs who have had little Influence by Aztecs or Spaniards in their lineage.

This list is brief; it is intended to simply give an idea of issues in the study of this prehistoric culture.

Behavioral groups come and go, as we see through history. We are curious as to what the circumstances are and have been when a culture disappears. One tool we have which may provide insights as to what could happen is the use of modeling and simulation (construction of dynamic paradigm case formulations).

As a example, consider the environmental problems with Biosphere II.

Another comes from NASA's Advanced Life Support activities. We know from mathematical modeling and simulation that, in a 3-trophic closed system (persons, microbes, and plants), under certain conditions, the system can become chaotic with time. This could cause significant problems on a nine month Mars mission. (However, the use of modeling gives us hope that we can spot the onset of chaos and intervene in a timely manner and/or try to prevent it in the first place. These are examples of prevention and precaution, topics mentioned in our 1997 and 1998 presentations.)