Conceptual Modeling in the Classroom

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Abstract: The conceptual model is the focal point of the pro-
cess of database design. All activities either converge
upon or emanate from the conceptual model. All structures,
through mappings either into or out of the conceptual
model, must be to some extent compatible with it. Students
generally find it difficult to manage the complexity sur-
rounding the conceptual model, its development and usage.
This article describes one approach to overcoming this
difficulty through an exercise in conceptual modeling and
shows some of the results of this approach.

The ANSI/SPARC DBSG three-schema architecture [1] for
database systems suggests that the conceptual schema must re-
present the organization's view of its data. To the extent
that this view must be compatible with the sum-total of all
individual user views represented by external schemata (be
what Kent calls a "mapping target", [3]), a good starting
point for the development of a conceptual schema is to merge
all external schemata into one large schema so that each ex-
ternal schema is faithfully represented in the merged schema
and eventually in the conceptual schema. Beginning database
designers frequently do not choose this path to the conceptual
schema. Instead they try the revelation technique. This is the
same method used by many high school students when confronted
with a mathematical word problem. They sit and look at the
words in the text for some time waiting for the required equa-
tion to be miraculously revealed to them. In teaching database
design, I have discouraged this approach and ask my students
to attempt conceptual schema development from the point of
view of merging external schemata.

However, even with an already developed strategy, stu-
dents often have difficulty taking advantage the available
logic to produce a good conceptual model. This is caused in
part by not having understood the roles played by the concep-
tual and external schemata in the process of database design.
Questions often left unanswered in many students' minds in-
clude; What is being represented anyway? Is the schema I've
developed any good? What do I do with it? The obvious question
that we as educators should ask is, What good is a logical ap-
proach if you don't see where it is leading you? i.e., what
good is it to know a lot about each of its limbs if you
haven't got some sense of what the whole elephant is all
about? (if the analogy escapes you, please read on) The addi-
tional problem that many students face is that of becoming
conversant in the design "language", be it entity-relationship

diagrams or Warnier-Orr diagrams, etc.

As a first homework assignment in a course on database design taught at New Paltz, students are given the task of developing a conceptual schema by merging, based upon the six external views expressed in the following slightly modernized version of a poem by John Godfrey Saxe entitled, "The Blind Men and the Elephant", [4].

Six wise men from India
An elephant did find
and carefully they felt its shape
(for all of them were blind).

The first he felt toward the tusk
"It does to me appear,
this marvel of an elephant
is very like a spear."

The second sensed the creature's side
extended flat and tall
"Ahah!", he cried and did conclude,
"this animal's a wall."

The third had reached towards a leg
and said, "It's clear to me,
what we should all have instead,
this creature's like a tree."

The fourth had come upon the trunk
which he did seize and shake,
quoth he, "this so-called elephant
is really just a snake.

The fifth had felt the creature's ear
and fingers o'er it ran,
"I have the answer, never fear,
the creature's like a fan."

The sixth had come upon the tail
as blindly he did grope,
"let my conviction now prevail
this creature's like a rope."

And so these men of missing sight
each argued loud and long
though each was partly in the right
they all were in the wrong.

As an exercise in conceptual modeling, I think this problem is particularly good because it avoids the two problems I mentioned earlier; namely those of not clearly understanding the purpose of conceptual modeling and not understanding the language used to affect that modeling. Everyone has a clear idea of what an elephant looks like (or do they??) and even if

they don't, the exercise permits them to model whatever they feel is particularly compatible with the wise men's views (see the work of Jeff Reno and Chris Scott). Secondly, there is no formal language requirement and so the student is left with the only tool at her disposal; her imagination. As such, and because of the novelty of the exercise, the results are a demonstration of her ability to use just her imagination.

While on the topic of imagination and having mentioned earlier that design languages are not well understood; let me put those two thoughts together. Design is basically an process of using one's imagination, be it with grade school word problems or conceptual modeling. It is a creative process. A good design language should therefore allow the user to represent on paper the results of a creative imaging process. To do this it must both represent the individual pieces of a puzzle and show how the user of the language imagines that they all fit together. As such there must be more to the design language than just elements of the problem and solution languages; it must promote expression of creativity. The language should be as free-style as possible, imposing few restrictions upon the user and her imagination. It is for this reason that most design languages are pictorial in nature; because pictures are one of the best ways we have of putting on paper pure thought-stuff without the encumbrances that go with more rigid formalisms. For example, the entity-relationship "language" has very few words (boxes, diamonds, bubbles and lines in its simplest form) and even fewer structural formalisms so as a representation language for conceptual schemata, it has a lot going for it. In summary then, a good design language must not only provide the means for building a bridge between the real-world problem (often expressed in natural language) and some automated solution (abstractly represented by some implementation language such as the relational data model) but it must also facilitate that mental bridge building process as much as possible. Since this process is both mental and creative the design language must be easy to use when capturing a designer's thoughts on paper. Some combination of pictures and words seem to be the answer.

Returning to the poem, one final value I see in this exercise is that it is just that - an exercise in thinking. Most answers are very "vertical", [2] but many students take the opportunity to risk a little "lateral" thinking and we are all rewarded as a result of their efforts. Some try to relate the exercise to database somehow but most do not. In any event, as a professor, one sees which students have a spark of imagination in them and this is a good thing to know early on in any course. What follows is a collection of some students' answers. The artists' name appears under his work. Some answers have been condensed to more clearly show the focus of what the students were trying to express.

Chris Scott and Jeff Reno take the position that it probably wasn't an elephant at all. After all, the six men were

blind weren't they? Their conceptual models are just faithful representations of some reality. Greg Melahn gives us a conceptual model of an elephant. Anonymous has taken a very matter-of-fact approach but draws well. Ami Fixler seems to be telling us that experience is the greatest teacher of all; that in the pursuit of one truth, others will be revealed. Don Nielson is just a skeptic. Tom Frank's use of the prism analogy is rich in content. Not only is there a merging process represented but also something of the synergy that the conceptual schema contains. We all feel that there is something more to white light than just the colours of the rainbow even though physics tells us otherwise. Finally, James Benhkart and Sean O'Keefe both tried to relate the exercise to database and rather successfully, I think.

Chris Scott
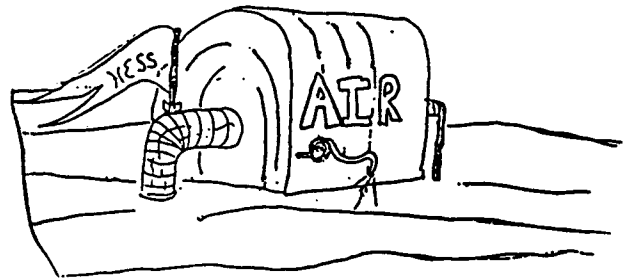
Jeff Reno

Anonymous

The fight grew strained into the night
until at once they turned,
for suddenly the creature spoke
and many things were learned.

They all stood straight in silent awe
whilst the animal sang his song,
"I am an elephant!", he declared,
"to believe otherwise is wrong."

"He who concluded I'm a tree
must know that I am tall,
but if you attempt to climb me
you'll discover I'm also a wall."

He who thought it was a snake
was invited to hold out his hand.
The snake then lifted him in the air
to discover it was also a fan.

The sixth stood beside his rope
A wasp buzzed 'bout his head.
The rope suddenly lifted, swung,
and zap, the wasp was dead.

Then from the bush a tiger neared,
growling and creating much fear,
the elephant calmly bent one knee
and charged forward with his spear.

Thus the creature did instruct
how each part played its role
until the sages' common thought
was of an elephant as a whole.

Now they all were truly wise,
accepting each other's predilections,
knowing the elephant was not
          ONLY a fan, rope, wall, etc.
but rather a unified collection.

Well, it was now very late
in hunger they did moan,
the elephant said, "climb aboard,
and I will carry you home."

The wise ones knowing they were safe,
agreed to his suggestion,
and thanked him for his offerings
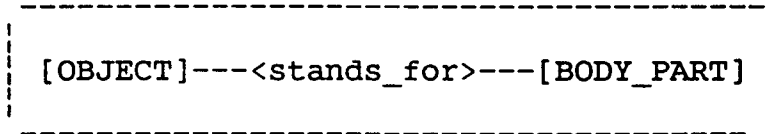which had broadened their perceptions.

Ami Fixler

A spear, a fan, a wall, a rope
A snaKe up in a tree
Disparate views we cannot hope
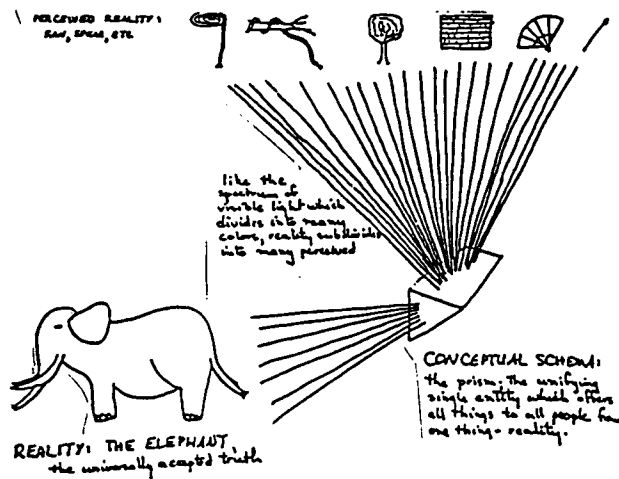Will represent reality.

Don Nielson
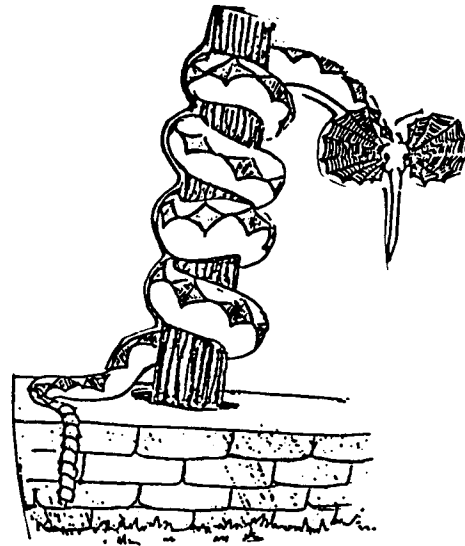
Greg Melahn

CONCEPT (by aggregation)
```
-------------------------------------------
|                                         |
|   [OBJECT]---<stands_for>---[BODY_PART]  |
|                                         |
-------------------------------------------
                  |
             <symbolizes>
                  |
              [ANIMAL]
```

James Benkart

Tom Frank

THE FIRST DATABASE

"BLIND"
Doing something that has not been done before

"SPEAR"
Must be able to cut through (solve) problems quickly, efficiently

"WALL"
Security of data from Unauthorized Users

DATA
DATA
DATA
DATA
DATA
DATA
DATA

"TREE"
Represents relationships between the data

"SNAKE"
Connects the different parts of the database

DATA
DATA

"FAN"
Data must flow easily

"ROPE": Ties everything together

Sean O'Keefe

Conclusion:

An exercise in conceptual modeling gives students the opportunity to creatively approach the process of conceptualization without the encumbrance of having to give the "right" answer. The author would be happy to hear any good elephant stories if any readers decide to give the same exercise to their own students.

Bibliography:

[1]   The ANSI/X3/SPARC DBMS Framework, Report of the Study Group on Database Management Systems,)D. Tsichritzis and A. Klug, eds), AFIPS Press, 1977.

[2] DeBono, Edward. "New Think", Avon Books, 1971.

[3] Kent, William. "Splitting the Conceptual Schema", Proceedings of the Sixth International Conference on Very Large Databases, Montreal, 1980.

[4] Saxe, J.G. "The Blind Men and the Elephant", in The Home Book of Verse (B.E. Stevenson, ed), Holt Rinehart & Winston, New York, 1953.