# Developing an Idea Processor in Prolog

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**ABSTRACT**

This paper describes the design concepts behind the development of the Axon Idea Processor, a software developed in Visual Prolog to provide an environment for supporting the thinking process. Some of the reasons for using Prolog as the programming language are also explained in this paper.

**Why Prolog?**

Ideally the language used for developing an idea processor should be a close match to how the brain works. In this respect there is no close second choice to Prolog.

Idea processing is all about problems (logical negation) and solutions (logical assertions), questions and answers, unknowns and facts. Thinking arises when you have no solution or answer to a problem or question. You need not think if you already know.


*Fig.1 – Idea Processing is about problems and solutions, questions and answers, unknowns and facts.*

Consider a simple neuron receiving inputs A, B, C and producing an output D when the threshold value is 3. The cell activation equation can be represented as:

(A & B & C) → D ---------- (1)

This can be rewritten as the predicate logic:

~ (A & B & C) or D ---------- (2)

Notice in equation (2) that the arrow (axon) is now replaced by a negation and the "or" operator. Proving the truth of the equation is the basis of the Prolog language. The backtracking theorem proving mechanism is thus the equivalent of our thinking process. Further development of this theory leads to higher-order hierarchical clusters of self-organizing neurons. These clusters contain feedback (upwards) links, feedforward (downwards) links, and cross links (horizontal) as shown in Appendix B.

Predicate logic can best be represented using Ferguson diagrams, where negations and assertions are represented as cell-like, mirror-image semi circles.

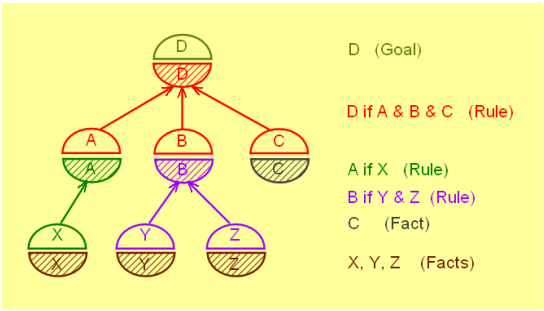



*Fig. 2 - Ferguson diagram illustrating the close resemblance of predicate logic and neuron activation.*

With this insight, the Axon Idea Processor commenced development (in 1990) using the DOS prolog compiler from PDC. Since then it has undergone yearly revisions. Thanks to the stability of the language platform, the program has been continuously enhanced using the same prolog language, moving from DOS to 16-bit Windows, then to 32-bit, etc.

**A Modeless Design**

A modeless design allows the user to "do anything at anytime", without the need to

switch mode. An example of a modeless system is the aircraft cockpit that enables the pilot to simultaneously steer the plane, communicate with control, locate enemy target, fire the gun, etc.

*Fig. 3 – The cockpit's modeless design allows the pilot to do anything at anytime.*

Examples of other modeless designs are a control room, and an operating theater. As our brain also functions modelessly, so must the idea processor. To be modeless, writing, drawing, organizing, navigating, etc. must be doable at the same time without having to switch modes. This means that the Axon's tools must be highly integrated. In contrast, a traditional modal system requires you to enter different modes to perform different functions.

**Axon's Entities**

An Axon diagram is essentially built from two basic entities - Objects (the nodes) and the Links that connect them. Objects have the functionality for idea processing, such as carrying out an Action and storing text contents. Links show the relation between Objects. (Axon is named after the numerous links which are of great importance). There are other entities such as Shapes (simple geometric drawings found in most drawing software) and Points (which has position but no size).

In addition to the basic entities, Axon provides an integrated set of idea processing tools. An overview of the Axon program can best be described as a concept map in Appendix A.

**Prompting Tools**

Our brain is rich in ideas. We recall an idea when a cluster of neurons are activated. One method to improve recall is by prompting. In the laboratory, an electrode inserted into the brain can bring about selective memory recall depending on which cells are activated. Prompting can also arise from visual or textual prompts. For example, looking at the photograph of a person facilitates the recall of this person. In essence, prompting is an effective way to amplify intelligence.

Axon provides many prompting tools for both text and graphics, such as the "Checklists", "Questions", the "Random Pictures", the "Generator", etc.

**Diagramming Tools**

A large portion of the brain (the hind brain) is for visual processing. Vision is by far the most developed of all mental faculties. Our vision also has a longer period of evolution (100 million years) than other faculties such as logical thinking (1 million years, since the ape man). As such Axon is designed to exploit as many visual attributes as possible, such as size, shape, color, textures, depth, and proximity. The recent introduction of GDI Plus in VIP6.3 provides even more visual attributes such as anti-aliasing and curve smoothing.

Imprecision is also another useful diagramming attribute that can increase the level of abstraction, distill the generic attributes of ideas, and encourage exploration. Imprecision is implemented using "freehand" lines, doodles, and symbolic icons. To quote from another researcher, "a sketch is not so much vague as it stands for a family of precise models".

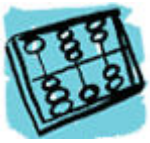


*Fig.4 – "A sketch is not so much vague as it stands for a family of precise models".*

An Axon diagram is multi-layer (i.e. multi-level), and can be viewed as 3D. A tool called the "3D Viewer" enables quick switching between 2D and 3D perspectives.

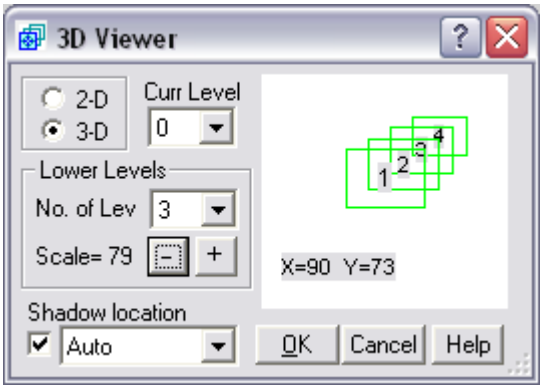



*Fig.5 – The 3D Viewer tool provides quick switching between 2D and 3D.*

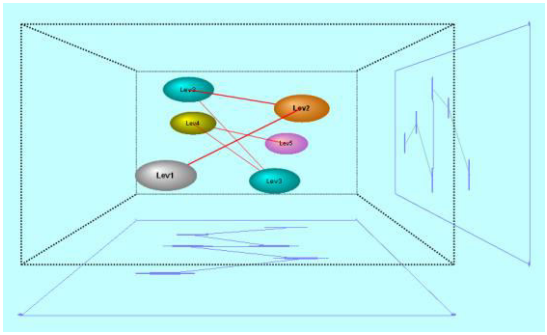


*Fig. 6 – An example of a 3D diagram where shadows on walls, floors and ceilings provide positional cues.*

## Writing Tools

Our brain has well developed faculties for text processing. Writing involves many simultaneous mental tasks such as setting goals, making deductions, constructing sentences, and correcting grammar. Our inability to cope with too many tasks results in mental blocks or even black-outs. Axon allows you to focus your attention on fewer areas, and at a higher level of abstraction. For example the Sequencer tool can be used to sequence ideas at a later stage, thus freeing the mind from sequencing tasks during the initial idea generation stage.

Axon also provides text processing tools such as the "Analyzer", and a pre-writing tool called the "FreeWriter". The Analyzer, for example, can transform the sentence "*In the beginning, we may suppose, there was silence*" into the form:

```
sent_(
    pp   (p   ("In")
         np  (det    ("the")
              n   ("beginning"))), )
    sent     (pron    ("we")
         vp  (v_mod   ("may")
              v   ("suppose"))), )
    sent_    ( pron   ("there")
         v_aux   ("was")
         n   ("silence") ). )
```

*Fig 7 – The Analyzer can perform text analysis such as sentence parsing. These are typical applications of Prolog.*

## Computing Tools

Axon can also compute like a spreadsheet where the cells can be floating, i.e. each cell is identified by name and not its row-column position. An S-Expression parser in prolog can handle the most complex of mathematical expressions.

Sometime in the year 2000, it was apparent that Axon's graphical user interface and object-oriented (O-O) design are extremely suitable for simulation modeling. To do this, a new entity called a Packet is introduced. Anything that moves, such as a physical object or a conceptual token, can be represented by a Packet. The concept of a Packet is likened to the Object concept in the O-O sense. (The O-O concept is derived from the early simulation language Simula).

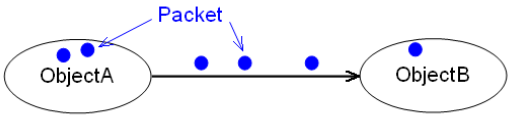



*Fig 8 – Packets are used by the Simulator. A Packet can reside in an object or move along a link.*

The Axon Simulator caters for continuous and discrete event simulation, provides animation and graphical output. It has been successfully used for reliability modeling, facility planning, and medical research.

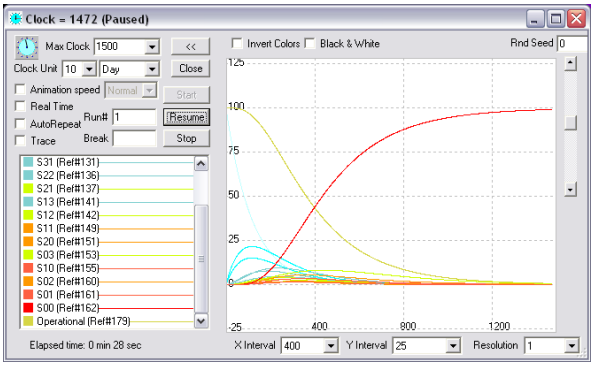



*Fig.9 – The Simulator tool supports discrete and continuous event simulation. Packet movement can be visualized as moving dots.*

## Conclusion

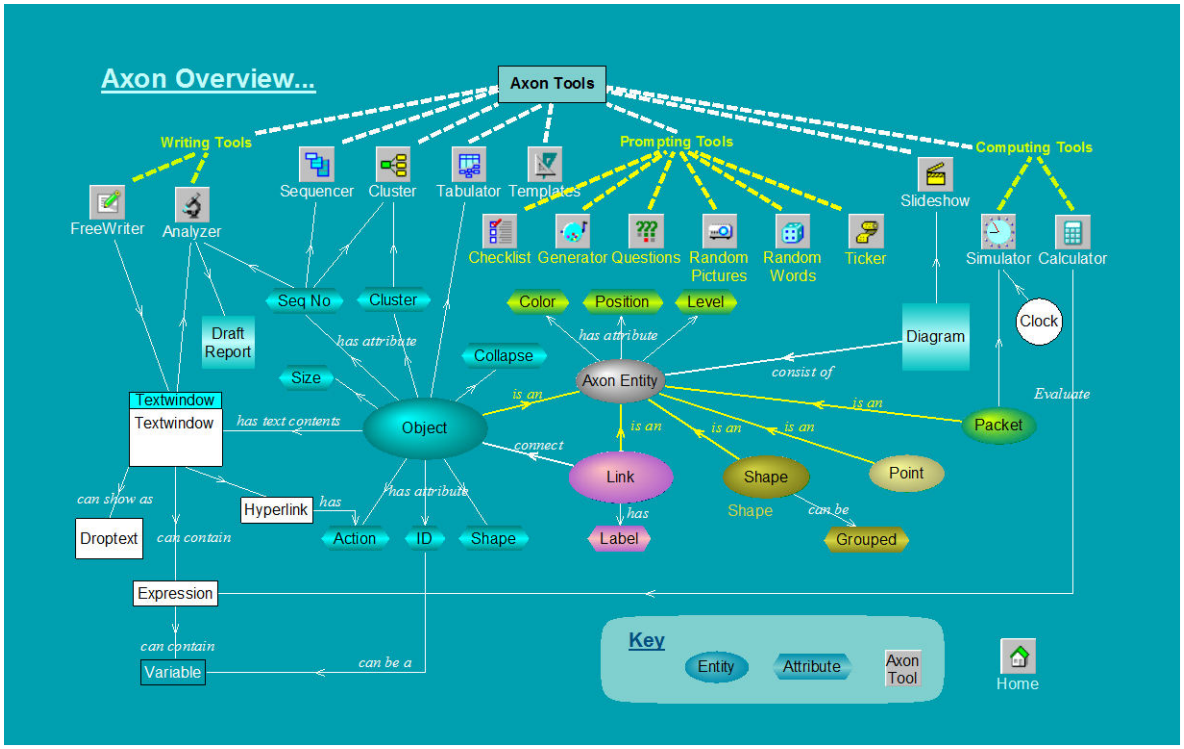
The Axon Idea Processor demonstrates that complex diagramming, writing, text analysis, expression parsing, modeling, prototyping, etc. are all well suited for Prolog programming. Prolog also enables the programmer to work at a high conceptual level near to normal precise thought. The synergy between Axon and VIP Prolog results in a powerful, extensible, and visually appealing system.

## References

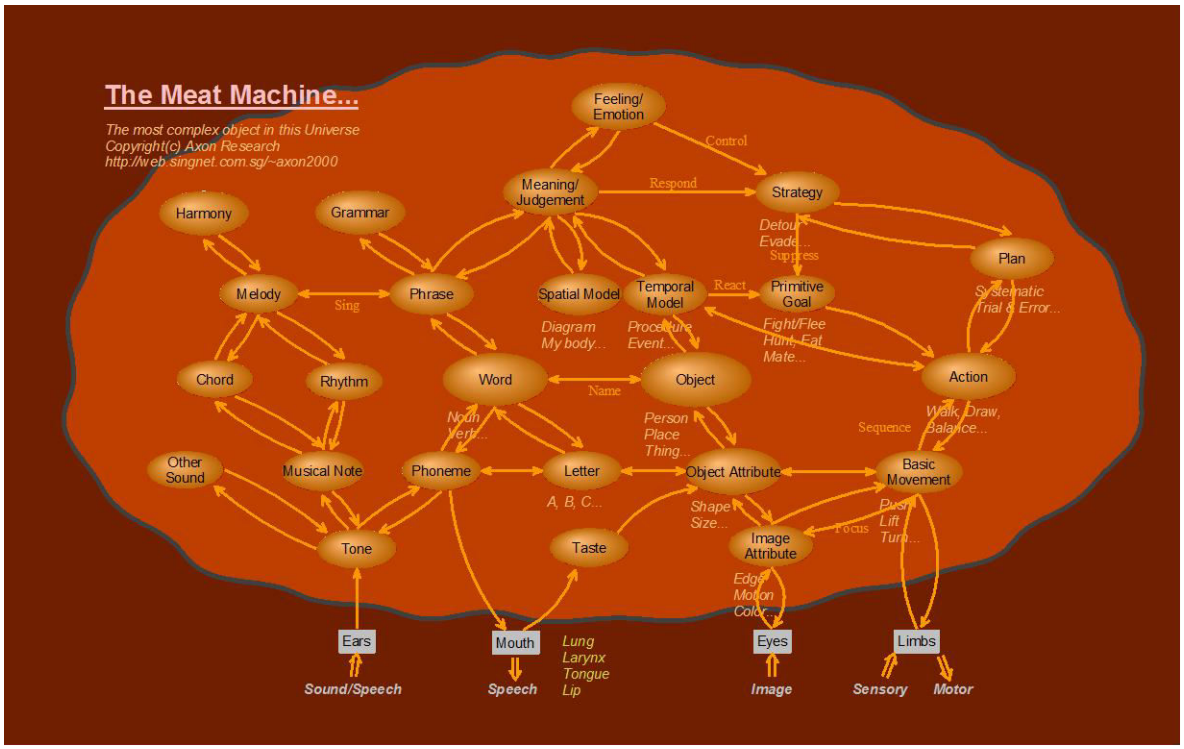

[1] A R Luria "*The Working Brain*", Penguin Books.

[2] "*Axon Idea Processor*", Axon Research *http://axon-research.com*

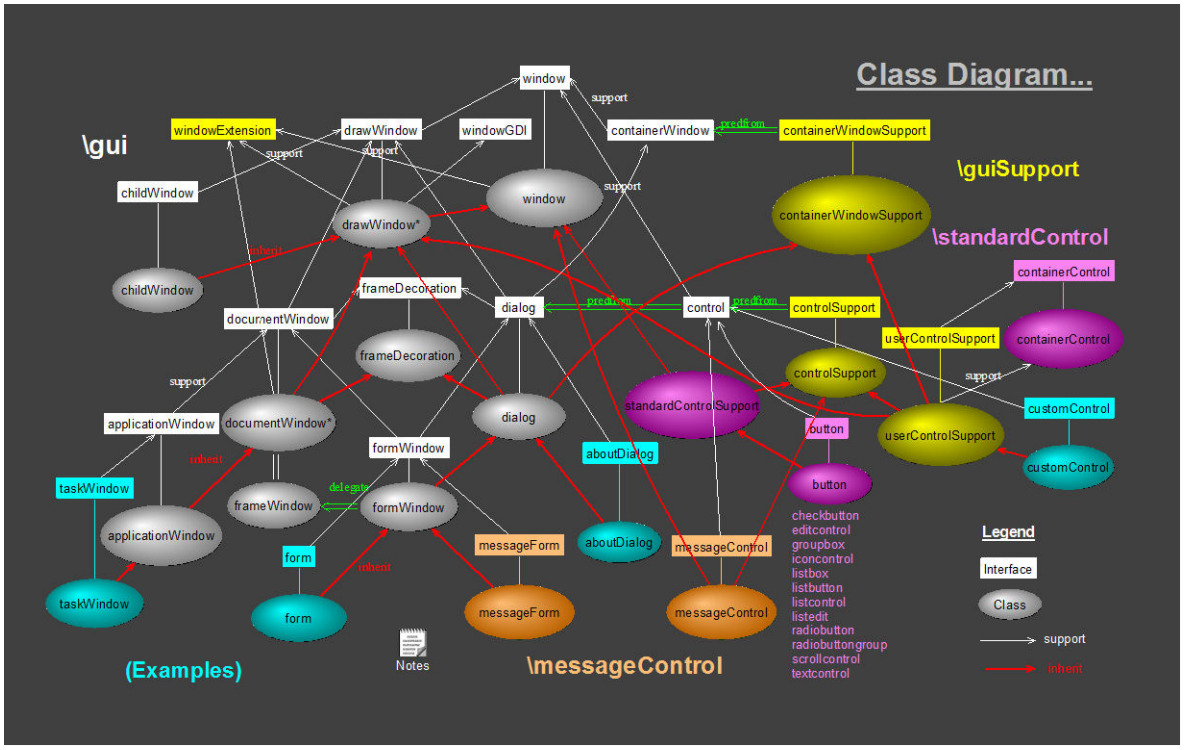

## Appendices




*Appendix A - A concept map of the entire Axon Idea Processor showing the various entities (as ellipses) and tools (as icons).*




*Appendix B - A model of the brain showing a combined hierarchical and network structure.*




*Appendix C - A "Class Diagram" of PDC's OOGUI package, based on an early (VIP6.2) version.*