Software and Standards

Steve Epstein
Open PSA
ABS Consulting
sepstein@absconsulting.com
SKYPE woodyep

21 years ago, risk software boldly stepped out to go where no risk software had gone before …

… to the PC.

CAFTA, RISKMAN, Saphire, SETS, FTAP, and NUPRA in a group photo, circa 1986

and over those 21 years, our abilities in and demands of PRA analysis have grown

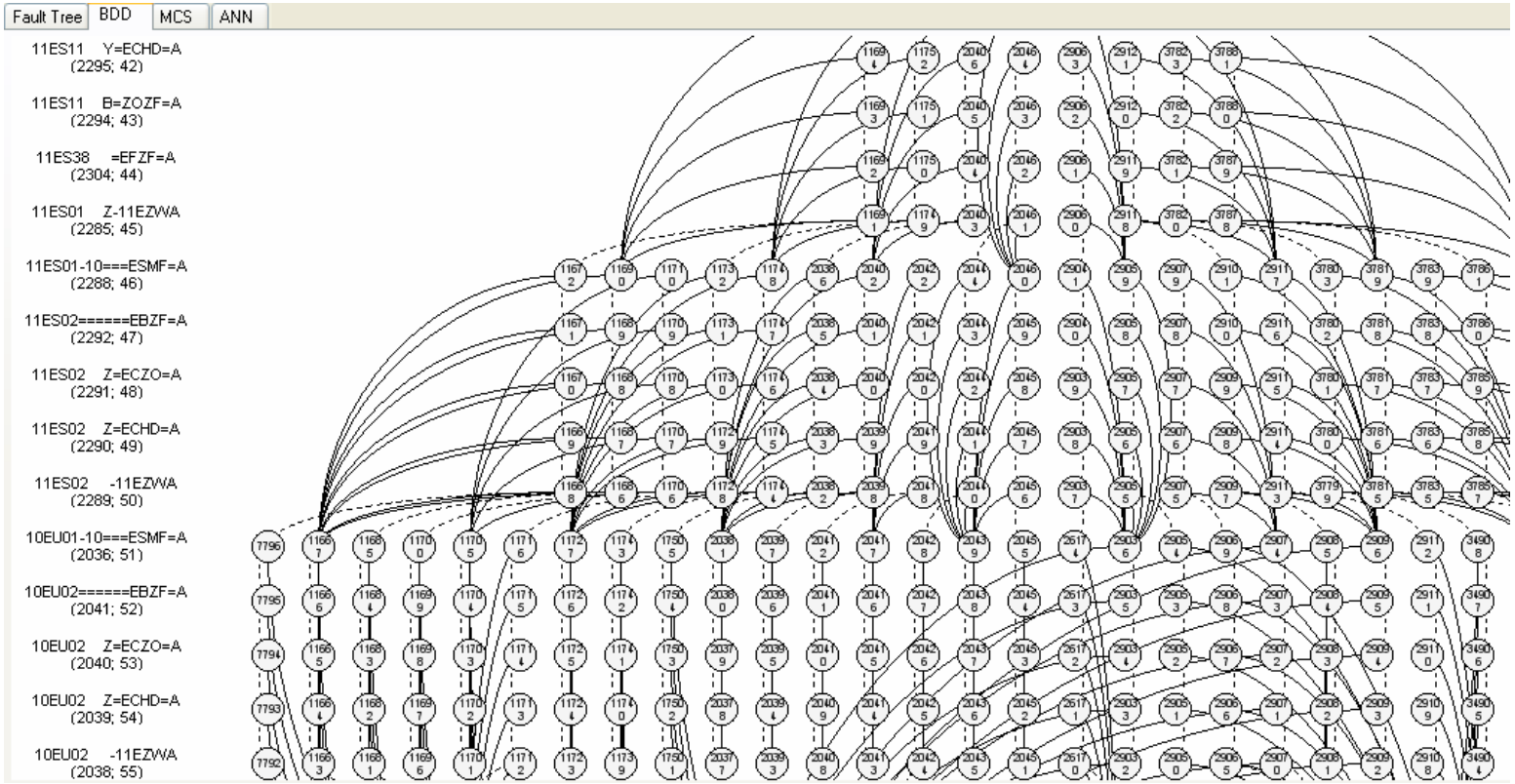
…

- Safety Monitors;
- Model size;
- On Line Maintenance;
- Risk Informed Applications
- Seismic, fire, BOP, and flood analyses;

… we have made strides in computer software as well…

Alternative Data Structures
Directed Acyclic Graph (DAG) and BDD

- BDD complexity is not related to the number of prime implicants of the encoded formula
- This small BDD (37620 nodes) encodes a total of 10^9 cutsets

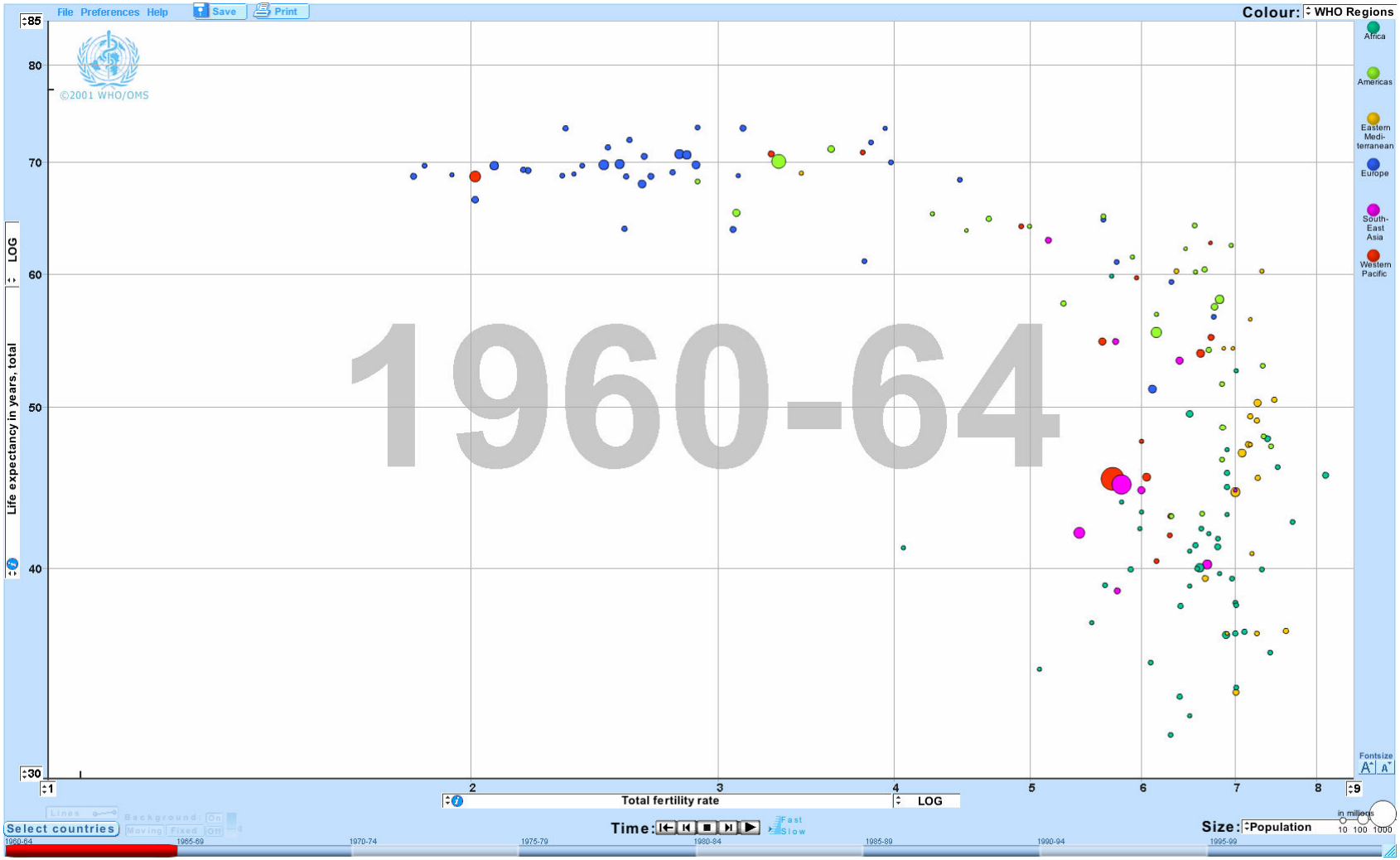


Coding Breakthroughs

In a recent PhD thesis concerning nuclear PSA* large FT models could be solved analytically for >3000 basic events, with no truncation.

* Analytical Solutions of Linked Fault Tree Models using Binary Decision Diagrams with Emphasis on Nuclear Probabilistic Risk Assessment
---------- Dr. Olivier Nusbaumer, 2007

New Ways of Visualizing Data



Because of these success, we have heard in the streets and marketplaces the rumblings and rumors of creating …

PRA SOFTWARE
The Next Generation

What is really needed, before we develop new methods, software, and user interfaces, is to take a look at what we have now and to realize …

There is no free lunch.

Model Size And Problem Complexity

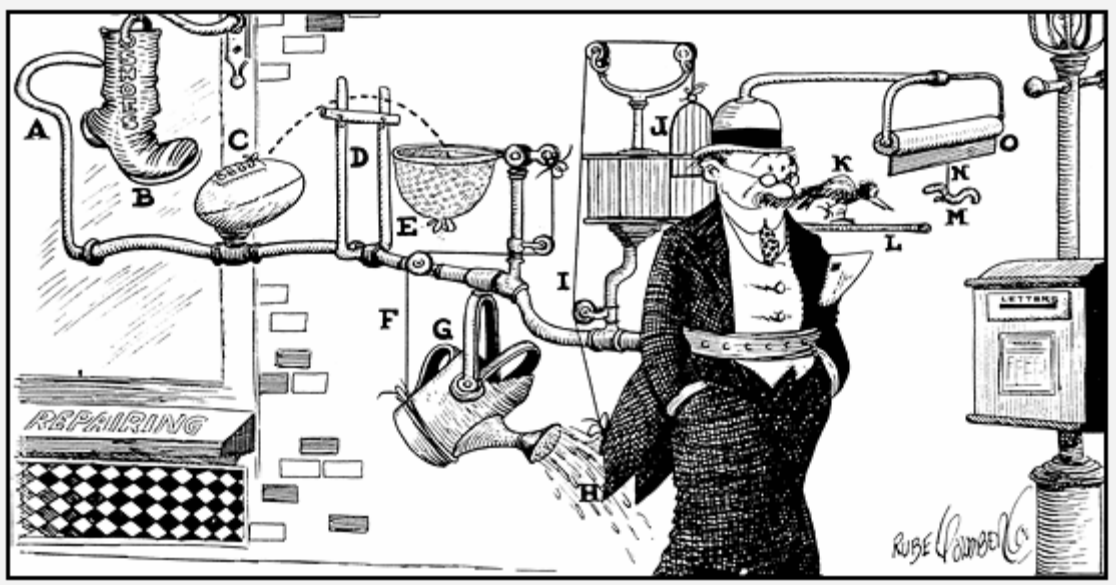
What's in a name?
That which we call a truth table
By any other name would taste as bad;
- William Shakespeare

So before beginning the "Next Generation" PRA Software (no matter how nice the vision …)

Looking at The Vision of the Next Generation PRA Software

… and to avoid the dreaded …

Second System Effect



Rube Goldberg gets caught in a revolving door and becomes dizzy enough to dope out an idea to keep you from forgetting to mail your wife's letter.

As you walk past cobbler shop, hook (A) strikes suspended boot (B), causing it to kick football (C) through goal posts (D). Football drops into basket (E) and string (F) tilts sprinkling can, (G) causing water to soak coat tails (H). As coat shrinks, cord (I) opens door (J) of cage, allowing bird (K) to walk out on perch (L) and grab worm (M) which is attached to string (N). This pulls down window shade (O) on which is written, "YOU SAP, MAIL THAT LETTER." A simple way

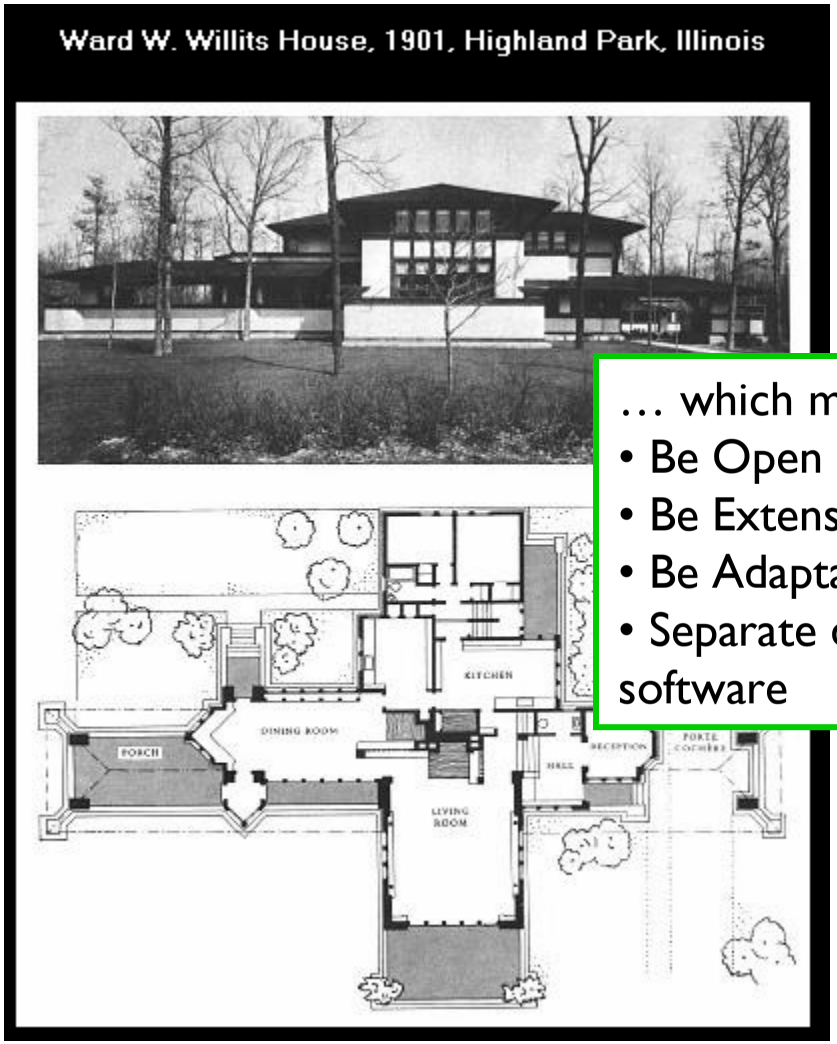
…we must create a PSA Software …

ARCHITECTURE

Ward W. Willits House, 1901, Highland Park, Illinois

…we must create a PSA Software …

ARCHITECTURE

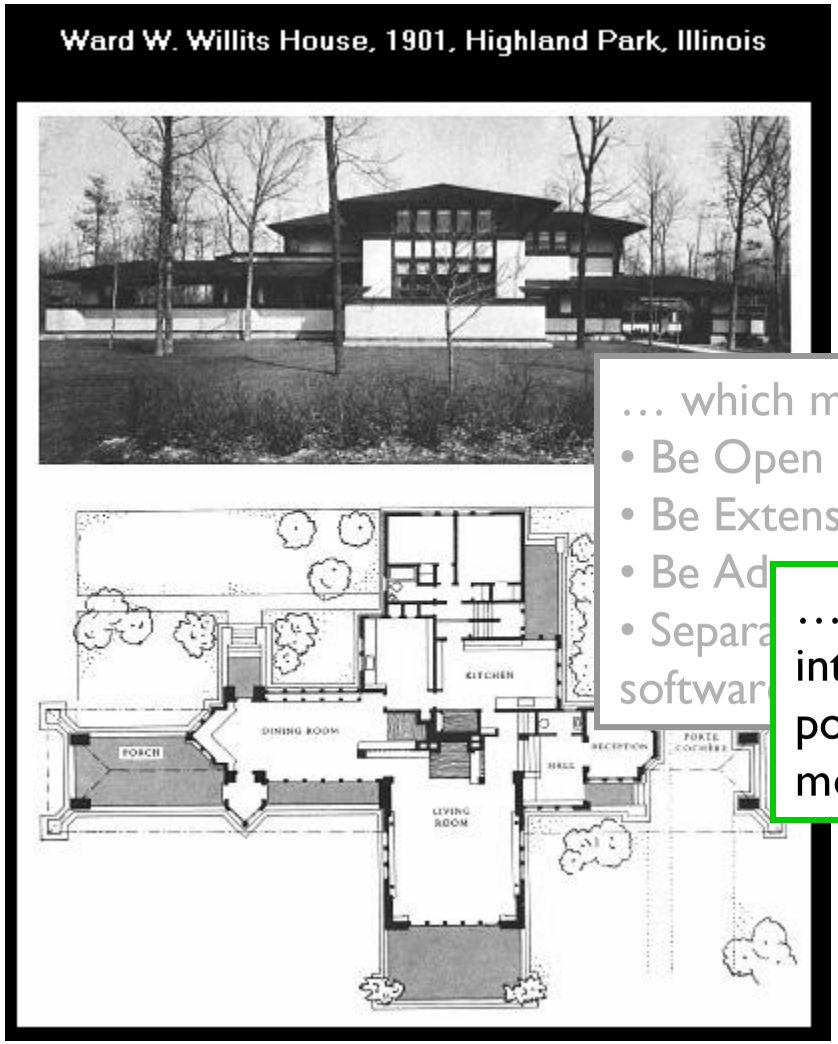


… which must:

- Be Open
- Be Extensible
- Be Adaptable
- Separate data and software

…we must create a PSA Software …

ARCHITECTURE



… which must:
- Be Open
- Be Extensible
- Be Ad
- Separa

softwar

… to allow the greatest inter-connectivity and portability between data, models and software.

… and in this way, we can make headway against the hobgoblins of complexity.

- Model Size
  - Elements of Modeling Style
  - Declarative Modeling
- Problem Complexity
  - Modeler based heuristics
  - Structured Modeling

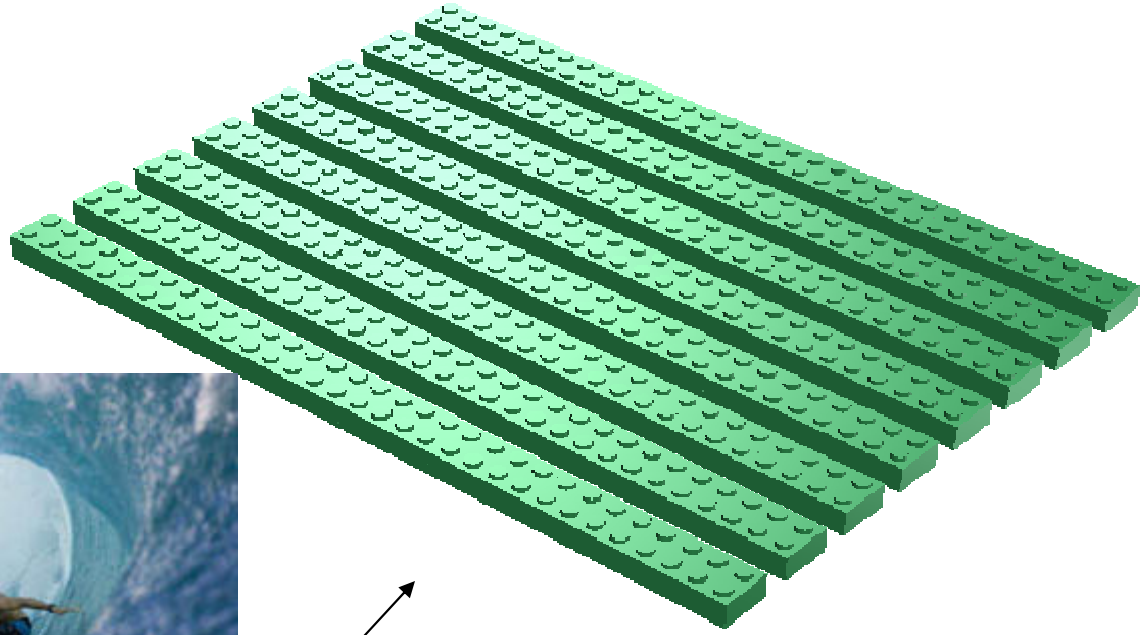
Our Proposed PRA Software Architecture

- The foundation is a standard for representing a PRA model, therefore facilitating independence between model representations and software;
- Each risk application would generate a model in this standard from it's own internal representation;
- Viewers and calculation engines would interface with models via the standard representation.

… but enough words, let's look at this like engineers ...

The LEGO Model of the PRA Architecture

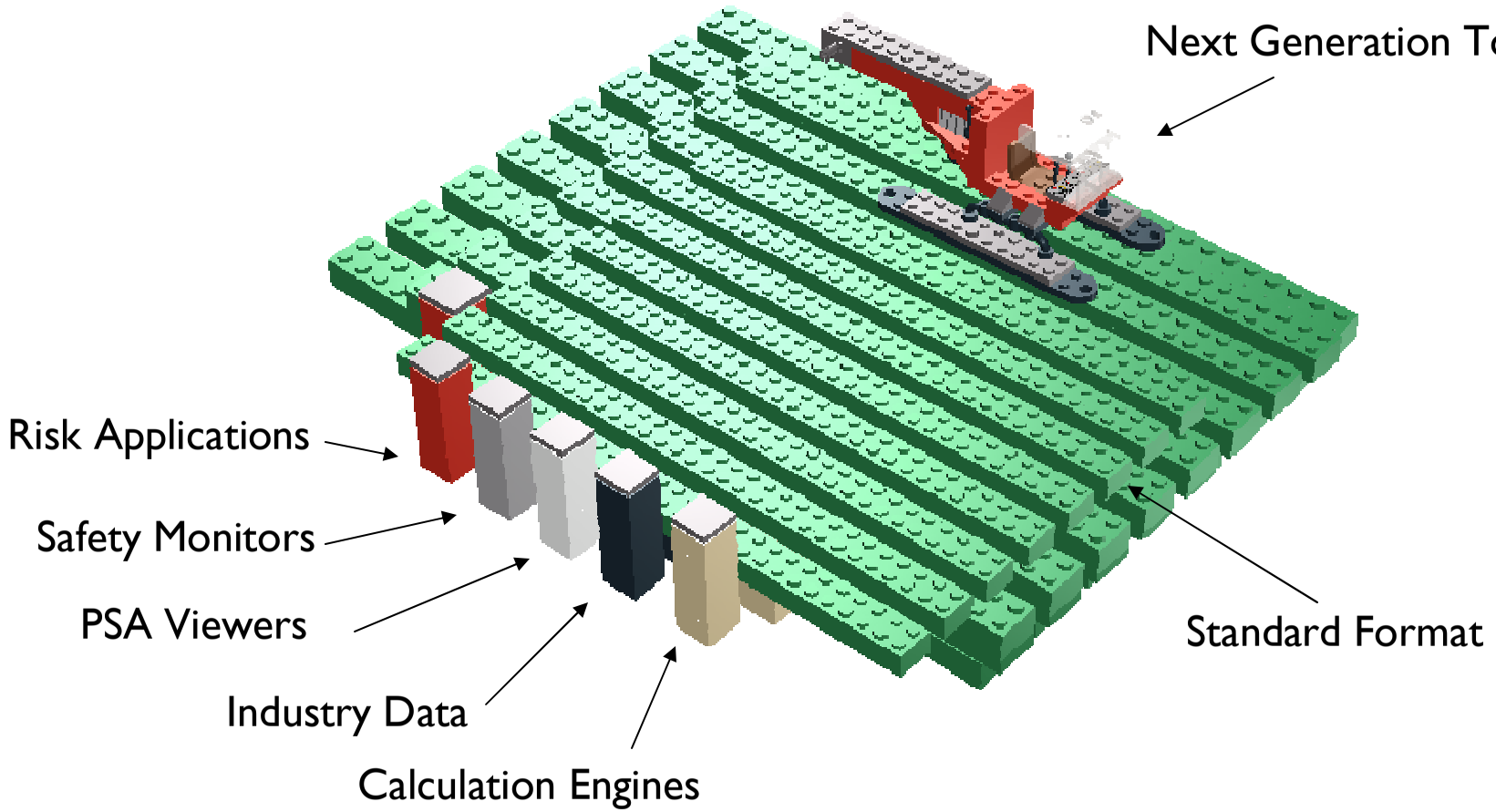
… first the foundation …



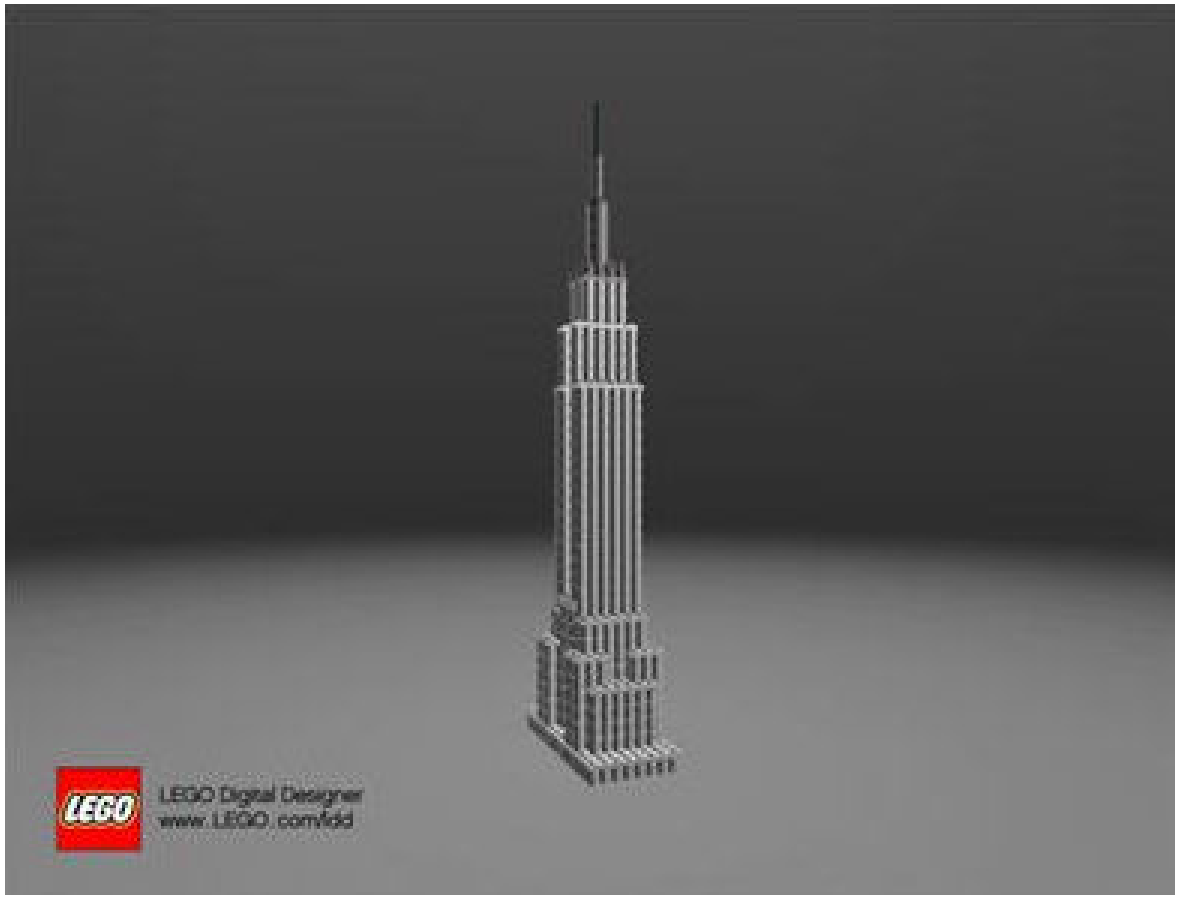
Standard Representation Format (SuRF)

catch the wave of the future

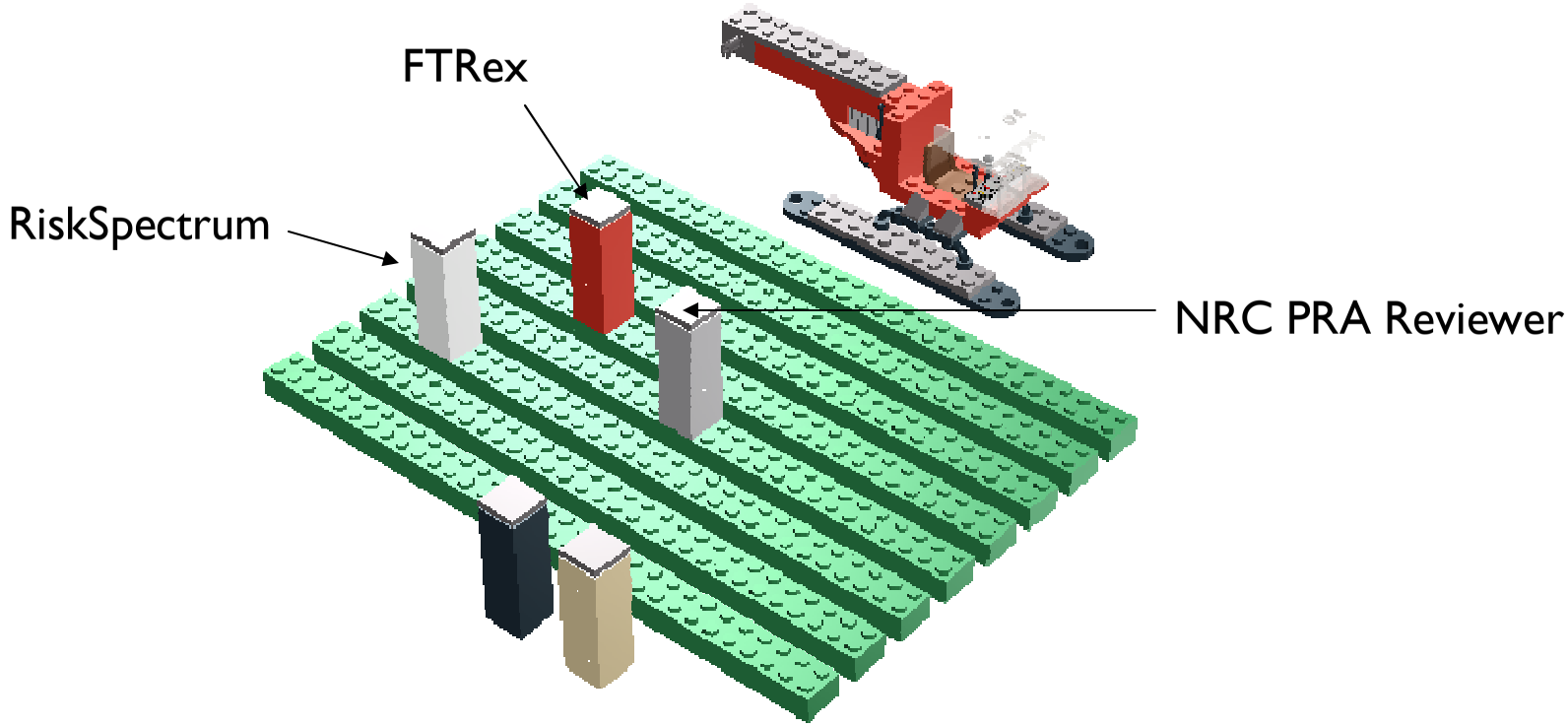
… now assemble the risk applications and data …



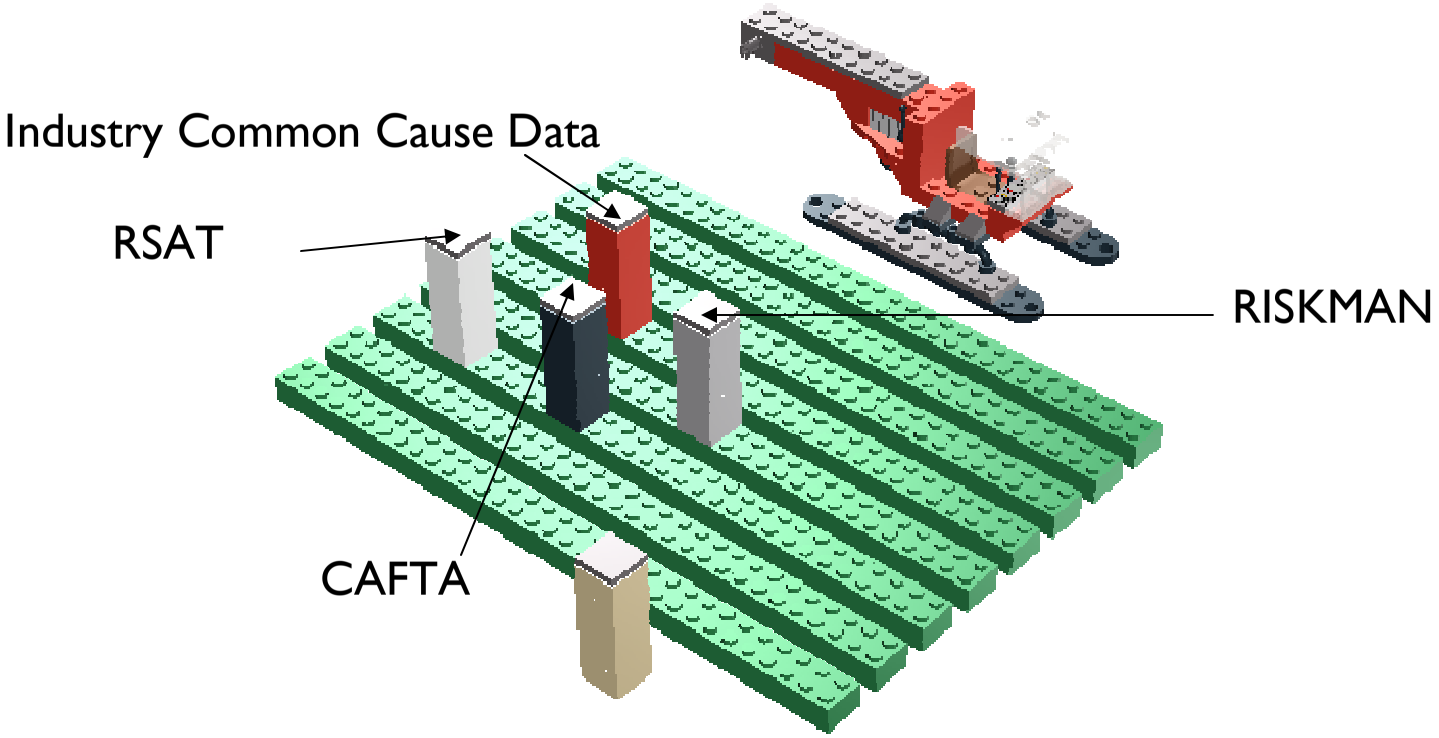
… and then build upon the foundation …



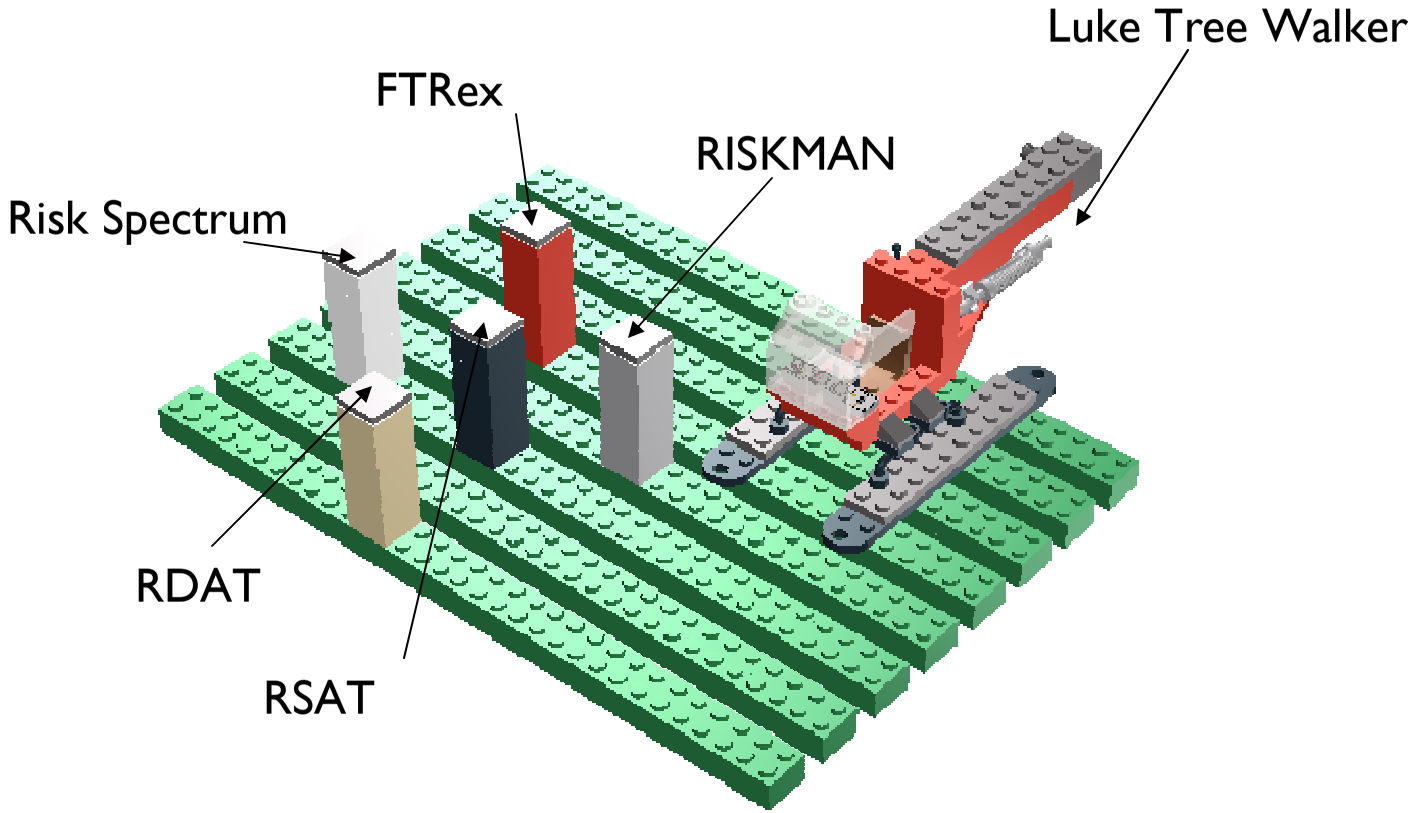
… for example …



… or this …



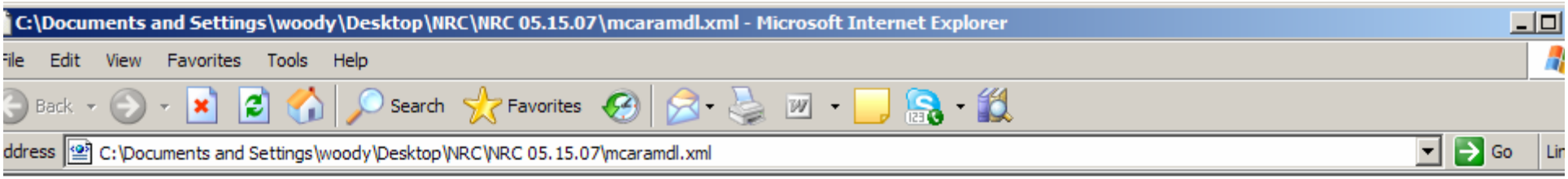
… or even this …



… all interconnected through the foundation: a Standard Model Representation Format.

This is not just imagination.

We have actually used a prototype format like this in research and production.




```
<?xml version="1.0" ?>
<!DOCTYPE riskman (View Source for full doctype...)>
- <riskman name="BU">
  - <faulttree topevent="BU">
      <!-- The Fault Tree -->
    - <gate name="BU" type="or">
        <fanin name="G00MAB" />
        <fanin name="G00MDB" />
        <fanin name="CHECKV4FTO" />
      </gate>
    - <gate name="G00MAB" type="or">
        <fanin name="TANKRUP" />
        <fanin name="MANUALVTC" />
        <fanin name="CHECKV3FTO" />
      </gate>
    - <gate name="G00MDB" type="and">
        <fanin name="G00MDC" />
        <fanin name="G00MJC" />
      </gate>
    - <gate name="G00MDC" type="or">
        <fanin name="MDPUMP1FTR" />
        <fanin name="MDPUMP1FTS" />
        <fanin name="CHECKV1FTO" />
        <fanin name="MOVALVE1FTO" />
        <fanin name="HETEST1" />
        <fanin name="G00MGD" />
      </gate>
    - <gate name="G00MGD" type="and">
        <fanin name="G00MGE" />
        <fanin name="CHECKV2FTR" />
      </gate>
    - <gate name="G00MGE" type="or">
        <fanin name="MDPUMP2FTR" />
        <fanin name="MDPUMP2FTS" />
      </gate>
    - <gate name="G00MJC" type="or">
        <fanin name="MDPUMP2FTR" />
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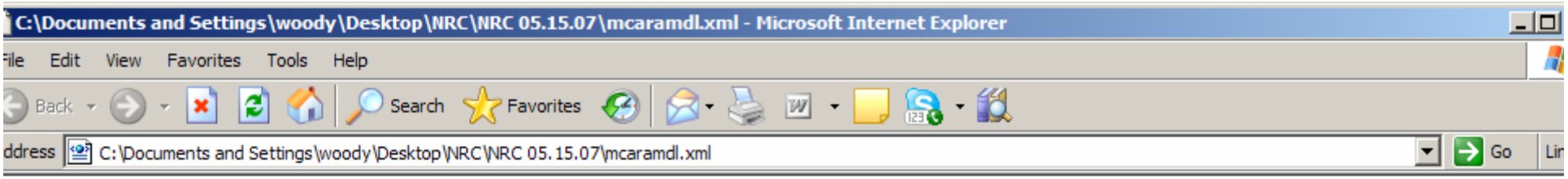



```
<?xml version="1.0" ?>
<!DOCTYPE riskman (View Source for full doctype...)>
- <riskman name="BU">
```


XML (Extensible Markup Language) is a public-domain, flexible way to create common information formats and share both the formats and the data on the World Wide Web, intranets, and between computer programs.

For example, software makers might agree on a standard or common way to describe and exchange data and then describe the data format with XML. Such a standard way of describing data would enable users to make valid comparisons.

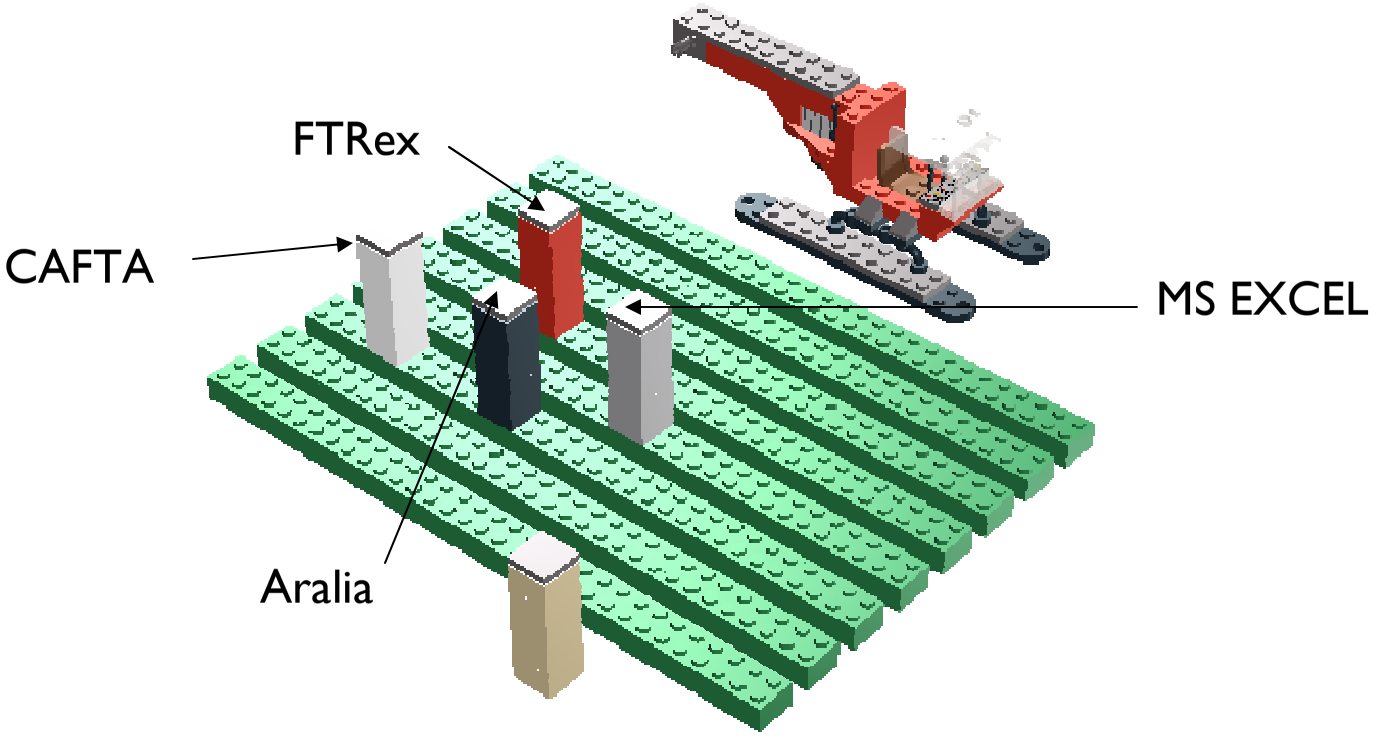
XML, a formal recommendation from the World Wide Web Consortium (W3C), is similar to the language of today's Web pages, the Hypertext Markup Language (HTML). An XML file can be processed purely as data by a program or it can be stored with similar data on another computer or, like an HTML file, that it can be displayed. Each application can decide how to handle the incoming data; it could be calculated, displayed, or inform the user that this type of data cannot be used.

XML is "extensible" because the markup symbols are unlimited and self-defining. XML is actually a simpler and easier-to-use subset of the Standard Generalized Markup Language (SGML), the standard for how to create a document structure.

It is now the case that XML is used in many Next Generation applications.

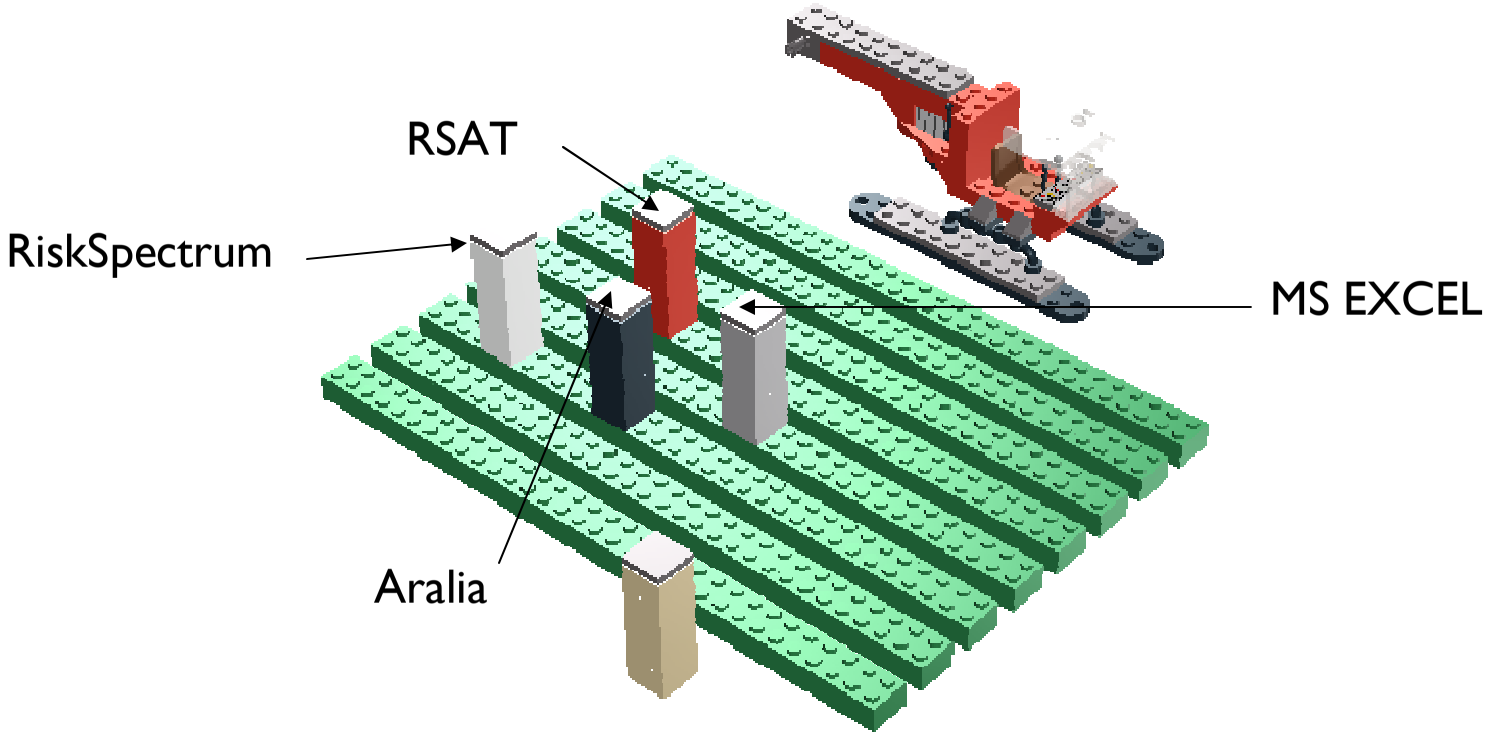

```
<fanin name="MDPUMP2FTR" />
```

Example #1



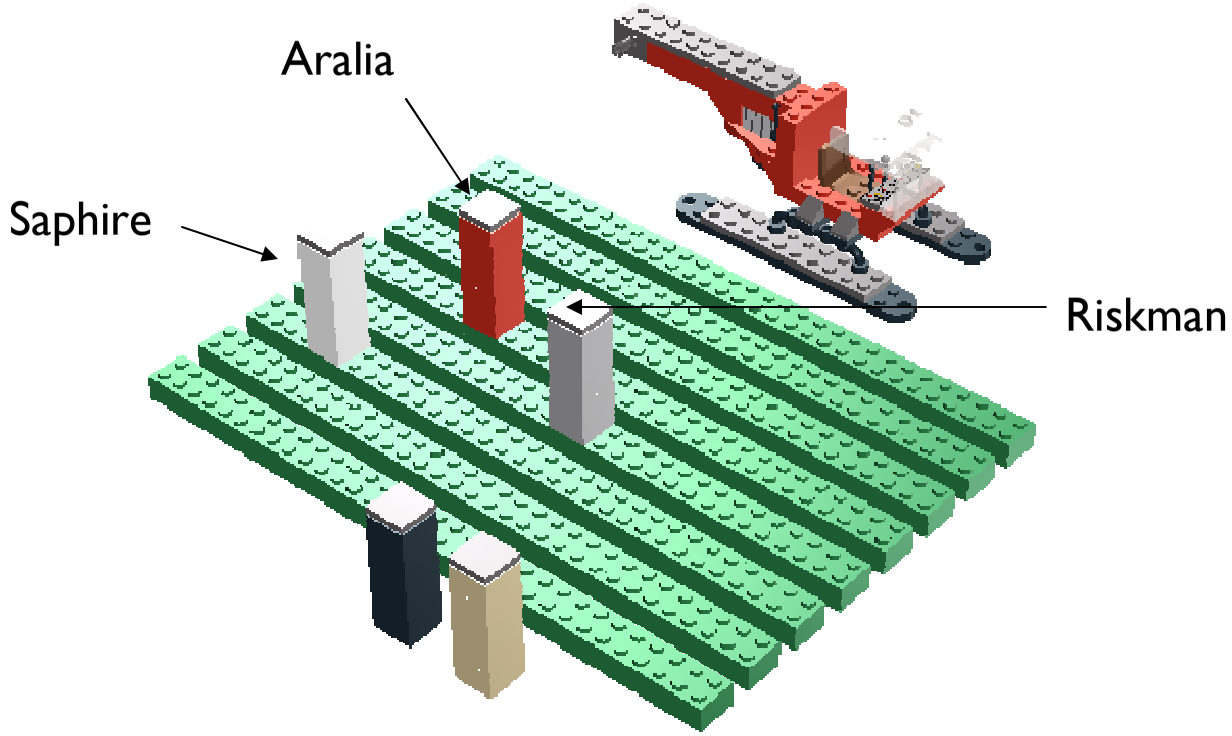
Three different CAFTA models from three different US organizations.

Example #2



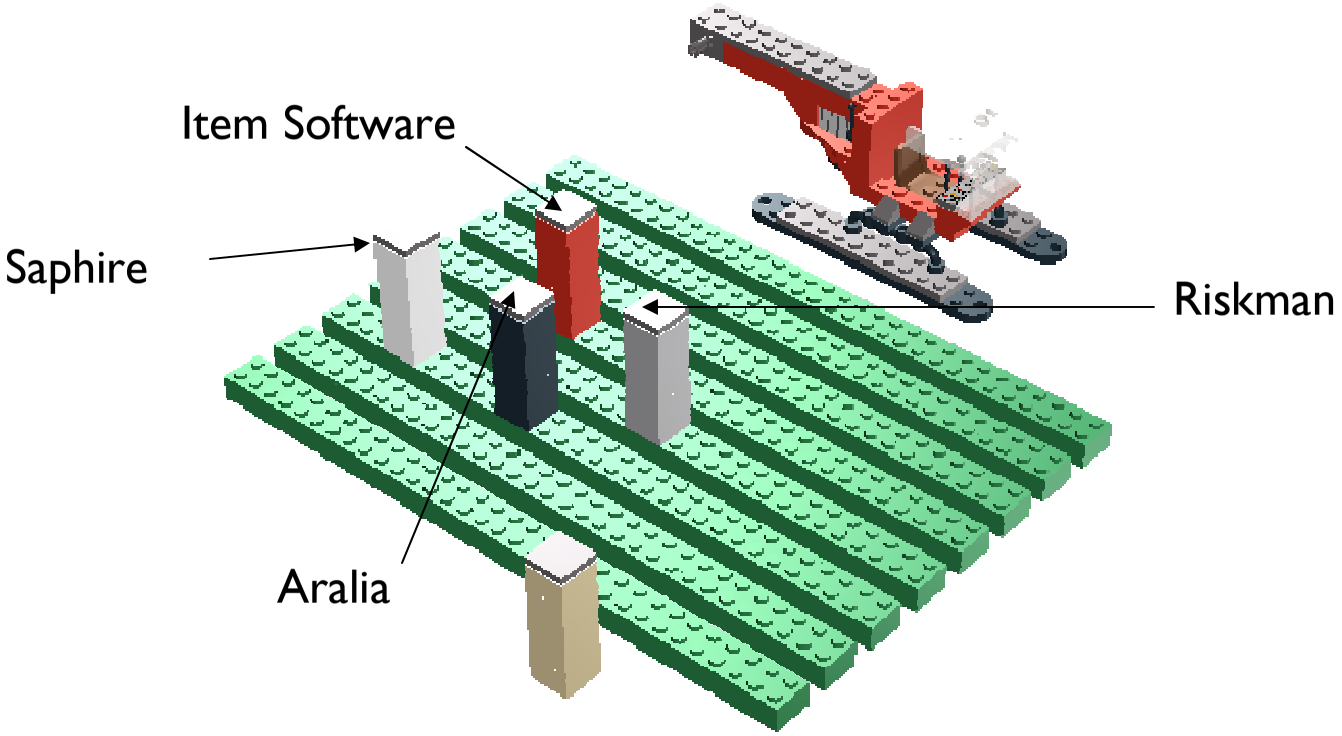
A Japanese core damage model solved exactly with BDD.

Example #3



An investigation of a SPAR model.

Example #4



A sanity check on the MER PRA done by NASA.