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Empirical Modelling
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Dependency by definition in Imagine-d Logo: applications and implications

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Computer Science
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EuroLogo 2007
Bratislava

Acknowledgements

Dave Pratt and Antony Harfield

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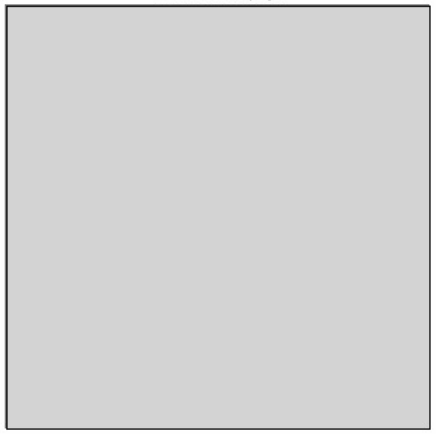

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Dependency: Changing one value propagates change to other values in a predictable way as if in one and the same action.

The agenda raised by studying dependency:

- **Practical programming:** What advantages / drawbacks does introducing dependency have?
- **Pedagogy:** What is the significance of dependency in relation to learning?
- **Computing Science:** How can we make conceptual sense of "programming with dependency"?

These general questions relate in particular to Logo.

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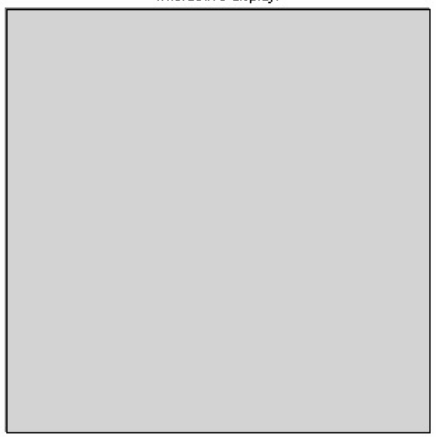

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Chris Roe's Imagine-d Logo prototype ...

... adds dependency to Imagine Logo, in such a way that:

- Programmer / model maker just writes the formula
  - *"dependency by definition"*
  - *how dependency is implemented not a concern*
- Programmer / model maker is able to **see** formula
  - *consider how the definitions of spreadsheet cells are inspected*
- Dependencies beyond go what a basic spreadsheet does, as when:
  - *presentation is dependent on values*
  - *formulae can use sliders*
  - *cells can be named variables and can be freely laid out*

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Some related previous work ...

- **Peter Tomcsanyi , 2003**
  Implementing object dependencies in Imagine Logo
- **Sendov and Dicheva, 1988**
  Geomland as a 'mathematics laboratory'
- **Erich Neuwirth**
  Implementing spreadsheets in Logo

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Tomcsanyi:

- dependencies implemented by the programmer through embellishing the underlying classes in Imagine Logo
- technically challenging, but very general in scope

... doesn't meet the end-user need as a spreadsheet does

... doesn't provide an easy way to inspect dependencies

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Roe:

- attributes can be given values using *definitions* that can be specified and edited dynamically
- applies in particular to geometry, in some ways similar to Geomland
- more general, less specialised in scope: cf. *Visual Fractions* and *Cabri geometry*

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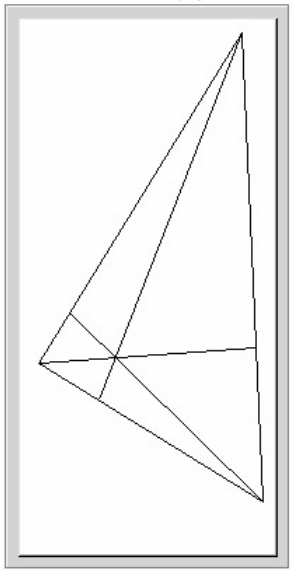

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A simple illustrative example

Tomcsanyi implements

"a kind of canonical construction of dynamic geometry"

... a triangle together with the common point of intersection of the perpendiculars dropped from its vertices onto the opposite side

```
%eden
include("link.angel");
include("triangledisplay.s");
```

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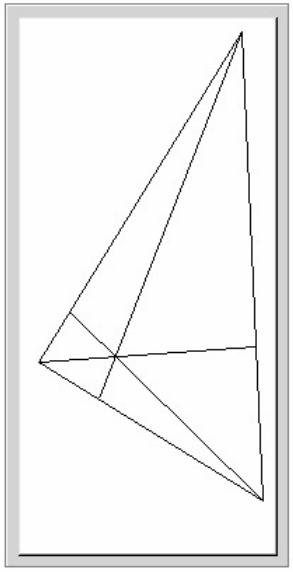

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```
%donald
line AB, BC, AC
point A, B, C
AB=[A,B]
## the line joining points A and B
BC=[B,C]
AC=[C,A]
A = {20, 180}    ## the point p4
B = {260, 490}   ## the point p1
C = {285, 50}    ## the point p3
line perpA, perpB, perpC
perpC = perpend(C, AB)
##  perpendicular from C on to AB
perpB = perpend(B, AC)
perpA = perpend(A, BC)
point D
D = intersect(perpA, perpB)
```

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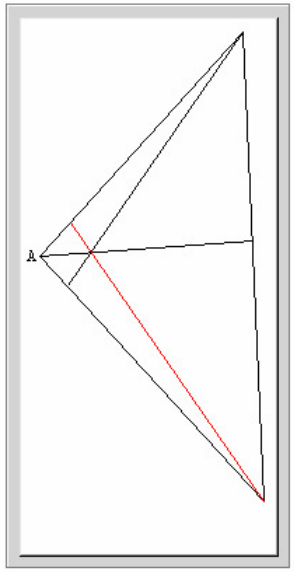

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```
%donald
A = {20,280}
```

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```
%eden
A_perpC = "color=red";
```

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```
%donald
label LA
point px
LA = label("A", A-px)
px = {10,0}
```

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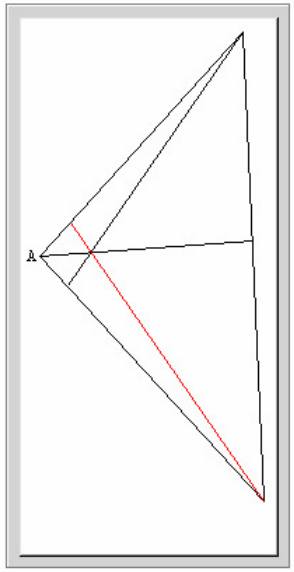

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The agenda raised by studying dependency:

- **Practical programming:** What advantages / drawbacks does introducing dependency have?
- **Pedagogy:** What is the significance of dependency in relation to learning?
- **Computing Science:** How can we make conceptual sense of "programming with dependency"?

Central themes in the Empirical Modelling project
- see **http://www.dcs.warwick.ac.uk/modelling/**

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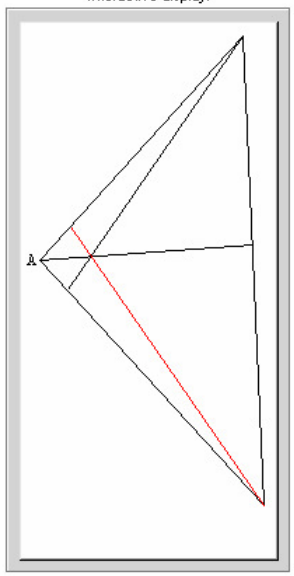

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Practical programming: What advantages / drawbacks does introducing dependency have?

- *programming with dependency is powerful but can promote conceptual confusion*
- *ease-of-use doesn't mean "good vehicle for constructivist learning"*

Empirical Modelling demonstrates:

- an approach to programming that is essentially based on model building using definitions
- a methodology for modelling with dependency associated with a radical rethinking of computing

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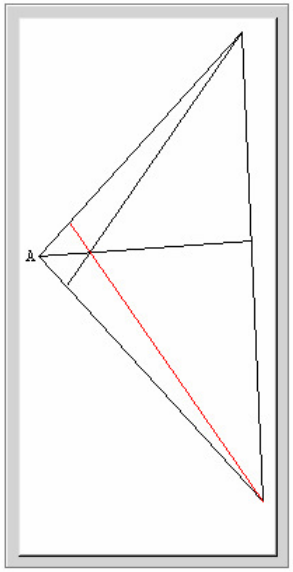

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Enter EDEN statements:

```
  type: DONALD
  box: [{10, 10}, {190, 390}]
  pict: "TRIANGLE"
  border: 2
  bgcolor: "white"
  xmax: 300
  ymax:500
  sensitive: MOTION
};


%eden
_A is cart(20, trianglepic_mousePos);
*/
```

Practical programming:
introducing dependency ha

- *programming with depe*
  conceptual confusion
- *ease-of-use doesn't mean "good vehicle for constructivist learning"*

Empirical Modelling demonstrates:

- an approach to programming that is essentially based on model building using definitions
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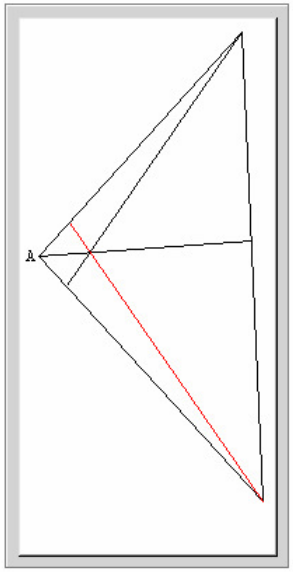

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Pedagogy: What is the significance of dependency in relation to learning?

- *di Sessa: "make it experiential is perhaps the single most powerful educational heuristic I know"*
- *di Sessa: why should educational software come in large units so slick and complex they require man-years of effort from highly technically competent software engineers?*

Empirical Modelling exploits dependency:

- to give priority to expressing latent dependency in situations over describing processes and behaviours
- allowing pupil, teacher and developer roles to be synthesised in a homogenous model-building environment

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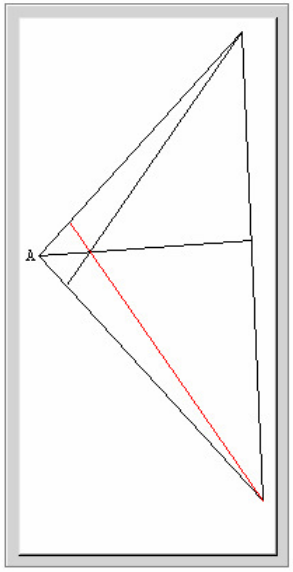

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Computing Science: How can we make conceptual sense of "programming with dependency"?

- *Large-scale software development involving radical rather than routine design is an exercise in constructivist learning*

Empirical Modelling activity:

- builds artefacts using principles resembling bricolage and the 'scientific method'
- supports primitive learning for familiarisation and understanding
- is in the spirit of di Sessa's *material intelligence*: building *construals* not programs

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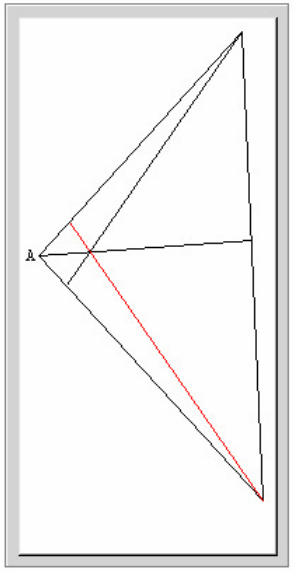

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Future directions?

- Introduce a dependency front-end to Imagine Logo, for use in a discretionary way - a *mixed-paradigm* approach
- enhancing Empirical Modelling tools by drawing on the excellent qualities of Logo and Boxer where accessibility is concerned

BUT ...

... Empirical Modelling has a Jamesian philosophical stance, for which Peter Naur proposes as a metaphor *an octopus jumping in a pile of rags*

For more background, see:

Meurig Beynon, Computing technology for learning - in need of a radical new conception, *Educational Technology & Society* 10(1), 94-106, 2007

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