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Defining and designing architectural ideotypes to control epidemics?

Didier Andrivon, Carole Giorgetti, Alain Baranger, Agnes Calonnec, Philippe Cartolaro, Robert Faivre, Sébastien Guyader, Pierre-Eric Lauri, Françoise Lescourret, Luciana Parisi, et al.

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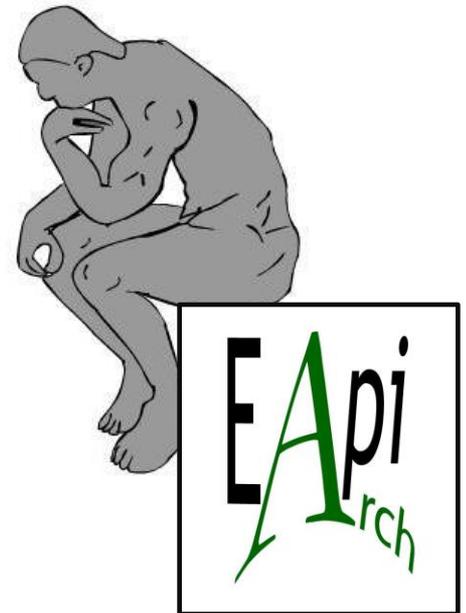
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Defining and designing architectural ideotypes to control epidemics?

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I have a dream...



Ideotypes: what and what for?

- The quest of the perfect plant
 - Highest yield and quality...
 - ... in a given environment
- Other qualities to be pursued
 - Low disease losses
 - Escape
 - Tolerance
 - Slow epidemic processes
 - > architecture comes into play!

Ideotypes: defining the objective and constraints

Growing waxy rice without fungicides



Control *Magnaporthe oryzae*

No resistant waxy cultivars



Ideotype 1 –
Cultivar mixtures

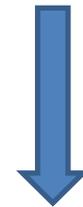
Ideotype 2 –
(GM) Resistant waxy cv

Labour not limiting



Ideotype 1.1
Alternate rows of waxy & non-waxy cvs

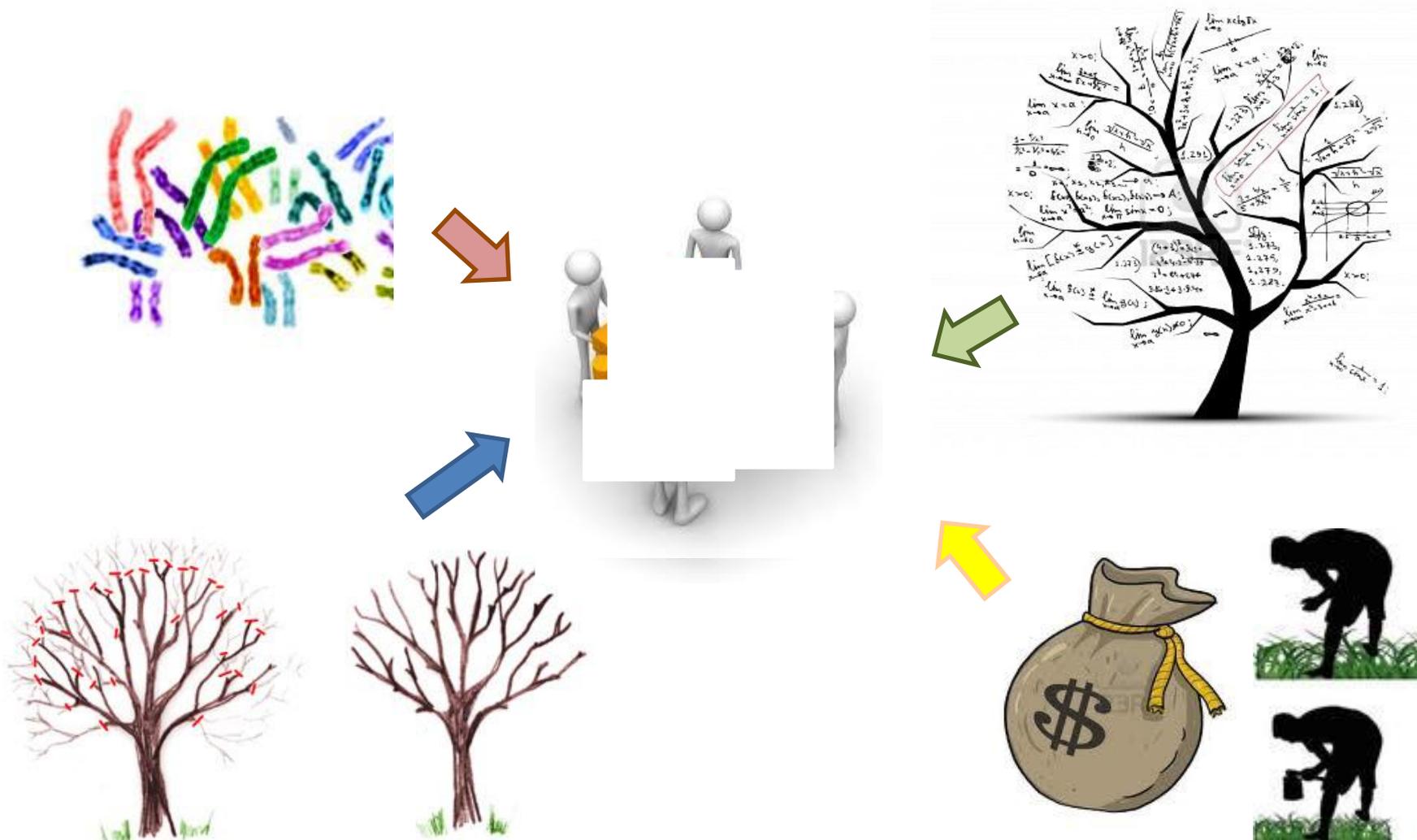
Labour limiting



Ideotype 2.1 –
Monoculture GM resistant waxy cv



The conceptual dimensions of ideotypes



The conceptual dimensions of ideotypes – consequences for design

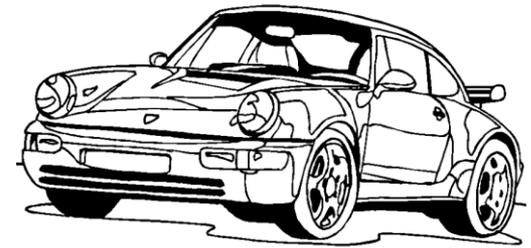
- **Dealing with the multiple dimensions : a conceptual dilemma**
 - look for a (maybe non-optimal) compromise...
 - ... or make strong choices favoring one view over all others?
- **Ideotypes as virtual objects**
 - ***What they are not***
 - blueprints /robot pictures of a wannabe cultivar
 - sheer utopia
 - ***What they could be***
 - formal, explicit tools to design multidisciplinary solutions to practical problems
 - useful to
 - formulate, confront, and sometimes reconcile, disciplinary visions
 - assess their operational potential and limitations
 - choose between competing designs
- **Many dimensions = many possible solutions**
 - Not a single ideotype, but several alternatives

Designing ideotypes

- The 'adaptation method'



• Start from the existing...
and gradually modify



- **Strengths**

- Familiar to breeders /agronomists
 - Always possible to 're-adjust' during the process
 - Direct output of new cultivars at each stage
 - Acceptability generally good

- **Weaknesses**

- Not highly innovative : no breakthrough expected
 - The ideotype might never be reached

Designing ideotypes

- The 'redesign method'



- Start from the goal >
imagine possible solutions >
build their components



- **Strengths**

- Possible to design ideotypes 'out of the blue': imagination rather than current status is the limit
- Entirely new types can be created

- **Weaknesses**

- Long process
- Solutions not always attainable (eg genetic diversity not available)
- Highly dependent upon the initial definition of objectives!!

Designing ideotypes

- The 'redesign method'
 - Leads to re-think the functions... and the objects to fulfill them



≠



**Defining the goal as precisely as possible is critical...
but tough!!**

Architectural ideotypes to limit epidemics

Leaf area index

Leaf size

Internode length

Stem density

Stem firmness

Leaf area density

Plant shape

Spacing leaf/fruit

Branching

Canopy closure

Earliness

Ontogenic R

Designing ideotypes: models as tools

Model parameters and integrative variables: simplifying complex issues

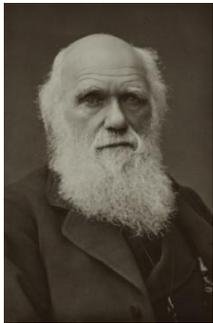
One example : canopy porosity



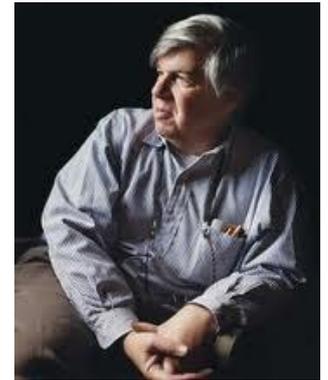
A hand pointing to a whiteboard filled with mathematical equations. The equations are complex and involve variables like α , β , γ , and δ . The hand is holding a pen, suggesting the equations were just written or are being explained.
$$\begin{aligned} \alpha(\alpha\beta) &= \alpha(\alpha\beta\delta) - \alpha(\alpha\beta\gamma) \\ \alpha(\alpha\beta\delta) &= \alpha(\alpha\beta\delta) - \alpha(\alpha\beta\gamma) \end{aligned}$$

Designing ideotypes: models as tools

- Models and theories: can evolutionary ecology help?



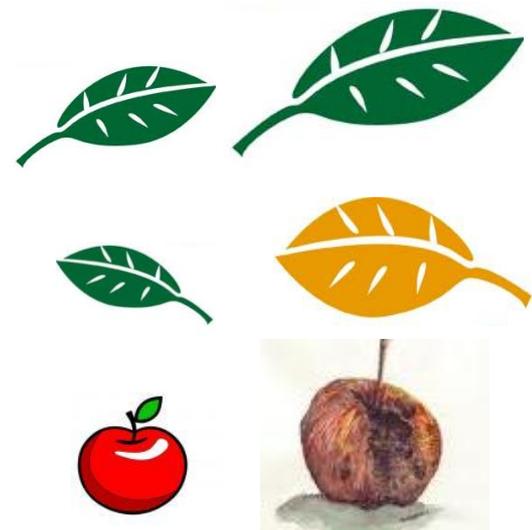
- The adaptation method :
a gradualist, Darwinian process
- The 'redesign method'
a catastrophist, Gouldian process



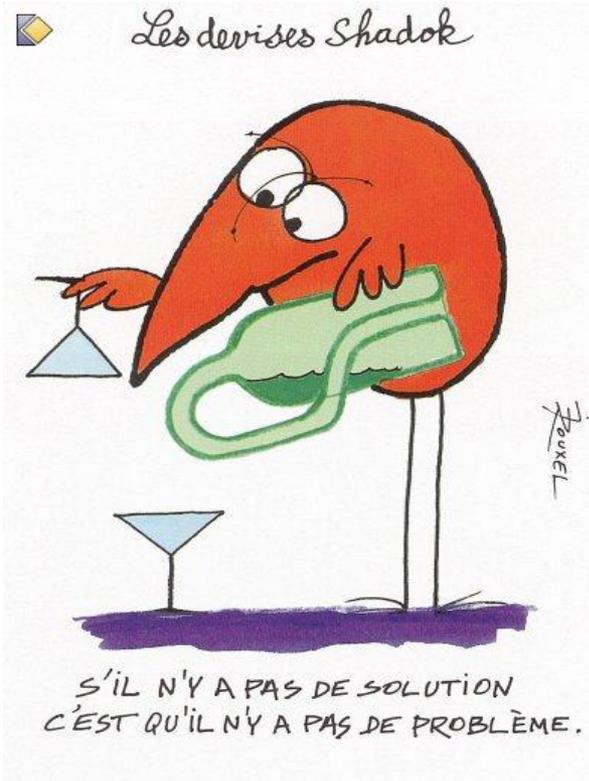
- Compromises and trade-offs

- One can't win on all bets
> choose what you'll lose

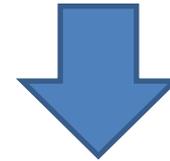
> **model your losses to choose wisely**



Lessons from the Shadoks



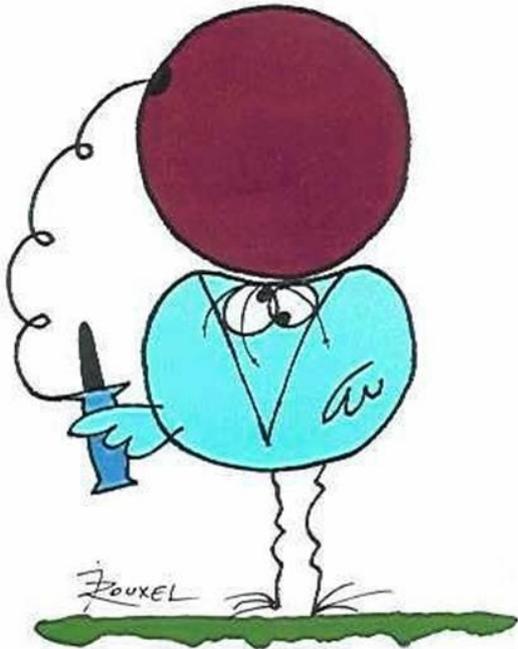
*If there is no solution,
there is no problem*



**Setting the problem
right is the key**

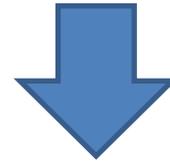
Lessons from the Shadoks

Les devises Shadok



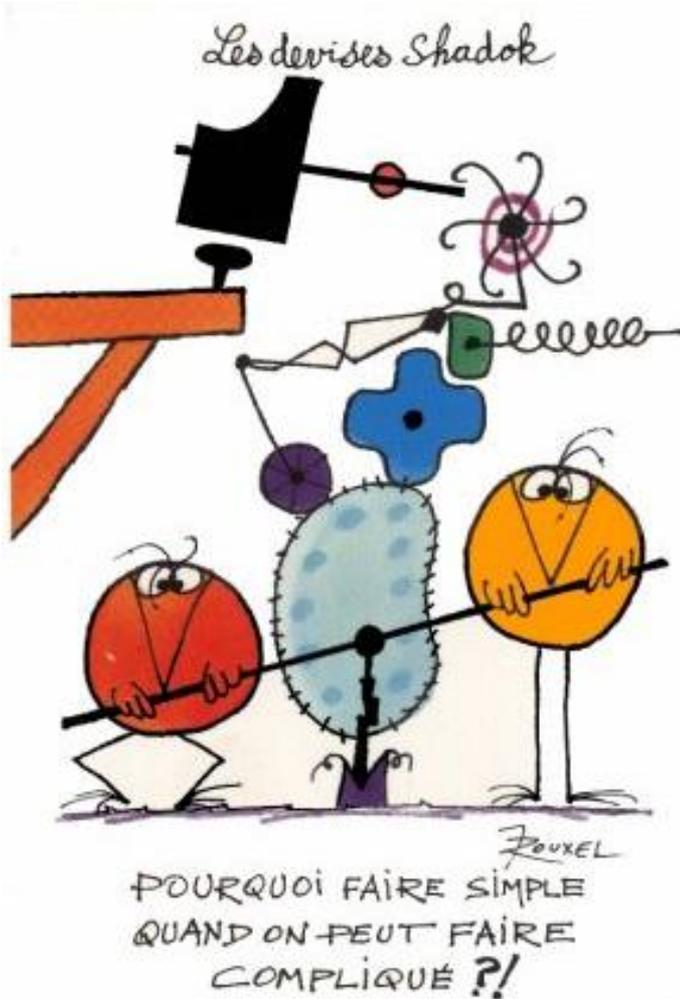
EN ESSAYANT CONTINUUELLEMENT
ON FINIT PAR RÉUSSIR. DONC:
PLUS ÇA RATE, PLUS ON A
DE CHANCES QUE ÇA MARCHE.

***When trying continuously, one ends up succeeding:
So, the more it fails, the more it is likely to work***



**Don't be afraid to try, even
if it seems hopeless at first**

Lessons from the Shadoks



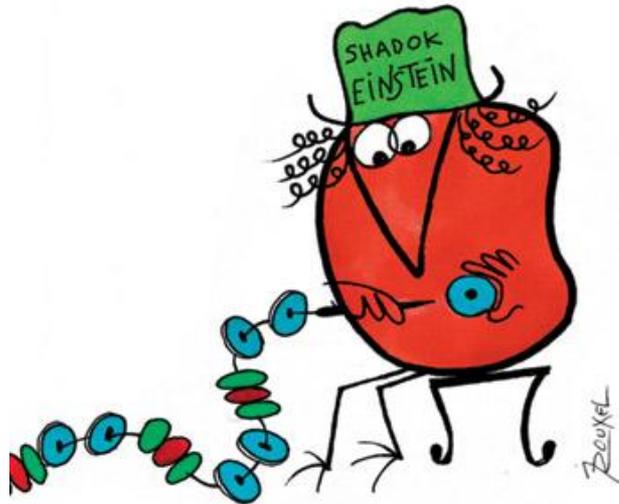
Why make it simple when it can be complicated?



**Don't be afraid of complexity:
that's where innovative
solutions are created**

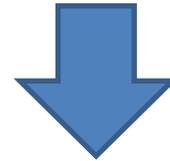
Lessons from the Shadoks

Les devises Shadok



IL VAUT MIEUX MOBILISER
SON INTELLIGENCE SUR DES
CONNERIES QUE MOBILISER
SA CONNERIE SUR DES
CHOSSES INTELLIGENTES.

***It's better to use one's intelligence on stupid things
than to use one's stupidity on intelligent things***

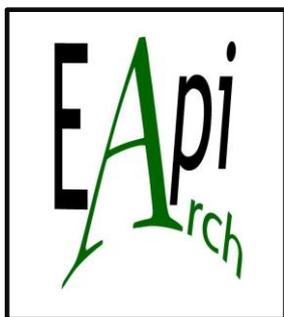


**Brain power...
and research!**

Some take-home messages

- An ideotype requires a precise context
 - Objective & constraints
 - Moving contexts = moving targets
- Several conceptual dimensions
 - More than one solution = more than one ideotype
 - Trade-offs are essential > an ideotype is a choice
 - Interdisciplinarity is mandatory
- Two main ways to conceive ideotypes
 - Theory can help... but expert knowledge is crucial
 - Models are useful to choose and to decide

Thanks to



All of you for listening ... and questions!