

# Innovation beyond Fiction



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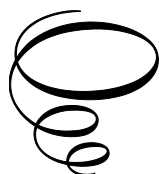
*An Imaginative Play  
with Mathematics*

By

Mathias Béjean

Foreword by Andrée Ehresmann  
and Jean-Paul Vanbremeersch

**Cambridge  
Scholars  
Publishing**



Innovation beyond Fiction: An Imaginative Play with Mathematics

Series: "Schwung"; Critical Curating and Aesthetic Management for Art,  
Business and Politics

By Mathias Béjean

This book first published 2022

Cambridge Scholars Publishing

Lady Stephenson Library, Newcastle upon Tyne, NE6 2PA, UK

British Library Cataloguing in Publication Data

A catalogue record for this book is available from the British Library

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ISBN (10): 1-5275-7998-0

ISBN (13): 978-1-5275-7998-9

*To the memory of my mother:  
may the Armada watch over her*



# TABLE OF CONTENTS

List of illustrations.....	ix
Foreword .....	xi
Author's acknowledgements .....	xv
<b>The Innovator's Odyssey: Mathematics for Innovation .....</b>	<b>1</b>
Prologue : Portrait of the Inventor as Gardener .....	3
Part 1- Explorations : Climbing the Tree to its Roots.....	17
Part 2- Incubation : Subterranean Germination of the Mathesis Singularis.....	43
Part 3-Acceleration : Back into the Unknown .....	65
Epilogue.....	89
Notes.....	91
<b>Philosophising Innovation: The making of the Innovator's Odyssey</b>	<b>93</b>
Origins of the book .....	94
Prologue.....	97
Part 1.....	103
Part 2.....	110
Part 3 and Epilogue.....	115
Appendix : D-MES: a Mathematical Approach to Innovative Design ...	123
Glossary .....	151
References .....	153





## LIST OF ILLUSTRATIONS

Figure 1: Eno Vaytor .....	5
Figure 2: The Armada.....	6
Figure 3: The Wayfarer .....	7
Figure 4: The Superintendents.....	10
Figure 5: The Land of Problems.....	11
Figure 6: The Land of Solutions.....	12
Figure 7: Paths of Invention .....	13
Figure 8: The Vizier .....	15
Figure 9: The Hole weaves its toils .....	19
Figure 10: Theatres of Machines .....	20
Figure 11: Stratagem of the Third Type .....	21
Figure 12: Mathematical memories .....	22
Figure 13: Piles of knowledge .....	23
Figure 14: A Graph lies still in its paper sleep.....	24
Figure 15: Phase diagram in flight.....	25
Figure 16: Janis.....	27
Figure 17: Rescued while at sea in reason.....	29
Figure 18: A philosophical oyster.....	31
Figure 19: Kant v. Simondon.....	33
Figure 20: Propagation of a transductive wave.....	35
Figure 21: The Hermit .....	37
Figure 22: Troglodyte theatre .....	39
Figure 23: Theoria and her followers .....	40
Figure 24: Modelia's dance .....	41
Figure 25: Simulia and the last of the villagers .....	42
Figure 26: A new mission.....	46
Figure 27: Sibylline melodies.....	47
Figure 28: The Assistant.....	49
Figure 29: Foundational diagrams .....	51
Figure 30: Colimit bringing form to the formless.....	53
Figure 31: Dynascope in operation.....	55
Figure 32: The embrace of the Topos.....	58
Figure 33: Scission .....	60
Figure 34: Developing motif in an evolutive system.....	61
Figure 35: Illumination by bat .....	64
Figure 36: The Voice.....	69

Figure 37: Making and thinking .....	71
Figure 38: The Revelation of the Tetrahedron.....	74
Figure 39: Experiment in speculative science .....	75
Figure 40: Experiment in experimental science.....	76
Figure 41: The instrument-mediated experiment of technoscience .....	77
Figure 42: The Gates of Immersion.....	79
Figure 43: Entering into the flow.....	80
Figure 44: What it is like to be a bat.....	81
Figure 45: The immersive flow .....	83
Figure 46: Deep in the Playfield.....	84
Figure 47: Archetypal motif .....	85

## FOREWORD

The multiplying dreamlike images of Eno's visions form something like the conceptual forest of a poet gardener, his passage through it a mathematical journey full of incident, of impressions sometimes ethereal, sometimes densely vivid and weighty, with here the tangle of undergrowth, there the lucid certainty of the straight path. The tensions of certainty, the mobility of intuition, the torment of doubt. To seek, to find, to understand! A quest in which life itself is at stake, almost, an assault on the Alps of knowledge.

Eno suffers, Eno hopes, Eno gets carried away, as his encounters take him from graphs to Categories, from concepts to Systems, as if batted from one to another in the giant pin-ball machine of his enthusiasms. Theoria, Modelia and Simulia all fascinate him, but the Wayfarer and then his Assistant will beguile him with their mathematics. He imagines "himself the privileged listener of a Sibyl possessed of impenetrable secrets".

Each new dash sees him leave behind the previous impulse, but confirms him in his approach. Eno lives, in his progress, the evolutive nature of System. He absorbs ideas and energies as his dream draws him on. Immersion allows him to move "in bold zigzags, potentializing meanings, actualising intuitions." Now his avatar enters into the flow of the Evolutive, constructing its Landscape on the basis of Memory and its store of multifaceted and evolving impressions.

Their Ramifications form an Archetypal Motif, a "Third Person" conjured up by "the deepest and most archaic of feelings". Interestingly, Eno will represent this fundamental Archetype of the Memory Evolutive System as a Rorschach blot. And when Eno's journey finally comes to an end, he sees that his quest will go on, taking him out into the world.

### **Birth of a "*Mathesis Singularis*"**

The "Memory Evolutive Systems" that Eno discovers by happenstance were introduced by the authors of this foreword in the 1980s.

It was an accident of professional life that brought Dr. Jean-Paul Vanbremeersch, geriatrician, into contact with Andrée Ehresmann. Their ensuing discussions revealed the wealth of possibilities opened up by a category-theoretic approach, which seemed perfectly fitted for the description and understanding of the complex processes underlying ageing and disease.

Andrée Ehresmann was then a “pure” mathematician who for the previous twenty years had worked with her husband Charles Ehresmann (d. 1979) on category theory, and on a distinctive philosophy of mathematics:

...a kind of Mathematics much less motivated by possible applications than by a profound desire to find in each problem the very essence of it, the whole general structure on which it depends.... A mathematical theory not only must be rigorous, but it must also satisfy our mind in quest of simplicity, of harmony, of beauty; and a beautiful theory is an inspired creation like a piece of Art.<sup>1</sup>

On the occasion of the “3<sup>ème</sup> Colloque sur les Catégories, dédié à Charles Ehresmann” (Amiens, 1980), Andrée asked Jean-Paul to help her write a short introduction to category theory that would be comprehensible to non-mathematicians. It was during this collaboration that Jean-Paul suggested applying the categories to the problems of emergence and complexity, and it is our research in this area that led to our work on “Memory Evolutive Systems”.

The notion of the Memory Evolutive Systems is intended to model the organisation and developmental dynamics of “living”, that is, biological or social systems. The MENS model developed for neuro-cognitive systems allows study of the formation of higher-order cognitive processes such as consciousness, anticipation and creativity.

Mathias Béjean came to hear of Memory Evolutive Systems in 2012, at the Mamuphi seminar (held at that time at the *Ecole Normale Supérieure de la rue d’Ulm*, this seeks to bring together mathematicians, musicians and philosophers, hence the name). At first, Eno/Mathias must have been surprised to discover a new kind of mathematics: “He had before him a mathematics that seemed in principle ideally suited to his new mission, but still hadn’t been able to think of one pertinent use for it.”<sup>2</sup>

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<sup>1</sup> Charles Ehresmann, "Trends toward unity in Mathematics", *Cahiers Top. et Géom. Dif.*, VIII (1967), reprinted in *Charles Ehresmann : Œuvres complètes et commentées*, Part III, 1980, Amiens, pp. 759–76.

<sup>2</sup> Chapter 2 below.

He wanted, in any event, to know more, and decided to read our book on *Memory Evolutive Systems*.<sup>3</sup> Andrée acquainted him with the MENS model, showing him the slides of our lecture “Comment modéliser la complexité et l’émergence en Art ?” (“How Does One Model the Complexity and Emergence of Art?”), given as part of the Agora Festival at the Centre Pompidou in 2009, which looked at the consciousness and creativity at work in Picasso’s creation of a painting (recorded in a film by H.G. Clouzot). In 2014, our paper on time and incompleteness presented at the Mamuphi seminar revealed to him the ancient roots of the MES and of the philosophy of what Eno/Mathias calls a *Mathesis Singularis* (Part 2, § 12), that is to say, a mathematics motivated less by the number and importance of its applications than by—as was said above—“a profound desire to find in each problem the very essence of it, the whole general structure on which it depends”.

Over time, our discussions with Mathias led quite naturally to our writing articles together, notably on the application of MES to design and forecasting. One of these is included as an appendix to this book, following the novella “The Innovator’s Odyssey” and the author’s account of its writing.

This book is for everyone, mathematicians or not. It succeeds in combining mathematics and poetry in gripping fashion, while the almost mythic character of the superb illustrations making the whole an outstanding aesthetic achievement.

Andrée Ehresmann and Jean-Paul Vanbremeersch

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<sup>3</sup> Andrée Ehresmann and Jean-Paul Vanbremeersch, *Memory Evolutive Systems: Hierarchy, Emergence, Cognition*, Amsterdam, Elsevier 2007.



## AUTHOR'S ACKNOWLEDGEMENTS

This text would never have been written without the many scholarly exchanges and friendly discussions that punctuated its development. I would therefore like to express my great gratitude to Pierre Guillet de Monthoux.

I also want to warmly thank Andrée Ehresmann and Romain Laufer, whose thinking and encouragement have been a support to me for many years. While they can in no way be held responsible for any failings on my part, this work owes them a very great deal.

My thanks go also to Frédéric Triail and Philippe Petit, not only for rewarding discussions of the literature but also for their highly attentive reading of different versions of the manuscript. Their solid knowledge and well-informed commentary gave me courage as I made my way along what felt like a narrow and exposed ridge. I hope we shall have a chance to continue our stimulating discussions.

Other friends and colleagues were also kind enough to offer feedback. Particular thanks go to Jean-François Bordron, Andrea Cavazzini, Joël Chevrier, Sophie Coiffier, Cathy Dubois, Jean-Paul Dumond, Olivier Germain, Cédric Hachard, Olivier Hirt, Jean-Claude Moison, François Nicolas, Isabelle Perrot, Robert Picard, Jean Sallatin, Arancha Tejedor and Jérôme Tomasi.

The text itself has been greatly enriched by the contribution of the two illustrators. I would therefore like to thank Fabrice Cochet for the incisive drawings that have given flesh to my “conceptual characters” and substance to the sites of their interactions, and Laure Garreau, whose wholehearted engagement yielded the “illucepts” that have taken my concepts further than I had imagined possible.

Sincerest thanks go to my translator, Dafydd Roberts, for a thorough and creative piece of work. I had not thought that translation could cast so fruitful a fresh light on my tale. I hope that he will forgive me for the many hours spent in search of the mot juste and the right turn of phrase.

Finally, I would like to thank my family and my closest friends for their patience and support through the long days of writing stolen from the “holidays”. Special thanks go to my wife Stéphanie and my daughters Sacha and Élisa. Thank you as well to my Chilean family, the Mapuche Indians...and the bats.

Mathias Béjean  
Montgeron, 10 April 2020.



THE INNOVATOR'S ODYSSEY:  
MATHEMATICS FOR INNOVATION



Translated from French by Dafydd Roberts

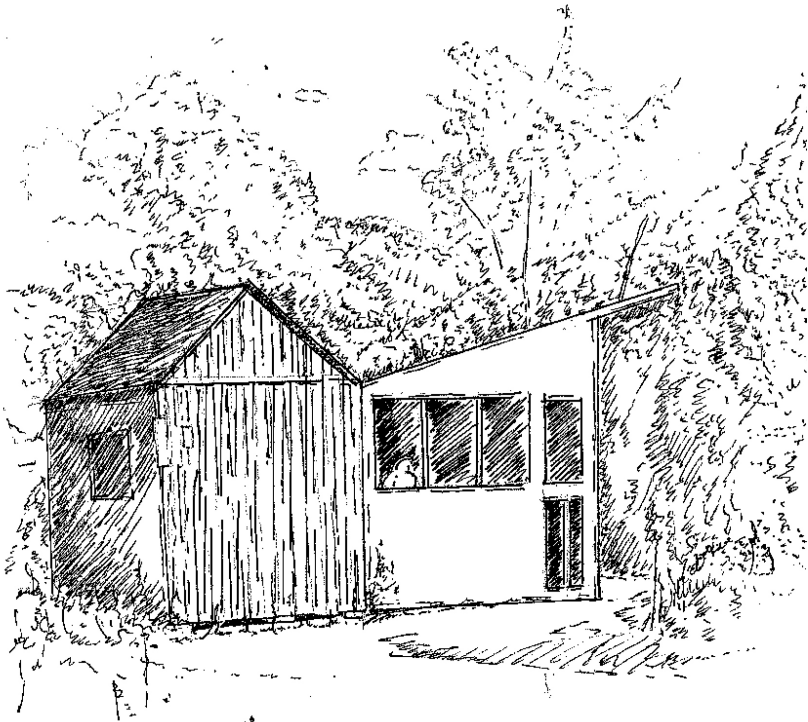
Illustrated by Laure Garreau and Fabrice Cochet



## PROLOGUE

### PORTRAIT OF THE INVENTOR AS GARDENER

*In which are evoked certain problems regarding the organisation  
of collective invention*



## 1. Invention

Of Eno Vaytor, one might say that he had been born an inventor. From earliest childhood he dreamed of making all kinds of things. His mother, who had brought him up alone, enjoyed telling anyone who would listen that one of his earliest ideas was to create an “Armada”, a company of robots to help her with her everyday tasks. With the passage of time, it would seem, childish enthusiasm became adult vocation, for when he completed his studies he set himself up as a self-employed inventor with a fabrication shop of his own, not far from the family home.

There he designed technical devices for a variety of clients, mostly industrial firms. He had decided not to specialise in any particular branch, and took on jobs of every kind. On the other hand, this Jack-of-all-trades never engaged in series production, but created only one-off pieces. Often, he would design only a prototype and leave it to a larger agency to develop it for industrial manufacture. What Eno’s clients were really after when they sought him out in his den was his spirit of invention.

## 2. Garden

Young as he was, Eno soon gained a reputation as unusually creative. Having successfully developed a number of inventions, he attracted the attention of informed commentators, and one day, on entering the Innovation in Agricultural Engineering competition, he won an important prize with his design for an intelligent watering system that measured soil humidity to optimize the distribution of water among different plots. This triumph won him a bit of a name as the local genius, and drew many curious visitors to his workshop.

Having dedicated his shed to the conception and nurturing of the new, Eno was delighted to welcome the public. He liked to call it his Garden, and his visitors Wayfarers—a term he preferred to “Clients” as it better expressed the type of relationship he hoped to establish with them as they went on together. Though he dreamed from time to time of some big, adventurous project, he loved the variety of his work and the freedom he enjoyed. He felt indeed that he lived a privileged life, and would have carried on a long time as he was, had not something happened.



Figure 1: Eno Vaytor

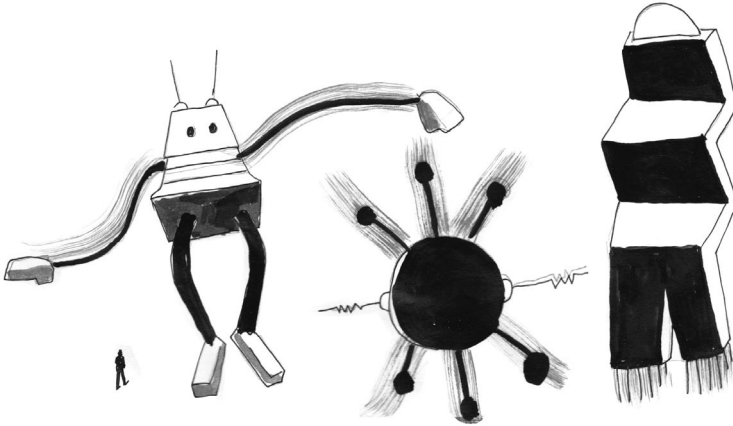


Figure 2: The Armada

### 3. The Wayfarer

One evening, as he potted in his Garden workshop, he was visited by a curious character who arrived after nightfall with a large leather bag of books slung over his shoulder and a sheaf of annotated papers under his arm. Observing from a little distance his appearance and his rapid gait, Eno first took him for a great explorer in quest of worlds unknown. Then the man came up to him, and took him by the arm, inviting him to join him on his walk. As they went on, Eno realised that of all his wayfarer-clients, this one would always be, for him, *The Wayfarer*.

After a conversation serious enough to call for occasional relief in the way of digressions somewhat less rigorous, Eno learnt that The Wayfarer was a relatively high-ranking scientist who intended to enter a technological competition and needed assistance in developing a concept demonstrator. As he wasn't yet sure what he was looking for, he wanted Eno to help him test a number of innovative hypotheses at the cutting edge of science. This was a challenge the young inventor felt he could not refuse.



Figure 3: The Wayfarer

#### 4. Dream

After shared mutterings about the timidity and stupidity of some, the two shook hands on their new partnership. The following weeks saw Eno dazzled: immersed in the world of scientific research, he discovered hitherto unimagined prospects. A few days after The Wayfarer eventually took his leave, Eno received from him a letter of thanks that also noted the award of a special jury prize. And enclosed with the letter was a press cutting about

a big engineering company specialising in leading-edge technology. Its name was Ingeniosa.

Eno read the text with attention. It catalogued the activities of what seemed an extraordinary business, whose Research Laboratory, it said, had been responsible for the most outstanding inventions of recent years. Alongside the text, illustrations showed some of the firm's production facilities and beautiful modern buildings where engineers and scientists were absorbed in their work. The presentation was completed by an announcement of vacancies. A wide-mouthed Eno read through it once again. A decision had been taken.

## **5. Ingeniosa**

After a brief exchange of correspondence, Eno was granted a job interview with Ingeniosa. With his reputation as an inventor already established, he met with the greatest solicitude. Concerned to show the firm in the best light, his interviewers boasted of the originality of their projects and emphasized the freedom and the wealth of resources that Ingeniosa could offer. They concluded by inviting him to join the most creative of their engineering design teams. The situation seemed so ideal that Eno found himself wondering whether he might not bump into his amazing friend The Wayfarer somewhere about the building.

At the end of the day, Eno was received by the company's technical director. Formally polite but cordial, the latter closed their conversation by commenting on the black-and-white portrait photograph that hung on the wall behind his desk, showing an elderly man with top hat and handlebar moustache posing alongside an industrial machine tool. This, he explained, was Ingeniosa's founder, adding with some little pride that his great-grandson still held a stake in the firm. Charmed by the presence of this tutelary figure, Eno accepted the offer there and then.

## **6. Camaraderie**

Eno's first years with Ingeniosa did not disappoint. As his interviewers had promised, he enjoyed great autonomy and found himself working on a number of truly innovative projects. These new adventures had taken him further than he had ever gone before and he thrived on the company of others at least as obsessed as he. They, for their part, acknowledged him as a colleague of talent. Rediscovering the joyful energy of his early days in the Garden, he felt himself buoyed up and carried along by the spontaneous camaraderie that seemed to exist between the inventors.



In recognition of his achievements, Eno was granted a little space of his own he called the Barn. There, together with a few close friends among his colleagues, he worked on personal projects. The tech topics of the day were much discussed, but the group was just as happy to look at crazy ideas and find out if they worked. All were equals in this space of sharing and collaboration: all were Gardeners united in the quest for the new. Having dreamt of such complicity between inventors ever since his encounter with The Wayfarer, it all seemed perfect to Eno, though as time passed he did realise he was missing the Wayfarers he used to see.

## **7. Superintendents**

Since the days of the Founder, a new division of roles and responsibilities had arisen within Ingeniosa. Alongside the Gardeners there had appeared other figures who grew in number as the company developed and diversified. Eno called them the Superintendents. They did not belong in the teams with the Gardeners, but occupied themselves in organising the latter's activities. Eventually, it was they who ended up talking to the Wayfarers. This arrangement, which Eno had always found odd, now seemed to him to be increasingly problematic.

His early experience in his own workshop had convinced him that direct contact with the Wayfarers was crucial to the success of his projects. Every time he was asked to do something, it was that face-to-face encounter that had allowed him to grasp the issues and turn his imagination to them. At Ingeniosa, he came to miss these exchanges, and as time went on, Gardeners' opportunities to engage with Wayfarers about their problems grew fewer and fewer. Disturbed by this development, Eno decided to speak up.

## **8. Protestations**

To address his colleagues, Eno chose one of the regular continuous improvement workshops that had been introduced at Ingeniosa. The Superintendents who were present listened as he expounded his vision of the inventor's work and his thoughts about how it was presently organised. He took the opportunity to criticize the rigidity of the new procedures, notably the requirement that a Gardener had to submit an official request every time he wanted to invite a Wayfarer into the department. This kind of bureaucracy, he said, was an obstacle to the kind of collaborative work that was needed.

The Superintendents' response was not slow in coming. They vigorously disagreed with Eno, claiming that, on the contrary, the separation of functions was essential to prevent slippages of cost, quality and time. That was something that Eno might well learn from, for his recent efforts had been very costly in terms of resources for very little result. For Ingeniosa, it was time to professionalise and there could be no timewasting any longer. Unsurprised by this reaction, Eno turned to his colleagues in search of some sign of sympathy.



Figure 4: The Superintendents

## 9. Disillusionment

Eno knew that not all his colleagues shared his vision. He had been told that some of them made fun of his group and their “Wonder Barn”. Yet he never could have imagined what he heard next. To listen to them, it seemed that some of the Gardeners were quite happy with the situation. They wanted a clear framework where each person had a determinate role and precisely designated responsibilities. According to them, it was this wonderful collective machine that had allowed Ingeniosa to achieve and maintain its position as market leader in innovation.



Figure 5: The Land of Problems

Astonished, Eno had tried to persuade his gainsayers of the risks of such a mechanisation of thought. Reason certainly had its place, but invention could not be reduced to a series of scientific deductions with no input from the imagination. To correctly formulate the problem was to go much of the way to solving it. How could they delegate that task to others? But one of his opponents retorted that the Land of Solutions was an Eldorado sufficiently vast and wealthy to allow scope to his creativity; there was no need to concern himself with the Land of Problems.

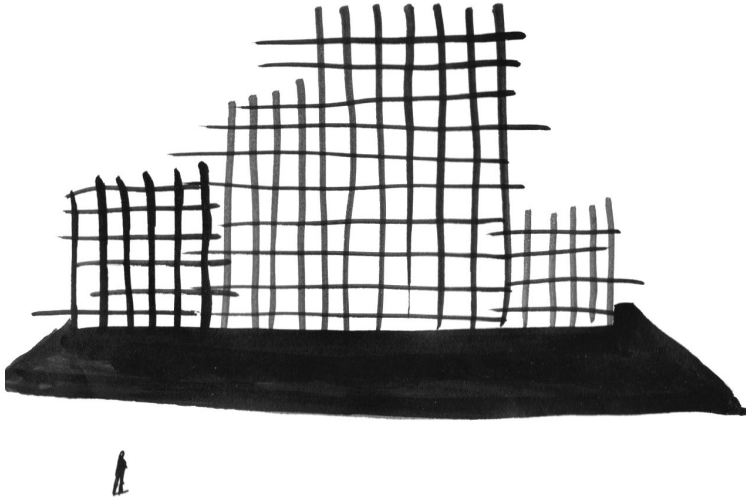


Figure 6: The Land of Solutions

## 10. Innovation

After the workshop, Eno was called in by the Superintendents for a personal interview. They wanted to clarify his position and had asked him to provide an up-to-date report on his doings at the Barn. In the course of the discussion, Eno sought to justify himself, arguing that the road of the New did not lie on the beaten track. While he understood their concern for risk control, the Superintendents should not to take too rigid or too linear a view of the paths of Invention. The course of creative thought could be tortuous and slow.

To Eno's surprise, the Superintendents raised no objection to this, and even reminded him that the inevitable "iterations" were provided for in their manual of procedures. But they distinguished between the Invention that Eno was always talking about and the Innovation that created value and on which Ingeniosa's growth now depended. Blinded by the desire to create, the inventor, they said, was playing about like a child, while the business needed rational and calculable decision-making. It was time he got a grip.



Figure 7: Paths of Invention

## 11. Viziers

Concerned by the tenor of the discussion, Eno went to see some of the firm's Elders. Recalling a better time when everything seemed different, they told him how competition had made things more difficult. Growing uncertainty about Ingeniosa's markets had prompted the Superintendents to strengthen their control over process and methods. Since then, competition had become even fiercer, and, in a way, they could understand the concerns of these managers of instability. Yet Eno wondered whether there was not another reason why his concerns could not get a hearing.

Recent years had seen new figures appear at the Ingeniosa offices. Though he had never met one himself, he had heard a great deal about them: they were called the Viziers. Holding themselves out as a new kind of scientists, they claimed to have identified general laws applicable to all practices, however different they might be. At Ingeniosa, they had the ear of the Superintendents and enjoyed growing authority over matters of work organisation. Which is why, as a last resort, our unhappy Gardener decided that he should visit these powerful figures.

## 12. Retreat

Among all the Viziers who lorded it at Ingeniosa, there was one who was particularly famous for having developed a Theory. Assuming him then to be more or less open to reason, Eno decided to speak to him first. Sadly, the Vizier in question received him with uncommon hostility. With barely disguised contempt, he explained to him that Ingeniosa needed not "ridiculous horticultural metaphors" but rather Science and Method. And then, siding with the Superintendents, he threatened to have Eno's heretical Barn closed down.

The Vizier's voice was so firm and confident that Eno found himself impressed, but thinking of his friends the other Gardeners he struggled valiantly to argue back. Yet he hardly knew how to respond to his opponent's powerful rhetoric, and with his back against the wall he ended up leaving the room, slamming the door behind him. Wandering the corridors, he began to imagine the Superintendents laughing at him and his humiliation. Miserable, upset at the way things were going, he decided it was time to retreat to the countryside.