

What a difference a few words make.

Peter Bentley's book EVOLUTIONARY DESIGN BY COMPUTERS 1999 Morgan Kaufmann ISBN 1-55860-605-X is often cited as a clear example of the application of the creative power of "mindless" evolution by natural selection. An alternate reading of Bentley's book does the opposite and strengthens the case that no truly novel design arises without the input of intelligence.

Here is an edit of part of the first chapter of the book to make the thesis supportive of ID rather than of evolutionary philosophy.

It turns out that very few "evolutionary substitutions" are necessary to make this text support ID. Often it is the spin given to research data that supports evolution, not the data itself. In fact in order to call his brand of computer aided design "evolutionary" Bentley cites the success of evolution itself in producing biological design. He assumes the very thing that those who cite his work say he proves ie the creative power of Natural Selection. This is circular reasoning. Bentley rightly confesses "I cannot pretend to hold unbiased views in this area".

EDIT of part of Chapter 1 of EVOLUTIONARY DESIGN BY COMPUTERS

An Introduction to Enriching Design using Computers

(originally) By Peter Bentley

1.1 Introduction

Computers can only do what we tell them to do. They are our blind, unconscious digital slaves, bound to us by the unbreakable chains of our programs. These programs instruct computers what to do, when to do it, and how it should be done.

But what happens when we loosen these chains? What happens when we tell a computer to use a process that we do not fully understand, in order to achieve something we do not fully understand? What happens when we tell a computer to enrich the designs for us?

As this book will show, what happens is that the computer gains almost human-like qualities of autonomy, innovative flair, and even creativity. These 'skills' which clever programming so mysteriously endows upon our computers open up a whole new way of using computers in design. Today our former 'glorified typewriters' or 'overcomplicated drawing boards' can do everything from generating new ideas and concepts in design, to improving the performance of designs well beyond the abilities of even the most skilled human designer. Enriching design using computers now enables us to employ computers in every stage of the design process. This is no longer computer aided design – this is becoming computer design.

The pages of this book testify to the ability of today's computer techniques in enriching design. Flick through them and you will see designs of satellite booms, load cells, flywheels, computer networks, artistic images, sculptures, virtual creatures, house and hospital architectural plans, bridges, cranes, analogue circuits and even coffee tables. Out of all of the designs in the world, the collection you see in this book have a unique history: they were all enriched by computer, not designed by unaided humans.

1.1.1 Enriching Tools

This may sound a little alarming to the designers and artists amongst us, but it should not be. In fact, these are the people who should feel most excited and optimistic by these advances, for it is the designer and artist who are the main beneficiaries of this field of research. Computer enriched design systems are advanced software tools which are intended to be used by people, not to replace people. They are the latest in a

number of computer software advances created to improve the productivity, quality, speed and reduce the expense of designing.

Today, designers recognise the usefulness of computers for data management and drawing – most art and design departments use graphics software or computer aided design (CAD) packages to draw, manipulate and store their designs. These software tools are becoming more and more advanced, with many having the ability to render designs with photorealism, produce animations, or even generate stereoscopic virtual reality worlds. Analysis tools that can simulate and measure the performance of designs are also becoming more common, with much of engineering design relying on software analysis to test designs before prototypes are built.

Computer enriched design builds on these software tools by actually taking over part of the design process. It allows designers to improve the performance of their designs automatically, judged by analysis software. It allows a designer to explore numerous creative solutions to problems (overcoming ‘design fixation’ or limitations of conventional wisdom) by generating these alternative solutions for the designer. It can use knowledge from designers to generate new solutions, based on many separate ideas. It can even suggest entirely new design concepts, or new ways of using existing technology. Computer enriched design can and does achieve all of this with the blinding speed and low cost of the computer.

However, although the field of computer enriched design is showing some impressive results, the computers are not fully autonomous. People are required to work out what function the design should perform, and how a computer should be applied to the problem. As this book describes, there are many complex issues involved in getting a computer to design anything useful at all.

And although the ‘design skills’ of the computer are surprisingly good, they are still no match for the human brain.

1.1.2 The Power of Design

In reality, computer enriched design by computers does not involve conscious design at all. How could it, for today’s computers are incapable of independent conscious thought, and computer enriched systems have no consciousness of their own. Computer enriched design is simply a process capable of generating designs, it can never truly be called a designer. This can be difficult to understand – surely an intricate design must be designed? The answer is yes. Biology has taught us this lesson – and there are no designs more complex than those found in nature.

Nature displays the original and best design system. Designs have appeared in nature for hundreds of millions of years. Biological designs that far exceed any human designs in terms of complexity, performance, and efficiency are prolific throughout the living world. From the near-perfection of the streamlined shape of a shark, to the extraordinary molecular structure of a virus, every living thing is a marvel of design. Moreover, as biologists uncover more information about the workings of the creatures around us, it is becoming clear that many human designs have existed in nature long before they were thought of by any human, for example: pumps, valves, heat-exchange systems, optical lenses, sonar. Indeed, many of our recent designs borrow features directly from nature, such as the cross-sectional shape of aircraft wings from birds, and velcro from certain types of ‘sticky’ seeds. As Ray Paton observed: ‘A very good example of how biology can inspire engineering solutions is the work of Professor O. H. Schmitt who introduced the term “biomimetic” (emulating biology) into the US literature over a decade ago. It is fascinating to see how, following his Ph.D. thesis on the simulation of nerve action, four well-known electronic devices emerged: Schmitt trigger, emitter-follower, differential amplifier and heat pipe.’ (Paton, 1994, p. 51).

1.1.3 Enriched Design by Computers

So it is clear that nature is capable of generating astonishingly innovative designs. This book demonstrates how enriching design by computers is also capable of such innovation. To achieve this, the highest achievers in computer enriched design have come together for the first time to contribute chapters and provide a showcase of the best and most original work in this exciting new field. The book promotes the use of the word ‘Design’ in its broadest sense, allowing all aspects of computer enriched design to be explored, including: computer enriched optimisation, computer enriched art, computer enriched artificial life and creative computer enriched design. Of course the number of pages available for such a volume is finite, and so not every researcher in this field can be a contributor of a chapter. As the editor of this book I have tried my hardest to ensure a coherent and definitive selection of significant developments in

computer enriched design is included, but there will always be omissions, and for that I apologise.

The contributors all have considerable technical expertise in this area, but beginners to this field should take heart, for the concept of computer enriching is a simple one, and the simpler forms of computer enriched design do not require years of study to achieve. Indeed, to help budding computer enriched designers get started, the CD-ROM included with this book contains code from many of the contributors of the chapters, including some demonstration computer enriched design systems. Perhaps one of the primary barriers to understanding is the terminology, which often seems to be an impenetrable tangle of words such as *meiosis*, *allele*, *epistasis* and *embryogeny*. Never fear: even the most experienced of us sometimes forget what the latest term to be stolen from biology means, so do not be afraid to consult the glossary included in the book!

And finally: before we open up computer enriched design by computers and explore its gory innards, a warning. This has been an area of computer science which has fascinated and thrilled me for some years. Like any researcher with a 'pet subject', I cannot pretend to hold unbiased views in this area. But I still find the excitement of my computer assisting in developing an innovative design is undiminished, despite the hundreds I have already been privileged enough to see with my own eyes. I hope I can transfer some of my enthusiasm to you, my perceptive reader, so sit back and enjoy the ride!

You can see below how I have edited (--words deleted-- and ++words added++) the following passages to esponge the reference to evolution at the same time as maintaining the essential meaning.

Chapter 1

An Introduction to --Evolutionary-- ++Enriching++ Design by Computers

By Peter Bentley

1.1 Introduction

Computers can only do what we tell them to do. They are our blind, unconscious digital slaves, bound to us by the unbreakable chains of our programs. These programs instruct computers what to do, when to do it, and how it should be done.

But what happens when we loosen these chains? What happens when we tell a computer to use a process that we do not fully understand, in order to achieve something we do not fully understand? What happens when we tell a computer to <<evolve>> ++enrich the++ design <<s>> ++for us++?

As this book will show, what happens is that the computer gains almost human-like qualities of autonomy, innovative flair, and even creativity. These 'skills' which --evolution-- ++clever programming++ so mysteriously endows upon our computers open up a whole new way of using computers in design. Today our former 'glorified typewriters' or 'overcomplicated drawing boards' can do everything from generating new ideas and concepts in design, to improving the performance of designs well beyond the abilities of even the most skilled human designer. --Evolving designs on-- ++Enriching designing using++ computers now enables us to employ computers in every stage of the design process. This is no longer computer aided design – this is becoming computer design.

The pages of this book testify to the ability of today's --evolutionary-- computer techniques in ++enriching++ design. Flick through them and you will see designs of satellite booms, load cells, flywheels, computer networks, artistic images, sculptures, virtual creatures, house and hospital architectural plans, bridges, cranes, analogue circuits and even coffee tables. Out of all of the designs in the world, the collection you see in this book have a unique history: they were all --evolved-- ++enriched++ by computer, not designed by ++unaided++ humans.

1.1.1 --Evolutionary-- ++Enriching++ Tools

This may sound a little alarming to the designers and artists amongst us, but it should not be. In fact, these

are the people who should feel most excited and optimistic by these advances, for it is the designer and artist who are the main beneficiaries of this field of research. --Evolutionary-- ++Computer enriched++ design systems are advanced software tools which are intended to be used by people, not to replace people. They are the latest in a number of computer software advances created to improve the productivity, quality, speed and reduce the expense of designing.

EVOLUTIONARY DESIGN BY COMPUTERS Copyright © 1999 Morgan Kaufmann ISBN 1-55860-605-X All rights of reproduction in any form reserved

Today, designers recognise the usefulness of computers for data management and drawing – most art and design departments use graphics software or computer aided design (CAD) packages to draw, manipulate and store their designs. These software tools are becoming more and more advanced, with many having the ability to render designs with photorealism, produce animations, or even generate stereoscopic virtual reality worlds. Analysis tools that can simulate and measure the performance of designs are also becoming more common, with much of engineering design relying on software analysis to test designs before prototypes are built.

--Evolutionary-- ++Computer enriched++ design builds on these software tools by actually taking over part of the design process. It allows designers to improve the performance of their designs automatically, judged by analysis software. It allows a designer to explore numerous creative solutions to problems (overcoming 'design fixation' or limitations of conventional wisdom) by generating these alternative solutions for the designer. It can use knowledge from designers to generate new solutions, based on many separate ideas. It can even suggest entirely new design concepts, or new ways of using existing technology. --Evolutionary-- ++Computer enriched++ design can and does achieve all of this with the blinding speed and low cost of the computer.

However, although the field of --evolutionary-- ++computer enriched++ design is showing some impressive results, the computers are not fully autonomous. People are required to work out what function the design should perform, and how a computer should be applied to the problem. As this book describes, there are many complex issues involved in getting a computer to --evolve-- ++design++ anything useful at all.

And although the 'design skills' of the computer are surprisingly good, they are still no match for the human brain.

1.1.2 The --Unconscious-- Power of --Evolution-- ++Design++

In reality, --evolutionary-- ++computer enriched++ design by computers does not involve conscious design at all. How could it, for today's computers are incapable of independent conscious thought, and --evolution-- ++computer enriched systems have++ --has-- no consciousness --of its own--. --Evolutionary-- ++Computer enriched++ design is simply a process capable of generating designs, it can never truly be called a designer. This can be difficult to understand – surely an intricate design must be designed? The answer is --no-- ++yes++ --, an intricate design can arise through slow, gradual, mindless improvement--. --Evolutionary-- Biology has taught us this --harsh-- lesson – and there are no designs more complex than those --evolved-- in nature.

--Natural evolution is, of course,-- ++Nature displays++ the original and best --evolutionary-- design system. Designs have --been evolving-- +appeared++ in nature for hundreds of millions of years. Biological designs that far exceed any human designs in terms of complexity, performance, and efficiency are prolific throughout the living world. From the near-perfection of the streamlined shape of a shark, to the extraordinary molecular structure of a virus, every living thing is a marvel of --evolved-- design. Moreover, as biologists uncover more information about the workings of the creatures around us, it is becoming clear that many human designs have existed in nature long before they were thought of by any human, for example: pumps, valves, heat-exchange systems, optical lenses, sonar. Indeed, many of our recent designs borrow features directly from nature, such as the cross-sectional shape of aircraft wings from birds, and velcro from certain types of 'sticky' seeds. As Ray Paton observed: 'A very good example of how biology can inspire engineering solutions is the work of Professor O. H. Schmitt who introduced the term "biomimetic" (emulating biology) into the US literature over a decade ago. It is fascinating to see how, following his Ph.D. thesis on the simulation of nerve action, four well-known electronic devices emerged: Schmitt trigger, emitter-follower, differential amplifier and heat pipe.' (Paton, 1994, p. 51).

1.1.3 --Evolutionary-- ++Enabled++ Design by Computers

So it is clear that --evolutionary design in-- nature is capable of generating astonishingly innovative designs.

This book demonstrates how --evolutionary-- ++enriching++ design by computers is also capable of such innovation. To achieve this, the highest achievers in --evolutionary-- ++computer enriched++ design have come together for the first time to contribute chapters and provide a showcase of the best and most original work in this exciting new field. The book promotes the use of the word 'Design' in its broadest sense, allowing all aspects of --evolutionary-- ++computer enriched++ design to be explored, including: --evolutionary-- ++computer enriched++ optimisation, --evolutionary-- ++computer enriched++ art, --evolutionary-- ++computer enriched++ artificial life and creative --evolutionary-- ++computer enriched++ design. Of course the number of pages available for such a volume is finite, and so not every researcher in this field can be a contributor of a chapter. As the editor of this book I have tried my hardest to ensure a coherent and definitive selection of significant developments in --evolutionary-- ++computer enriched++ design is included, but there will always be omissions, and for that I apologise.

The contributors all have considerable technical expertise in this area, but beginners to this field should take heart, for the concept of --evolution-- ++computer enriching++ is a simple one, and the simpler forms of --evolutionary-- ++computer enriched++ design do not require years of study to achieve. Indeed, to help budding --evolutionary-- ++computer enriched++ designers get started, the CD-ROM included with this book contains code from many of the contributors of the chapters, including some demonstration --evolutionary-- ++computer enriched++ design systems. Perhaps one of the primary barriers to understanding is the terminology, which often seems to be an impenetrable tangle of words such as *meiosis*, *allele*, *epistasis* and *embryogeny*. Never fear: even the most experienced of us sometimes forget what the latest term to be stolen from biology means, so do not be afraid to consult the glossary included in the book!

And finally: before we open up --evolutionary-- ++computer enriched++ design by computers and explore its gory innards, a warning. This has been an area of computer science which has fascinated and thrilled me for some years. Like any researcher with a 'pet subject', I cannot pretend to hold unbiased views in this area. But I still find the excitement of my computer --evolving-- ++assisting in developing++ an innovative design is undiminished, despite the hundreds I have already been privileged enough to see --evolving before my eyes--. I hope I can transfer some of my enthusiasm to you, my perceptive reader, so sit back and enjoy the ride!