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Engineering Innovation

(TRIZ based Computer Aided Innovation)

by

Mir Abubakr Shahdad. (BEng, MSc)

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Abstract

This thesis describes the approach and results of the research to create a TRIZ based computer aided innovation tools (AEGIS and Design for Wow). This research has mainly been based around two tools created under this research: called AEGIS (Accelerated Evolutionary Graphics Interface System), and Design for Wow. Both of these tools are discussed in this thesis in detail, along with the test data, design methodology, test cases, and research.

Design for Wow (<http://www.designforwow.com>) is an attempt to summarize the successful inventions/ designs from all over the world on a web portal which has multiple capabilities. These designs/innovations are then linked to the TRIZ Principles in order to determine whether innovative aspects of these successful innovations are fully covered by the forty TRIZ principles. In Design for Wow, a framework is created which is implemented through a review tool. The Design for Wow website includes this tool which has been used by researcher and the users of the site and reviewers to analyse the uploaded data in terms of strength of TRIZ Principles linked to them.

AEGIS (Accelerated Evolutionary Graphics Interface System) is a software tool developed under this research aimed to help the graphic designers to make innovative graphic designs. Again it uses the forty TRIZ Principles as a set of guiding rules in the software. AEGIS creates graphic design prototypes according to the user input and uses TRIZ Principles framework as a guide to generate innovative graphic design samples.

The AEGIS tool created is based on TRIZ Principles discussed in Chapter 3 (a subset of them). In AEGIS, the TRIZ Principles are used to create innovative graphic design effects. The literature review on innovative graphic design (in chapter 3) has been analysed for links with TRIZ Principles and then the DNA of AEGIS has been built on the basis of this study. Results from various surveys/questionnaires indicated were used to collect the innovative graphic design samples and then TRIZ was mapped to it (see section 3.2). The TRIZ effects were mapped to the basic graphic design elements and the anatomy of the graphic design letters was studied to analyse the TRIZ effects in the collected samples. This study was used to build the TRIZ based AEGIS tool. Hence, AEGIS tool applies the innovative effects using TRIZ to basic graphic design elements (as described in section 3.3). the working of AEGIS is designed based on Genetic Algorithms coded specifically to implement TRIZ Principles specialized for Graphic Design, chapter 4 discusses the process followed to apply TRIZ Principles to graphic design and coding them using Genetic Algorithms, hence resulting in AEGIS tool.

Similarly, in Design for Wow, the content uploaded has been analysed for its link with TRIZ Principles (see section 3.1 for TRIZ Principles). The tool created in Design for Wow is based on the framework of analysing the TRIZ links in the uploaded content. The 'Wow' concept discussed in the section 5.1 and 5.2 is the basis of the concept of Design for Wow website, whereby the users upload

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the content they classify as 'Wow'. This content then is further analysed for the 'Wow factor' and then mapped to TRIZ Principles as TRIZ tagging methodology is framed (section 5.5).

From the results of the research, it appears that the TRIZ Principles are a comprehensive set of innovation basic building blocks. Some surveys suggest that amongst other tools, TRIZ Principles were the first choice and used most. They have thus the potential of being used in other innovation domains, to help in their analysis, understanding and potential development.

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Terms and Abbreviations

AD Axiomatic Design

ARIZ Algorithm for Inventive Problem Solving

CAD Computer Aided Design

CAI Computer Aided Innovation

CPS Creative Problem Solving

FA Function Analysis

FAA Function and Attribute Analysis

SDLC Software Development Life Cycle

TRIZ Theory of Inventive Problem Solving

Dedication

This thesis is dedicated to the memory and honour of my sister **Late Dr. Saba Shahdad**, who bravely fought cancer for a long time and always made me proud with her values and left an inspiration to millions of cancer patients worldwide to fight cancer bravely and proudly till the last breath. I miss her every day; she always supported me to make it possible, and always stood by me for anything I needed. She inspired me to step in to research and it was her dream to see me gaining this qualification.

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I also acknowledge the support I had from my parents, family and friends during all these years.

Declaration

At no time during the registration for the degree of Doctor of Philosophy has the author been registered for any other University award without prior agreement of the Graduate Committee. This study was financed with the aid of a studentship from the Great Western Research and Systematic Innovation Ltd, UK.

Relevant scientific seminars and conferences were regularly attended at which work was often presented; external institutions/ people were visited for consultation purposes and several papers prepared for publication.

Publications (or presentation of other forms of creative and performing work):

AEGIS- Software 7 Versions

DesignforWow.com website

- 1) Mann, D., Shahdad, A., Filmore, P., Dekoninck, E. (2009) From Computer-Aided Invention To Computer-Aided Innovation, Proceedings of TRIZCON2009, Conoga Park, California, USA, 16-18th March 2009.
 - 2) Shahdad, A., Filmore, P., Mann, D., Dekoninck, E. (2009) Automating the Innovation Process using Computer-Aided Innovation, Proceedings of the 2nd ISPIM Innovation Symposium: Stimulating Recovery – The Role of Innovation Management, Huizingh, Torkkeli, Conn, Bitran (Eds.), New York City USA, 6-9th Dec 2009, ISBN 978-952-214-864-3 (2009).
 - 3) Filmore, P., Mann, D., Shahdad, A. (2010) Computer-Aided (Systematic) Innovation – new tools and new ways of thinking, Proceedings of the Sixth TRIZ Symposium in Japan 2010, 9-11 September 2010, Kanagawa Institute of Technology, Atsugi, Kanagawa, Japan.
 - 4) Shahdad, A. (2009) From Computer Aided Invention to Computer Aided Innovation, Proceedings of UK TRIZ Symposium 1, 14/5/09, Clevedon, UK, ISBN 978-1-906769-12-13.
 - 5) Shahdad, A. (2010) AEGIS- Intelligent Mutation Design Support Software Capability Development, Proceedings of UK TRIZ Symposium 2, 13/5/10, Clevedon, UK, ISBN 978-1-906769-23-9.
 - 6) Shahdad, A. (2011) Design for Wow- Analysis of TRIZ Principles in Wow, Proceedings of UK TRIZ Forum #3, Clevedon, Nr. Bristol, 12th May 2011, ISBN 978-1-906769-16-1.
- POSTER PRESENTATION
- 7) Shahdad, A (2011) Design for Wow and AEGIS , PC CAT 2011, Exeter, 26 May 2011.
 - 8) Shahdad, A., Filmore, P. (2014) Applying TRIZ to Graphic Design using Genetic Algorithms. International Journal of Systematic Innovation.

Presentation and Conferences Attended:

Proceedings of UK TRIZ Symposium 1, 2009, Clevedon, UK
 Proceedings of UK TRIZ Symposium 2, 2010, Clevedon, UK
 Proceedings of UK TRIZ Forum #3, Clevedon, Nr. Bristol, 2011
 Proceedings of UK TRIZ Forum #4, Clevedon, Nr. Bristol, 2012
 Environmental YES Oxford UK
 PC CAT 2011, Exeter.
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External Contacts:

Dr Elies Dekoninck- University of Bath. Darell Mann, Systematic Innovation Ltd.
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Chapter 1: Introduction

1.1 Overview

This thesis describes the approach and results of the research to create a TRIZ based computer aided innovation tool. This research has mainly been based around two tools: called AEGIS (Accelerated Evolutionary Graphics Interface System), and Design for Wow. Both of these tools are discussed in this thesis in detail, along with the test data, design methodology, test cases, and research.

TRIZ was developed in former USSR by Genrich` Altshuller. It is an innovation methodology and is currently being used throughout the world. This research is mainly based on TRIZ Principles and TRIZ trends. Recently, TRIZ, a Russian acronym that means 'Theory of Inventive Problem Solving', developed by Genrich Altshuller, has been recognized as a widely popular subject concerning innovation in the technological field (Su et al., 2008)

Design for Wow (<http://designforwow.com>) is an attempt to summarize the successful inventions/ designs from all over the world on a web portal which has multiple capabilities. These designs/innovations are then linked to the TRIZ Principles in order to determine whether innovative aspects of these successful innovations are fully covered by the forty TRIZ principles. AEGIS (Accelerated Evolutionary Graphics Interface System) is a software tool aimed to help the graphic designers to make innovative graphic designs. Again it uses the forty TRIZ Principles as a set of guiding rules in the software.

From the literature review and TRIZ history, it appears that the TRIZ Principles are a comprehensive set of innovation basic building blocks. This is concluded from the study of TRIZ applications and TRIZ guidelines. The first tool in the algorithm for TRIZ listed by various TRIZ experts for problem solving (after the problem definition phase) is the Contradictions/ Matrix and Principles (Mann, 2007a). Altshuller realized that a problem requires an inventive solution if there is an unresolved contradiction in the sense that improving one parameter impacts negatively on another. He later called these "technical contradictions" (Altshuller, 1984). Altshuller suggested that these contradictions can be solved using the TRIZ matrix which he devised. The contradiction matrix consists of 39 rows and 39 columns. This matrix is used to identify that which TRIZ Principles can be useful in solving the particular problem by considering the contradiction in the problem (Moehrle, 2005). TRIZ Principles is the result of study of Altshuller, in which he analysed thousands of patents and concluded that a large number of patents were based on a small number of principles, which he defined as TRIZ 40 Principles and generalized them (Moehrle, 2005). They have thus the potential of being used in other innovation domains, to help in their analysis, understanding and potential development.

There are two ways to use the TRIZ Principles to solve a problem. One is to identify the problem then map the contradictions in that problem to the matrix. After that the matrix is used to point out the relevant TRIZ Principles helpful in generating the hints to the solution. This is a

concentrated approach in which the matrix helps to shortlist the useful principles for a particular problem. Using this approach, the researcher has to be careful and should have substantial knowledge of analysing the problem and mapping the contradiction parameters to the matrix rows and columns, this can go wrong sometimes and not lead to an ideal solution as sometimes the mapping can be ambiguous and needs thorough analysis and expertise of using matrix. Another method of using the TRIZ Principles is not to use the matrix. In this approach, the TRIZ Principles are brainstormed in context of the solution to the problem and the solution hints triggered by the principles are developed further to take it to a complete solution. The disadvantage to this solution approach is that it is a random approach and can involve lot of efforts to go through all the TRIZ Principles but it does not require matrix knowledge and often does not need the contradictions to be analysed in a problem. In some cases, this approach may not lead to the ideal solution of problem due to lack of concentration on specific relevant TRIZ Principles.

This research has been conducted at the University of Plymouth, as a PhD research project. The research has been jointly sponsored and funded by Systematic Innovation Ltd, United Kingdom and Great Western Research, United Kingdom. The tools and research are expected to benefit South-West United Kingdom businesses and other beneficiaries.

1.1.1 Research Contribution

Primarily, this thesis contributes a conceptual framework (especially using Genetic Algorithms structure) to automate (to some extent) the process of Graphic Design innovation. Some portion of this conceptual framework has been implemented as a software tool which contributes to the repository of Computer Aided Innovation modern day tools.

This thesis and research adds a very valuable milestone achievement to the TRIZ by adding a TRIZ guided computer based tool which helps automate innovation to some extent. This is mainly important because previous research has contributed mainly to the methodologies and tools like the toolset which assist researchers to implement TRIZ (Mann, 2006), improving use of TRIZ (Tsai, 2008) and creative interaction (Coughlan, 2009), etc. Further to this, few research groups have taken advanced steps in by creating automated environments whereby the computers push the designers to reach the boundary of creativity by helping them overcome design fixation when optimizing. One such example employs Genetic Algorithms, Evolutionary design, CAD/ CAE tools and TRIZ to construct a strategy for developing a crankshaft of engines based on a framework of computer aided innovation (Albers et al., 2009). However, at the start of this research, there existed no such tool which employed Genetic Algorithms and TRIZ to develop a Computer Aided Innovation tool which helped graphic designers innovate. Hence, this research takes a step further to add a toolset which

(to certain extent) automates the process of innovation without compelling the user to understand the TRIZ methodologies behind it in detail (this tool is for graphic design). This tool is called as AEGIS.

The knowledge which is added to this research related area via the AEGIS research is that general TRIZ Principles are applied to basic Graphic Design forms/ elements to formulate a Graphic Design version of TRIZ Principles. This can be useful for various user groups including researchers, students and graphic designers. This forms the basis of future work for Computer Aided Innovation tool developers in the domain of Graphic Design.

Furthermore, the thesis contributes to further verifying the original hypothesis of about TRIZ 40 Principles (although to a limited number of innovative content) claiming that TRIZ 40 Principles answers the logic behind all the innovations globally (Al' tshuller, 1984). This is achieved by publishing the website <http://designforwow.com> and allowing users to upload what they categorize as 'wow' and then allowing the research team to analyse where TRIZ exists in the 'wow' content. Some research groups have classified the patents automatically with respect to TRIZ Principles (Loh et al., 2006). These researchers have hence laid down a framework for future researchers to start working on an open database for TRIZ classified patents. Few other research groups have tried to relate properties and functions from patents to TRIZ Trends (Verhaegen et al., 2009). However, a concept to test the sufficiency of TRIZ Principles was lacking (the claim that Alshuller made that any problem can be solved using the TRIZ 40 Principles set). This research lays the framework/ methodology of classification of anything which a user thinks is innovative to TRIZ Principles. The future researchers can enhance the database and other aspects of the data and methodology to create a huge mapped database of TRIZ Principles and hence as more and more data is added to this database tool, the veracity of TRIZ 40 Principles will be tested again and again. Hence, TRIZ 40 Principles will be updated with latest designs and innovations and the need for 41st TRIZ Principle can be tested from time to time. This database tool is also a primary framework for future TRIZ users and researchers in the form of a method of analysing the presence of TRIZ Principles in the innovative content/ or design.

The contribution of work described in this thesis has been recognized through the peer-reviewed publications of it in many leading and high standard conferences globally. Please refer to Appendix-XIII for a partial list and content of some of the papers published under this research. One paper is also being submitted to International Journal of Systematic Innovation.

1.1.2 Thesis Outline

This thesis reports the development, background and previous work and findings from these research projects. Chapter 1 further discusses the research questions and objectives of the research which are primarily based on the questions raised on TRIZ innovation methodologies and its framework. Chapter 2 is the literature review where the background reading and previous work has been discussed for this project. It must be noted that due to the unique nature of this research project (as this research project consists of two sub-projects -AEGIS and 'design4wow'), some portion of literature has been placed in the respective chapters related to these two sub-projects specifically. Chapter 2 primarily discusses the TRIZ, systematic innovation process, TRIZ 40 Principles, contradiction (and its types) and other TRIZ tools (just on outline). Chapter 2 also discusses few of the current applications of TRIZ by other researchers. Chapter 2 further discusses the previous published graphic design methods, which are useful in understanding the users of the AEGIS tool and the already existing methodologies in graphic design. Chapter 2 takes the background chapter to the next level by discussing the Genetic Algorithms (GA's), followed by the background and history of Computer Aided Innovation (CAI).

In chapter 3, the application of TRIZ to graphic design is discussed. An investigation report is presented in this chapter discussing where innovation science (TRIZ) can be applied. Different innovative graphic design samples from various sources are discussed in detail in this chapter which is followed by analysing the presence of TRIZ in these pieces of design. This is followed by translating general TRIZ Principles to graphic design specific TRIZ Principles which is also aided by the analysis of questionnaire with designers results presented in this section. The chapter is concluded with defining the 'TRIZ Graphic Design Forms'.

Chapter 4 discusses the design and development of AEGIS versions 1 through 7.1 along with the samples tested, and feedback. After this section, TRIZ application to graphic design is presented in context of implementing this as a GA based software tool. Software requirements are discussed which were part of original research, it may be noted that this version of software requirement is more detailed and advanced than its previous version presented in transfer report in April 2010. Previous questionnaires included from report(Shahdad, 2010) have been presented for a brief review of the original research in this chapter followed by technical structure of Genetic Algorithms (TRIZ based). This is followed by discussing the AEGIS latest version (7.1) (classes, components, modules and forms along with its user guide). Few of the usage sessions with designers, IT professionals, artists and fashion industry people have been presented with a thorough discussion along with some important conclusions.

The background literature for 'Design for Wow' is discussed in chapter 5. In chapter 5, the design and development of 'Design of Wow' along with the technology used, are discussed. Different sections and features are illustrated in chapter 5. Chapter 5 also includes the discussion on development of 'Design for Wow' from a TRIZ tools perspective. TRIZ tagging methodology has been discussed in this chapter along with the points gaining analysis for TRIZ Principles. The analysis of data is presented in the last section with some important conclusions.

Future work and conclusions are summarized in chapter 6. The present conclusions have been drawn in chapter 6 for AEGIS and Design for Wow. Future work for Design for Wow and AEGIS has also been summarized in chapter 6.

Subsequent chapters list the references used in this thesis and appendices which inscribes the code samples used in Mathematica, c#.NET and layering c#.net code which was written to develop different versions of AEGIS. The appendix also includes the papers published and conferences attended, pertinent to this research.

1.2 Problem Statement

This section discusses the foundation of thesis by highlighting few of the important questions raised by TRIZ experts and other researchers.

1.2.1 Research Questions

Many questions have been formulated to be answered by this research. Some of the general questions are: Is it possible to automated innovation using TRIZ up to 100%? If not, then how much? Can the DNA of Innovation be captured (using TRIZ)? What percentage and how effectively?

Some specific research questions are: Can TRIZ Principles be implemented through CAI tools (automated) in case of graphic design/ (packaging design)? Specifically, can a tool be developed to help graphic designers innovate? Can TRIZ Principles be used to guide this tool and help in step-changes? If yes then how much and at which stage and can this process be automated?

AEGIS project is also aimed to find out that what will be the impact of CAI implementation on the speed/quality of packaging graphic designs as compared to the designs by graphic designers using existing tools?

1.2.2 Research Objectives

The first objective of this research while developing the AEGIS toolkit is to attempt the manufacture, design and testing of a software toolkit which helps automate the process of innovative design generation to a certain extent. The objective of AEGIS is also to assist the graphic designers while generating innovative packaging designs. The testing of AEGIS on sample data is an important aspect of AEGIS project, as it helped the research team to address many research questions.

The research questions asked in previous section need to be answered through the testing of AEGIS on data and collecting regular feedback from graphic designers. NB: The possibility of combining the AEGIS with existing tools to enhance the initial innovative idea generation is also not being ruled out in this research.

The objective of the Design for Wow project is to collect content on the site. The definition of content in this context is any “innovative design/good or bad innovation”. After the content has been uploaded by users of the site, the research team’s task is to link the

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contents to TRIZ Principles (if any links exist within each particular upload). TRIZ is being used across many industries and this research project aims to find the innovative capability of TRIZ in the content uploaded by users on the site.

1.3 Research Methodology

This thesis describes the research based around two sub-projects called 'AEGIS' and 'Design for Wow'. Both are CAI domain projects. Being software/web technology based projects, the development phases are designed according to SDLC (software development life cycle)(Glynn, 2012). Each tool development follows a series of steps as defined in SDLC standards. Steps include project planning, requirements, definition, design, development, integration & test installation & acceptance. Both the tools follow an iterative model of development where the tools have been progressively improvised in terms of functionality and interface after a series of feedback from research team and group users.

After reviewing the related literature and previous work for AEGIS and the previous versions of AEGIS(Shahdad and Filmore, 2013), the subsequent software design specification has been formulated. The criterion intended users, feedback providers, and questionnaire audience has also been formulated. The end user of software is intended to design graphic for different purposes (general purpose label design). The end user can be from varied industrial backgrounds example an IT engineer, a designer, an artist, a fashion analyst and so, on. The software specifications are mentioned in detail in chapter 4 of this thesis. The specifications were formulated after meeting with Systematic Innovation Ltd expert(Mann, 2010), who is the consultant for an end user group. After the initial specifications were formulated, the languages for development were shortlisted. The specifications were further filtered and upgraded from time to time after consulting graphic design experts (for graphic design and typography communication)(Jones, 2012).

The final language in which the advanced versions of AEGIS have been developed is C#(2010b) which; this was decided only after investigation/ creating of sample outputs and coding in shortlisted languages which included iteratively going through the design up gradation process and developing several versions of AEGIS. The technology language sets used to code AEGIS include Mathematica (1988), C#(2010a) and AForge (AForge, 2008).

The latest version of AEGIS has been developed employing the concept of Genetic Algorithms. This was mainly done after checking the drawbacks of previous versions. Few of the problems which were encountered during feedback and test stage were that the users were not given moderate transformation choices of their selections, as the selected image itself became the parent for next generation; hence the transformations and effects were too fast and inconvenient for the users to select from. The employment of Genetic Algorithms systematically handles these issues in the latest version.

There were many options available to evaluate both the outcomes of the software during generations of each population of images in the software and the collective outcomes of various sessions. As a general convention, the option to evaluate the populations in run phase of GA enabled software is the 'survival of fittest'. But since here the fitness criterion was more of a human problem rather a machine recognition criteria, hence rather than allowing the computer to choose the fittest, the user is allowed to choose the fittest members in a population. This is the best option at the moment, because there is no database available which relates graphic design images with the Genetic Algorithms using TRIZ Principles. Hence, it is necessary to follow the option of allowing this database to develop first using the user interactions and preferences. This is further strengthened by the sub module of the AEGIS software which stores the usage of AEGIS (fittest members of each population) in form of GA data and then presents that to the new users by applying those parameters to the problem in question, this further helps the database to develop intelligently.

Many versions of AEGIS have been planned and developed, each version has been analysed against the research questions and demonstrated to a group of graphic designers and research team and critically evaluated and further improvements were done. Samples have been processed through the software and demonstrated in front of feedback teams and research team to decide further on the developmental and research issues. The final version as expected demonstrates the capabilities as well as the weaknesses of CAI as an automated TRIZ tool to address the questions of this research.

The feedback process is aided in this research by questionnaires. The questionnaires participant sizes have varied from 6 people in a group to 100 people in a group. Questionnaires conducted in this research are mostly qualitative in nature, however many questions being quantitative in nature to help identify the general trend, and extrapolate the graph information to identify the strong and weak areas of this research and the software. Finally the end users, testers, researchers and programmers have tested the system and supplied their invaluable feedback. This has helped the researcher to critically evaluate the software and the research questions to be answered.

To summarize the four stages of the methodology employed for AEGIS research(Informatics, 2012):

1. Observation: The response of designers and end users is observed.
2. Hypothesis: It is assumed that the TRIZ Principles can be employed within a computer aided innovation tool to help graphic designers innovate and a certain portion of that process can be automated.
3. Testing: The AEGIS samples are tested with the end users and researchers.

4. Prediction: It is predicted that the outputs are useful to the end users.

The 'Design for Wow' concept was initially and subsequently discussed with the research team and the research questions formulated and discussed in section 1.2.2 of this document. The languages and technology chosen were under GPL/GNU license(Wang, 2012). The portal was first conceptualized under TRIZ. The methodology followed in the development of portal strictly follows SDLC methodology(Glynn, 2012). After conceptualizing the problem in TRIZ, a web 2.0 presence (Shang et al., 2011) was justified under this research for study, research and user interaction including answering some research questions.

After the development of portal, the second step in methodology identified was to allow the users to submit the content and perform various other operations on the portal. Once again, this project follows an iteration model of software development in which the web portal developed is further improved in terms of functionality after data collection and submission and after user feedback iteratively.

The research panel review is also a part of the methodology of this research in which the team links the content of portal to TRIZ principles. At the end of this research on design for Wow, the researcher further establishes the potential of TRIZ in the content submitted.

The rating of content determines the 'wow' effect the user decides the content has. As this research is about uploading what the users think is 'wow' and the user/ reviewer is allowed to decide how much of 'wow' is in the content. At the same time, the comments of the reviewer are also noted as this allows the research team to analyse in what context the rating was given. Number of views of content determine how appealing the design or the work is, and may in some sense point to the creativity of the content. While as the TRIZ content tagging by reviewer/ researcher is related to the strength of TRIZ Principles in the content. This review database is further strengthened in the knowledge by adding the information as to what parameters/ parts/ components/ aspects of the design in question are linked to the TRIZ Principles (the comments by upload users and other users are considered at this stage).

The TRIZ principles linked to the content have been compared to each other in terms of innovative capability as well.

To summarize the four stages of the methodology employed for Design for Wow research(Informatics, 2012):

1. Observation: The response of reviewers and website users is observed.
2. Hypothesis: It is assumed that all the content on the site are fully covered by the forty TRIZ Principles.

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3. Testing: The testing portion mainly translates to the TRIZ reviews tagged by review team in case of this project.
4. Prediction: It is predicted that TRIZ will be found in all content but the strength of linking of TRIZ Principles to content may vary.

Chapter 2: Background

2.1 Innovation

2.1.1 Innovation. Invention and Improvement

Many different authors and researchers have published slightly different versions the definition of innovation. Innovation is derived from the Latin verb *innovare or innovus*; “in to new”. People discussing innovation in business mingle three concepts usually- innovation, improvement and invention. In its simplest form, innovation means doing something different. Improvement on the other hand, is doing something better, while invention is the act of creating an idea of a method (Costello and Prohaska, 2013).

2.1.2 Graphic Design Innovation

Graphic Design is the act of detecting a functional need and completing it with a work of art. Well known graphic design experts design the modern graphic design it as a halfway between art and technology. In carrying out this act, design combined its own techniques (today’s technologies) with good taste and sense of art and creativity, and is always geared towards transmitting an idea. Therefore, the design can never be an end or an objective itself (Nielson and Trias, 2000). Although, Graphic Design industry has advanced from using first scribes to modern computer systems, but keeping in view the above definitions of graphic design it is difficult to exactly decide what is innovative and what is not in this field, it may always needs a human touch to decide what is innovative. Hence, in this project, although a sophisticated CAI tool has been developed and innovation is automated to certain extent, but the fitness criterion is still kept dependent on the users instincts. A graphic design innovation roughly defined is the piece of design which is different from the existing work, but at the same time fulfils the objectives of the design requirements. Many designers will argue with this statement, as every graphic design has to be different and appealing. But, the statement that innovation in graphic design means a design which is different has to be put with some conditions: it should not be an improvement of an existing design and should not be a new style/ invention (things like font are considered in this definition).

These aspects have been taken care of while designing AEGIS software. For example, while defining and framing the chromosomes, no new font is invented, but fonts are transformed to something different. Additionally, a chromosome cannot be an improvement of ambiguous technical improvements of itself or other chromosomes because each chromosome is uniquely formulated which sums up only innovative designs not the technical improvements of same innovative designs.

Graphic design innovation is difficult to be measured mathematically; hence this research utilizes qualitative research methods to determine innovation in graphic design. The subsequent chapters enlist the steps taken to highlight the graphic design innovation. For example the designers were involved to identify the innovative design, graphic design awards for innovation determine innovative design basic effects, consumers were questioned what they thought is innovative.

2.1.3 Systematic Innovation

As opposed to the belief of some people that innovation can be random or it needs a random brainstorming session to reach an innovative goal, the theory of systematic innovation states that innovation is a science and innovation can be achieved using predefined steps which need to be followed (Mann, 2007a, Al' tshuller, 1984, Su et al., 2008). This thesis is based on this foundation and hypothesis. The first two sections of this chapter are the literature review of systematic innovation and innovative design process and adopted and put forward by many researchers, especially using TRIZ. Figure 1 below shows how systematic process philosophy works (Mann, 2007a).

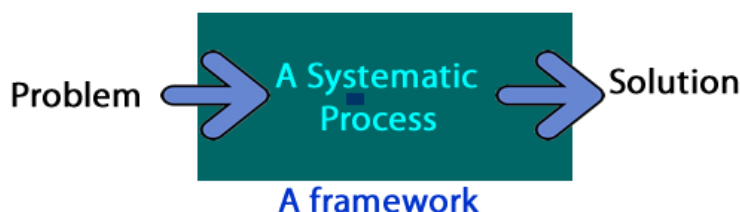


Figure 1: Systematic Innovation Process.

The framework mentioned in Figure 1 either means a methodology like TRIZ (Ilevbare et al., 2013) or a combination of tools. During the initial phases of this research, a comprehensive study of the various traditional tools and currently used tools, having a very good potential for problem solving across a wide range of domains was conducted. These tools had either been developed using traditions and customs of societies or had been invented by renowned scholars. The Systematic Innovation Ltd already has a database of these tools which were further extended to the level of atoms of molecules under this research. After a detailed study, the tools were classified under four categories of atoms. The figures below show the basic idea.

An attempt of this study was a higher level molecular model that allows us to custom-build 'innovation molecules' that allow companies to build their own innovation processes. Step one was to make sure all the known 'death by a million' tools content is on the D4W website. Step two was to

identify for each entry which of the four basic problem solving activities that tool/method is designed to achieve – see figure 2 and 3.

Figure 2 shows the categorization of atoms in to four basic categories. Problem definition atoms can be of two types, divergent and convergent. Divergent problems define ‘situations’, which cover broad range of problems related to a particular problem. Convergent problem definition defines/ filters the problem closer to the real factor causing the problem. Divergent solution space is a wide range of possible solutions for a particular problem, while as the convergent solutions are specific solutions for problems.

Figure 3 shows the constructive building of innovation molecules from problem solving atoms. Atoms are joined to make diatoms. Diatoms either constitutes of a problem solving pair of atoms (divergent problem solving and convergent problem solving) or a solution generation pair of atoms (divergent solution generation and convergent solution generation). Each problem definition diatom is followed by a corresponding solution generation diatom. The diatoms are joined to constitute molecules. Each molecule consists of two diatoms. Molecules are joined to form polymer. This methodology will allow the businesses to define their customized innovation solution ‘polymer’.

The initial idea was generated by Systematic Innovation Ltd and the researcher after considering the already existing tools list in Systematic Innovation Ltd and conducting a study of tools. The tools have been discussed in detail and available on design for wow site for reference at <http://www.designforwow.com/dbmt/> (Shahdad, 2010).

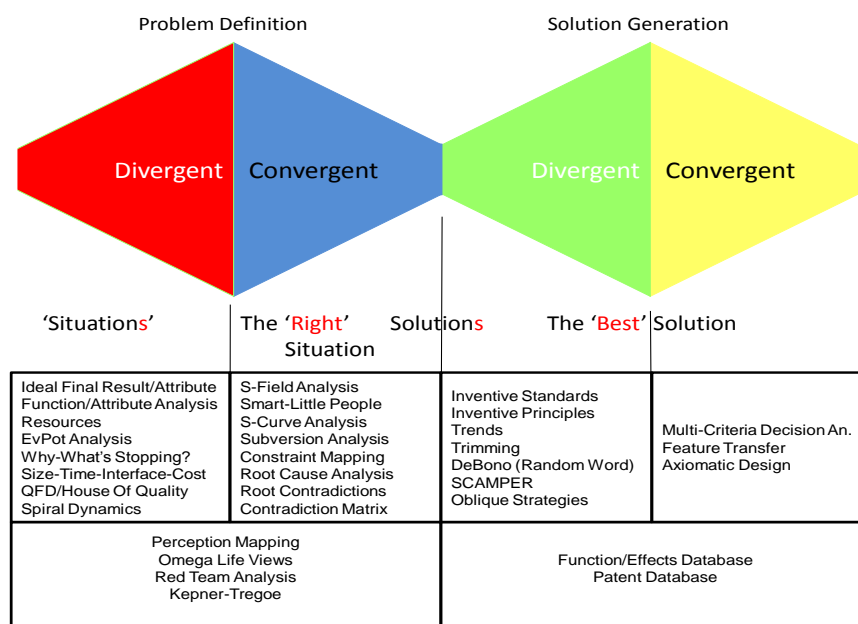


Figure 2: Shows the division of the tools in to four basic categories (building blocks/atoms for molecules of solutions) (Mann 2014).

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Appendix-IX shows the model, the concept of which was laid down by Darrell Mann and then further research was carried out by analysing the tools and categorising them as per this model (the categorization field has been added as seen in Appendix-IX). The tools mentioned in figure 2 are not the result of this research but this image has been taken from the original concept laid by Darrell Mann.

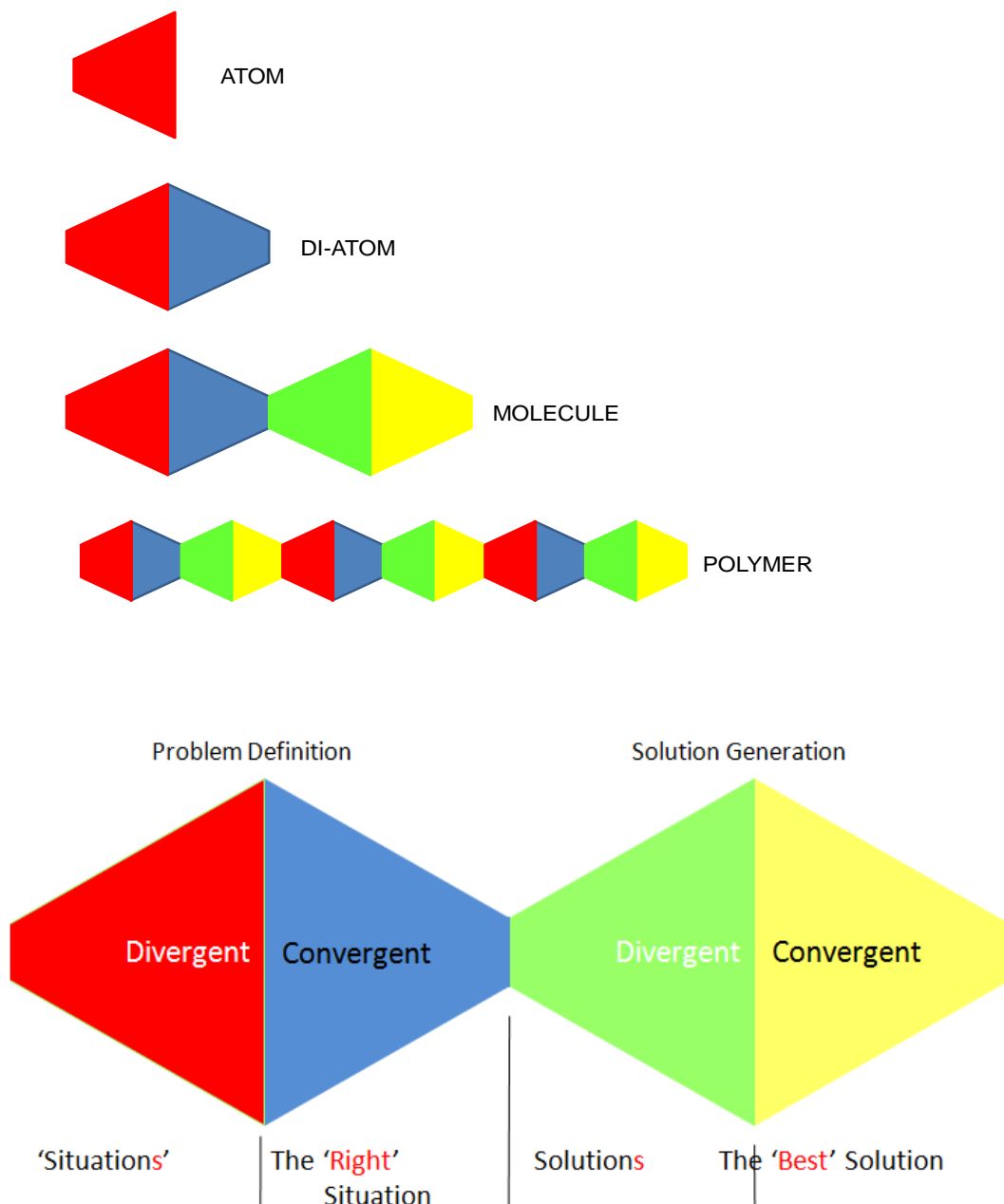


Figure 3: Shows the method by which the atoms are joined to make a solution(Mann, 2007a).

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Although this study was conducted in the initial phases of this research and all of these tools are applicable to figure1, but this research at this stage concentrates on TRIZ Principles and Physical Contradictions(Mann, 2007a, Mann, 2007b).

2.1.4 Incremental Vs Step Changes

While solving a problem or advancing to improve a system, there are two types of changes; step change and incremental change. Step change means a bigger change and a considerable jump on S-Curve(Chen et al., 2012) plot of innovation steps. While as incremental change can just mean one more step to optimising the current system and not a considerable jump on an S-Curve. Figure 4 shows the difference between step and incremental changes. The step change contributes to the innovation while as the incremental changes contribute to the improvement of an existing innovation.

The S curve depicts the life (introduction, growth and maturation) of an innovation or a new concept/ product. During its infancy, large investment and effort are expended on the new technology/ innovation but performance observed in minimal. However as the new technology id developed to a higher potential (as knowledge accumulates), progress becomes more rapid. As soon as major technical obstacles are overcome and the innovation reaches a certain adoption level an exponential growth takes place. During this phase relatively small increments of effort and resources result in large performance gains. Finally, as the technology starts to approach its physical limit, further pushing the performance becomes increasingly difficult, as the figure below shows.

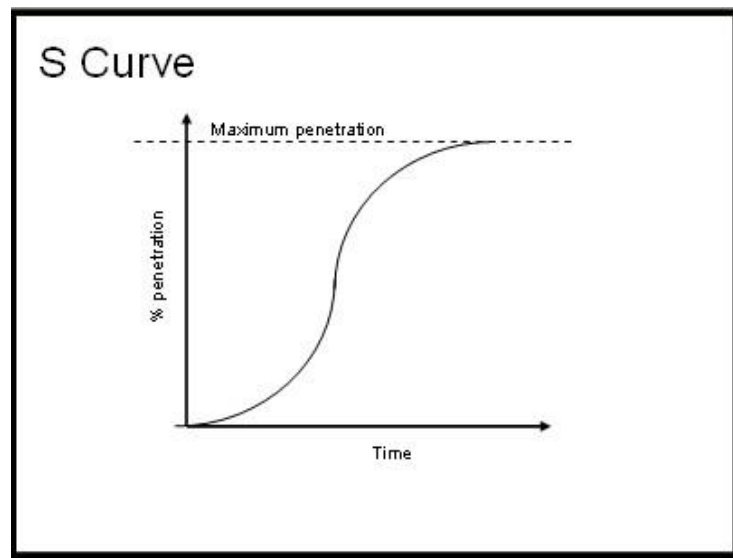


Figure 4: S-Curve.

Researchers have succeeded in taking step changes using TRIZ (Mishra, 2003, Filmore et al., 2010).

2.2 Common TRIZ Tools

TRIZ (/ˈtriːz/; Russian: теория решения изобретательских задач, *teoriya resheniya izobretatelskikh zadatch*) is a problem-solving, analysis and forecasting tool derived from the study of patterns of invention in the global patent literature. It was developed by the Soviet inventor and science fiction author Genrich Altshuller and his colleagues, beginning in 1946. Its English short name is TIPS (Theory of Inventive Problem Solving) (Mann, 2007a, Mann 2007b). One of the main findings of Altshuller's research is that problems and solutions are repeated across industries and sciences, the second that patterns of technical evolution are repeated across industries. The classic TRIZ was developed by Altshuller and his associates. He started TRIZ in 1946 while working as a patents inspector. During this research, he came across what he called as "technical contradictions" at a later stage. He suggested that these contradictions exist in a problem if improving one parameter impacts negatively on another. He suggested that these problems require an inventive solution.

TRIZ is a set of Methodologies, tools and frameworks which originated in Former USSR. It is a set of problem solving tools and methodologies and innovation framework. TRIZ means "The theory of solving inventor's problems" and is also called as "The theory of inventor's problem solving". Developed by a Soviet patent investigator and researcher Genrich Altshuller and his colleagues starting in 1946, TRIZ has been evolving ever since (Altshuller, 1984). By the early 1970s two decades of research covering hundreds of thousands of patents had confirmed Altshuller's initial insight about the patterns of inventive solutions and one of the first analytical tools was published in the form of 40 inventive principles, which could account for virtually all of those patents that presented truly inventive solutions.

TRIZ provides tools and methods for use in problem formulation, system analysis, failure analysis, and patterns of system. TRIZ, in contrast to techniques such as brainstorming (which is based on random idea generation), aims to create an algorithmic approach to the invention of new systems, and the refinement of old systems (Altshuller, 1984). Some TRIZ is in the public domain. Some TRIZ resides in knowledge bases held by commercial consulting organizations. A complete and open TRIZ development process is not yet evident. Various camps vie for control of TRIZ and interpretation of its findings and applications.

TRIZ presents a systematic approach for analysing the kind of challenging problems where inventiveness is needed and provides a range of strategies and tools for finding inventive solutions. One of the earliest findings of the massive research on which the theory is based is that the vast majority of problems that require inventive solutions typically reflect a need to overcome a dilemma or a trade-off between two contradictory elements. The central purpose of TRIZ-based analysis is to

systematically apply the strategies and tools to find superior solutions that overcome the need for a compromise or trade-off between the two elements.

This research is based mainly on three TRIZ tools (besides many other additional tools) (Ilevbare et al., 2013)

- TRIZ Principles
- TRIZ Contradictions (Physical)

Previous research (Dvorak, 2001) shows that application of TRIZ to problem solving not only makes possible solutions to problems which were previously considered non-solvable, but yields results far more quickly compared to other techniques. One of the most powerful methodologies of TRIZ is the use of contradiction. Contradiction enables the problem-solver to solve the root cause of problems in many industries.

The TRIZ method was invented by Russian patent analyst Genrich Altshuller after studying patterns and lessons he saw in the inventions on file in thousands of patents. He saw that the same fundamental problem had been addressed by similar inventions in a number of diverse technological areas/ industries(Al' tshuller, 1984). The effort led him to identify 40 Inventive Principles and around 40 (evolutionary) Trends. Three of the more frequently used Principles are called Segmentation, Inversion and Prior Action (Mann 2007). The researcher here agrees to the popularity of Segmentation Principle of TRIZ, this is depicted in the results of Design for Wow and also during AEGIS questionnaire sessions, it was noted that the graphic designers adopted themselves quickly in using this principle, partly because its application and clarity in understanding was easier than some other principles. As far as the Inversion and Prior Action principles are concerned, this research does not directly agree with the above statements of Darrell Mann. There can be many reasons for that. One is that Darrell Mann's researchers have scanned millions of patents till date, while as D4W website has content in hundreds of uploads only. Moreover, Darrell Mann's team considers only patents databases, while as the D4W laid down the application of a new concept called as 'W0w' which contains more than what patents mean. Similarly, in AEGIS the subject is specific (graphic Design) but on the other hand, Darrell Mann's research is multidisciplinary.

In 1984, Altshuller described "creativity as an exact science" (Altschuller 1984). He meant by this that innovation can be achieved systematically and not as many think via a random process. He went on further to reclassify trade-offs as contradictions. Figure 5 shows the structure of basic TRIZ solution approach to problem using few of the TRIZ methodologies and tools. As figure 5 depicts, the specific problem is abstracted to match the contradiction parameters of the TRIZ matrix, the matrix then acts as a guide to shortlist few TRIZ Principles to be used as a hint to the solution. This leads to typical/ generalized hints to the solution which is then concretized back to the context of problem to produce specific solution to the problem. The final solution has contradictions

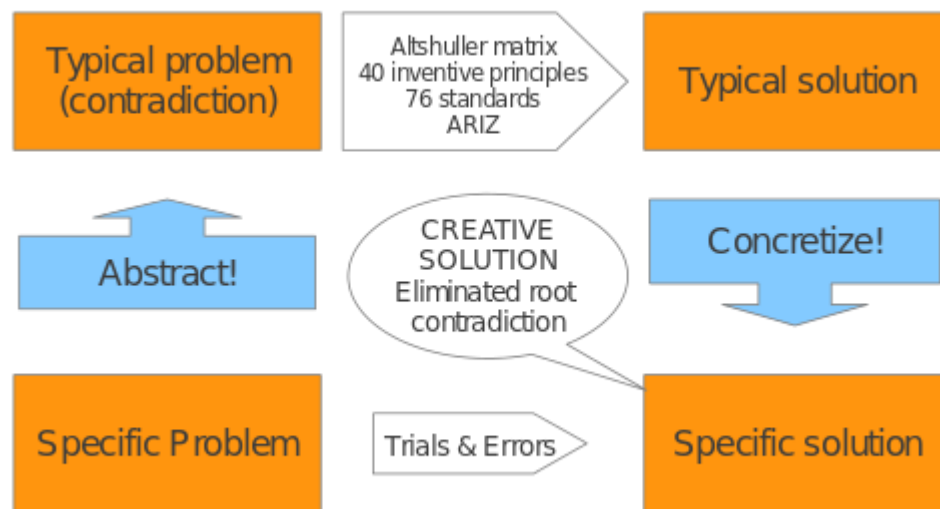


Figure 5: TRIZ process for creative problem solving (Andriu, 2014) (Copied under GNU License).

TRIZ has been widely recognized as highly relevant to innovation in the technological field (Su et al., 2008). The strength of TRIZ as a method for developing creative solutions to problems lies on its removal of contradictions rather than on the use of the conventional approach by means of compromises or trade-offs (Su et al., 2008).

2.2.1 The TRIZ Forty Inventive Principles

Altshuller, the inventor of the TRIZ method, analysed thousands of global patents across industries. He classified the patents according to patterns rather than industries. Eventually, he found that there were specific patterns of solutions applied in these patents, which he later generalized into TRIZ 40 Principles. (Su et al., 2008). The TRIZ forty Principles are discussed in detail in Appendix-I (Hipple et al., 2011).

2.2.2 Contradictions and Matrix

One of the main building blocks to analyse a problem is called as 'TRIZ Contradiction' (Loh et al., 2006, Su et al., 2008, Yanhong et al., 2009). Contradictions indicate conflict of desired features in a system (Ilevbare et al., 2013). Resolving the contradiction in a problem leads to an innovative solution (which is done by implementing TRIZ 40 Principles).

2.2.2.1 Technical Contradictions

The technical contradiction arises when the problem solver attempts to improve certain attribute or parameter of the problem and this in turn effects some other attribute of the problem/system under consideration(Ilevbare et al., 2013). For example, while trying to hire more staff to improve the customer service standards of a bank, the bank net profits goes down due to increased salary bills. Hence, improvement in customer service can lead to negative effect on the financial position of the bank.

2.2.2.2 Physical Contradictions

The physical (or self) contradiction arises when in an attempt to solve a problem; there are two different desirable values of the same parameter or attribute of a system(Ilevbare et al., 2013). Example of a self-contradiction is a bicycle seat, a cyclist wants a narrow bicycle seat so that he/she can paddle easily; while as a cyclist also wants a wide bicycle seat so that he/she can rest/sit on it properly. Hence this is a contradiction in itself as far as the bicycle seat width is concerned.

As far as physical contradictions are concerned, the matrix is not used to reach the principles useful for getting the solution, but another tool is used, this is in the form of a table called as contradiction solution route. Physical contradictions can be separated using four methods: in space, in time, on condition and by transition to an alternate system. There are few questions to ask before the analyst can decide which solution route to follow. The questions are:

1. Where do I want condition A? and where do I want condition A'?
2. When do I want condition A? and when do I want condition A'?
3. I want condition A if? And I want condition A' if?

Where, A' represents the opposite of any attribute A.

After answering these questions, the contradiction solution route is chosen: space, time, condition or transition. After identifying the solution route, the corresponding principle is applied. For example, if the solution route is 'separation in time', then the TRIZ Principles 1,2,3,17,13,14,7,30,4,24 and 26 are brainstormed for the solution (Mann, 2007a, Mann, 2007b).

2.2.2.3 Matrix

The technical contradictions discussed above can be mapped through a tool of TRIZ called as matrix which is a grid comprising of 39 rows by 39 columns. The contradiction parameters defined during the problem definition phase can then be translated to these rows and columns in the matrix. The parameter which we are trying to improve is mapped to the rows of matrix and the

parameter which worsens due to this is mapped to the columns on this matrix (Mann, 2007a, Mann, 2007b). When the particular row and column are traced to the body of matrix to coincide at a cell of the matrix, this cell then identifies the useful TRIZ principles particularly applicable to this problem.

There are two ways to use the TRIZ Principles to solve a problem. One is to identify the problem then map the contradictions in that problem to the matrix. After that the matrix is used to point out the relevant TRIZ Principles helpful in generating the hints to the solution. This is a concentrated approach in which the matrix helps to shortlist the useful principles for a particular problem. Using this approach, the researcher has to be careful and should have substantial knowledge of analysing the problem and mapping the contradiction parameters to the matrix rows and columns, this can go wrong sometimes and not lead to an ideal solution as sometimes the mapping can be ambiguous and needs thorough analysis and expertise of using matrix. Another method of using the TRIZ Principles is not to use the matrix. In this approach, the TRIZ Principles are brainstormed in context of the solution to the problem and the solution hints triggered by the principles are developed further to take it to a complete solution. The disadvantage to this solution approach is that it is a random approach and can involve lot of efforts to go through all the TRIZ Principles but it does not require matrix knowledge and often does not need the contradictions to be analysed in a problem. In some cases, this approach may not lead to the ideal solution of problem due to lack of concentration on specific relevant TRIZ Principles.

An example of how the Matrix parameters look is listed as follows: 1: Weight of moving object, 2: Weight of stationary object, 3: Length of moving object, 4: Length of stationary object, 5: Area of moving object, 6: Area of stationary object, 7: Volume of moving object, 8: Volume of stationary object, 9: Speed of object, 10: Force (Intensity) , 11: Stress or pressure , 12: Shape, 13: Stability of the object, 14: Strength, 15: Durability of moving object, 16: Durability of non moving object, 17: Temperature, 18: Illumination intensity, 19: Use of energy by moving object, 20: Use of energy by stationary object, 21: Power, 22: Loss of Energy, 23: Loss of substance, 24: Loss of Information, 25: Loss of Time, 26: Quantity of substance, 27: Reliability, 28: Measurement accuracy, 29: Manufacturing precision, 30: Object-affected harmful, 31: Object-generated harmful, 32: Ease of manufacture, 33: Ease of operation, 34: Ease of repair, 35: Adaptability or versatility, 36: Device complexity, 37: Difficulty of detecting, 38: Extent of automation, 39: Productivity.

2.2.3 Other TRIZ Tools

The list of few other commonly used modern day TRIZ tools (systematic innovation) is given below with brief description, these form the part of modern evolved TRIZ (Ilevbare et al., 2013, Mann, 2007a, Mann, 2002, Mann, 2007b, Mann, 2008).

For Problem Definition:

- Standard solutions.

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- System operator (9-windows).
- Problem explorer.
- Function analysis.
- S-Curve analysis.
- Ideal final result (IFR).

For Problem Definition:

- Inventive standards.
- Trends of technological evolution.
- Resources.
- Knowledge/effects.
- ARIZ.
- Trimming.
- Psychological inertia.
- Subversion analysis.

2.2.4 TRIZ Knowledge Base used by TRIZ Community

Today's modern TRIZ is more or less in the form of a Systematic Innovation toolkit. Since these decades, TRIZ has been developed to modern TRIZ which not only depends on Altshuller's basic toolkits (Principles and Matrix, etc), but also includes additional tools. In addition to this, the TRIZ Principles specialized versions have been created for various industrial segments. Few examples of modern TRIZ Knowledge base, developed during the decades of research in developed the TRIZ knowledge further are listed below (please note some of it is be open licensed knowledge base and some is subscription based or consultation based, this report does not discuss about the commercial charges incurred to use this knowledge base).

Although, it is not feasible to list all the TRIZ trainings going on around the world in this report, some of the training programs, which (please note some of these resources are open licensed knowledge base and some are subscription based or consultation based, this report does not discuss about the commercial aspects of these resources).

Few training and workshops and knowledge base of modern TRIZ base are mentioned below:

Systematic Innovation UK:

TRIZ Workshops held by some innovation solution companies both in and outside United Kingdom. One of them is Systematic Innovation Ltd, Bristol. This company hosts various level TRIZ workshops and trains people, clients and corporate offices on systematic innovation (Mann, 2014). This company runs specialized courses on certifying the people for TRIZ skills.

BioTRIZ UK:

BioTRIZ is a company in UK which offers training on TRIZ and specializes in application of TRIZ to biology, one of its flagship services is bio mimicry, which means mimicking nature to make innovative products and solutions (Bogatyrev, 2014).

Oxford Creativity:

At Oxford Creativity, TRIZ workshops are conducted and general TRIZ trainings are provided (Gadd, 2014).

TRIZ at various educational institutions

Across the world, TRIZ knowledge databases are being developed and research is carried out on TRIZ application to various fields. These research knowledge bases are proving a great help to the innovators, students, industries and research academia. One such example is TRIZ research centre at Plymouth University concerned with Computer Aided Innovation. Some specialized TRIZ research has been carried out in University of Sussex which was carried out on improving the use of TRIZ application (Tsai, 2008). The research oriented knowledge base is as important as is the knowledge base of TRIZ specialized application to various industries.

Outside UK also the TRIZ knowledge base has been developed to a substantial extent. Some examples are TRIZ trainings at Indian Institute of Technology campuses, courses at University of Twente – Netherlands, etc. Different conferences are hosted around the world to publish the work of TRIZ which is building as a strong base of TRIZ application and research knowledge.

2.3 Graphic Design

Graphic design in general can be described as the process in which the designer chooses words and organizes them along with images and messages in order to influence the user/ viewer and in order to communicate a particular message to the viewer(Council, 2012).

2.3.1 Graphic Design Stages

Most of the standard graphic design processes follow major four stages before reaching the customer delivery phase(Airey, 2006):

- Briefing
 - Initial discussion between designer and client (analysis and requirement collection session).
- Design
 - The designer reviews all the information including the background of the requirement and chalks out the standards of the requirement.
 - The designer then sketches the draft graphic design using graphic design tools.
 - The designer then presents the prototype (visual presentation) to the client and iteratively improves the design until the client is satisfied.
 - This phase when looked upon closely comprises of interpretation, idea generation and presentation(Tan and Melles, 2010).
- Artwork
 - Finally the artwork is prepared by the designer (original files used for production with high resolution necessary for high level printing).
- Production
 - The art work is forwarded to a commercial printer for printing.

2.3.2 Graphic Design Applications

Graphic design common uses are(Visualization, 2012):

- Designing logos (brand identity).
- Corporate identity designs.
- Value packaging.
- Website designing.
- Building an image in social media.

2.3.3 Graphic Design Branding

Brand design is the process of creating an individual and a unique identity in order to send the message of the presence of that organization, individual, product or a service and promote it to market or public(Council, 2012). Brand identity needs innovative ideas and thorough discussion with client and also needs a clear concept of the target market and the client requirements.

2.3.4 Graphic Design Tools

There are different graphic design tools (digital and non-digital).

Non-digital graphic design tools include (Tan and Melles, 2010):

- Pen
- Paper
- Drawing board
- Pencil
- Pencil colours
- Crayon colours
- Cowgum fumes (refer to questionnaire in appendix-VII-a)
- Sketch pad

Digital graphic design tools include (refer to appendix-VII):

- Adobe Photoshop
- Adobe Illustrator
- Microsoft Paint
- Adobe CS5 suite and previous versions

2.4 Genetic Algorithms

2.4.1 Background and History

Graphic design common Genetic algorithms were developed in USA in the 1970's (Eiben and Smith, 2012) they are typically applied to discrete optimization (Eiben and Smith, 2012). Genetic algorithms are considered to be slow and often produce varied and combined featured results. Genetic algorithms use the concept of living organisms in computer science. Since, living organisms are considered to be made of cells which in turn contain DNA which in turn is made up of chromosomes and genes; the genes control various properties of living organism. For example, one of the genes in human beings controls the colour of eye. The genes are coded in living organisms and when they are decoded they depict the value of organisms' particular property.

Similarly, chromosomes and genes are coded in computer systems to control particular aspects of the solution sets. The representation of genes in genetic algorithms in the simplest form is as binary string (01010.....) (Eiben and Smith, 2012). Mutation of genes takes place by flip flop operations (changing zero to one and vice versa). The parents for next generation are selected using a fitness function; all parents who pass a fitness function survive to the next generation and crossover with each other to form children.

There are two forms of representing the individual in genetic algorithms and biology- phenotype and genotype. The whole set of genes in an individual is called as genome. Genotype means the genes and the phenotype means the individual property that is visible after decoding the genotype. Genetic Algorithms are good at taking large, potentially huge search spaces and navigating them, looking for optimal combinations of things, solutions we might not otherwise find in a long time.

2.4.2 Concept and Framework

The Genetic Algorithms are coded in computing/ software artificial engineering as a mimic of natural genome system. Hence, the basic concept of GA is laid on some basic definitions. Some of the terms used in Genetic Algorithms are defined below and the discussion about how these concepts is implemented in the AEGIS (Goldberg, 2000, Forrest, 1996):

- a. **Genes:** A gene is usually encoded in 1's and 0's in genetic algorithms, it usually represents a property of an individual, example in human genetics, a gene can represent an eyes colour etc of a person.
- b. **Chromosomes:** A chromosome consists of many genes in sequence.

- c. **Genome:** A genome is the organism complete set of DNA or genes. Hence the summation of all chromosomes necessary to depict the complete individual/phenotype is called as genotype.
- d. **Population:** The sum up of all living individuals at a particular instant of time is called as population.

Having discussed the above definitions of the conceptualization of GA's, it is necessary to mention here the basic necessary stages which are followed in a typical GA environment to carry out the tasks of finding the solution set to the problem. Basic sequence of GA operations is listed below (Goldberg, 2000, Forrest, 1996):

- a. **Initialization:** Initialization in GA means the creation of initial population which represent a set of candidate solutions to the problem.
- b. **Selection:** Selection is done from the population, in which the parents for next generation are selected. Usually, a fixed number of parents are selected from the population.
- c. **Modification:** After selection, the population is modified and reproduced.
 - a. **Cross over:** Cross over is usually employed to reproduce the population as well. In crossover, the parts of homologous chromosomes are interchanged at certain points. Homologous chromosomes are the chromosomes across the population which contain the similar genes (genes controlling the same trait of an individual).
 - b. **Mutation:** Mutation is the process of random alteration of information on genes. In binary coded genetic algorithms, mutations are done using flip flop operations (change 1 to 0 and vice versa).

Some researchers prefer to mutate before cross over and some do after crossover. Crossover results in reproduction of the parents as well. When two parents cross over they can be classified as the off springs.

- d. **Evaluation:** Evaluation phase checks the fitness of an individual against the fitness function. The fitness function is the criterion which decides whether an individual is good enough to be considered a candidate solution or not. In many cases, the evaluation process is also used as selection process.
- e. **Discard:** The individuals who do not pass the fitness function criterion, are killed and discarded, while others are passed back to selection process and the process is iterated till the termination condition is met. The termination of all this process happens when the termination condition is met.

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This generational process is repeated until a termination condition has been reached. Common terminating conditions are:

- ✓ A solution is found that satisfies minimum criteria
- ✓ Fixed number of generations reached
- ✓ Allocated budget (computation time/money) reached
- ✓ The highest ranking solution's fitness is reaching or has reached a plateau such that successive iterations no longer produce better results
- ✓ Manual inspection
- ✓ Combinations of the above

The basic algorithm of GA can be defined in the form of a pseudo code in the following steps:

- I. produce an initial population of individuals
 - II. evaluate the fitness of all individuals
 - III. while termination condition not met do
 - a. select fitter individuals for reproduction
 - b. recombine between individuals
 - c. mutate individuals
 - d. evaluate the fitness of the modified individuals
 - e. generate a new population
- End while

2.4.3 Applicability

Genetic algorithms are used in (Brains.org, 2012):

- Automotive design.
- Engineering design.
- Robotics
- Evolvable hardware.
- Optimized telecommunications routing.
- Joke and pun generation.
- Bio mimetic invention.
- Trip, traffic and shipment routing.
- Computer gaming.
- Computer aided molecular design.
- Gene expression profiling.
- Optimising chemical kinetic analysis.
- Finance and investment strategies.
- Marketing and merchandising.

2.5 Computer Aided Innovation

In today's world of tough competition, businesses need to adapt more rapidly to market requirements which are highly influenced by product performance and competition.(Leon and Cho, 2009). Innovation has been seen as an essential tool for long term existence and to fight competition in today's market(Leon, 2006). Much focus is given to formal research based innovation methodologies in present time(Leon, 2006). A new category of tools called as CAI (computer aided innovation) is entering the market due to high demands for a fast and standard innovation. CAI is superior tool as compared to the old CAx generation tools; the former only aids in design while as the latter aids in innovation processes at various stages of innovation and production.

This thesis and research adds a very valuable milestone achievement to the TRIZ by adding a TRIZ guided computer based tool which helps automate innovation to some extent. This is mainly important because previous research has contributed mainly to the methodologies and tools like the toolset which assist researchers to implement TRIZ (Mann, 2006), improving use of TRIZ(Tsai, 2008) and creative interaction(Coughlan, 2009), etc. Further to this, few research groups have taken advanced steps in by creating automated environments whereby the computers push the designers to reach the boundary of creativity by helping them overcome design fixation when optimizing. One such example employs Genetic Algorithms, Evolutionary design, CAD/ CAE tools and TRIZ to construct a strategy for developing a crankshaft of engines based on a framework of computer aided innovation (Albers et al., 2009). However, at the start of this research, there existed no such tool which employed Genetic Algorithms and TRIZ to develop a Computer Aided Innovation tool which helped graphic designers innovate. Hence, this research takes a step further to add a toolset which (to certain extent) automates the process of innovation without compelling the user to understand the TRIZ methodologies behind it in detail (this tool is for graphic design). This tool is called as AEGIS. Primarily, this research contributes a conceptual framework (especially using Genetic Algorithms structure) to automate (to some extent) the process of Graphic Design innovation. Some portion of this conceptual framework has been implemented as a software tool which contributes to the repository of Computer Aided Innovation modern day tools.

The knowledge which is added to this research related area via the AEGIS research is that general TRIZ Principles are applied to basic Graphic Design forms/ elements to formulate a Graphic Design version of TRIZ Principles. This can be useful for various user groups including researchers, students and graphic designers. This forms the basis of future work for Computer Aided Innovation tool developers in the domain of Graphic Design.

Furthermore, the research contributes to further verifying the original hypothesis of about TRIZ 40 Principles (although to a limited number of innovative content) claiming that TRIZ 40

Principles answers the logic behind all the innovations globally (Al'tshuller, 1984). This is achieved by publishing the website <http://designforwow.com> and allowing users to upload what they categorize as 'wow' and then allowing the research team to analyse where TRIZ exists in the 'wow' content. Some research groups have classified the patents automatically with respect to TRIZ Principles (Loh et al., 2006). These researchers have hence laid down a framework for future researchers to start working on an open database for TRIZ classified patents. Few other research groups have tried to relate properties and functions from patents to TRIZ Trends (Verhaegen et al., 2009). However, a concept to test the sufficiency of TRIZ Principles was lacking (the claim that Alshuller made that any problem can be solved using the TRIZ 40 Principles set). This research lays the framework/ methodology of classification of anything which a user thinks is innovative to TRIZ Principles. The future researchers can enhance the database and other aspects of the data and methodology to create a huge mapped database of TRIZ Principles and hence as more and more data is added to this database tool, the veracity of TRIZ 40 Principles will be tested again and again. Hence, TRIZ 40 Principles will be updated with latest designs and innovations and the need for 41st TRIZ Principle can be tested from time to time. This database tool is also a primary framework for future TRIZ users and researchers in the form of a method of analysing the presence of TRIZ Principles in the innovative content/ or design.

The future potential of computer tools lies in the application of computer tools to aid innovation. One such example of such tool is trisolver tool. Figure 5 shows the user panel for trisolver software tool (CAI)(Trisolver, 1998). The TriSolver "Idea Generator & Manager" is a powerful tool for solution development and innovation management. Designed originally by TriSolver Consulting as an internal idea-generating tool, the software combines the proven problem solving capabilities of the TRIZ technology, customisable knowledge base approach and an intuitive user interface. TriSolver "Idea Generator & Manager" enables innovative thinkers to generate idea pools, evaluate possible solutions using graphical representation tools, augment and customise the built-in knowledge base with their own examples and inventive principles. The software automatically documents every stage in the idea development process, making it easier for the users to explore multi-path solutions. The software accelerates the innovation process and ensures the quality of possible solutions.

The users have the possibility to utilise their individual knowledge and creative expertise to expand and adapt TRIZ modules to the particular requirements of the company, modify or re-group TRIZ-tools to suit particular tasks (e.g. cost reduction), create the list of favourite principles etc. The software also automatically documents every stage in the idea development process, making it easier for the users to explore multi-path solutions (figure 6 and figure 7).

After analysis of Trisolver software, it is concluded that this tool indeed is a step towards CAI; it is an aid to help innovators and problem solvers and can indeed be classified as a CAI tool. However, AEGIS is a step further which falls under advanced category of CAI next generation tools,

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which aid idea generation and creative thinking by automating the process of innovation itself to certain extent. Moreover, in tools like Trisolve, the user is forced to learn about TRIZ and needs to go in to certain details of TRIZ before getting good level of outputs from this software, but in AEGIS the user does not have to be not much concerned about learning TRIZ and can use the software with a simple user guide. This speaks for the future, whereby the tools will be backed by innovation engines and user friendly interfaces will enable users to innovate without having to learn the details of innovation methodologies itself.

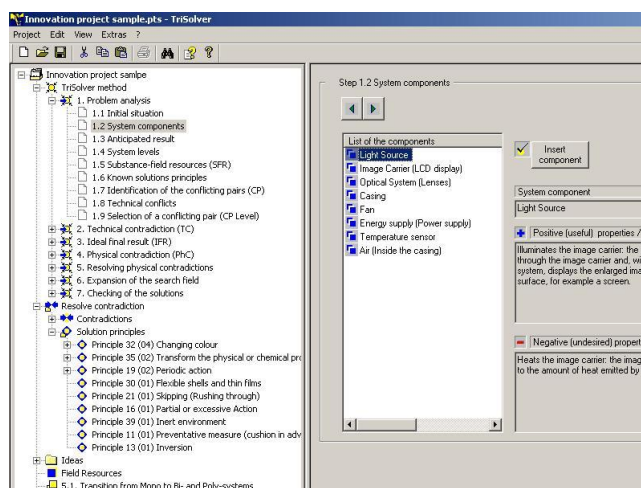


Figure 6: Innovation Project Sampler.

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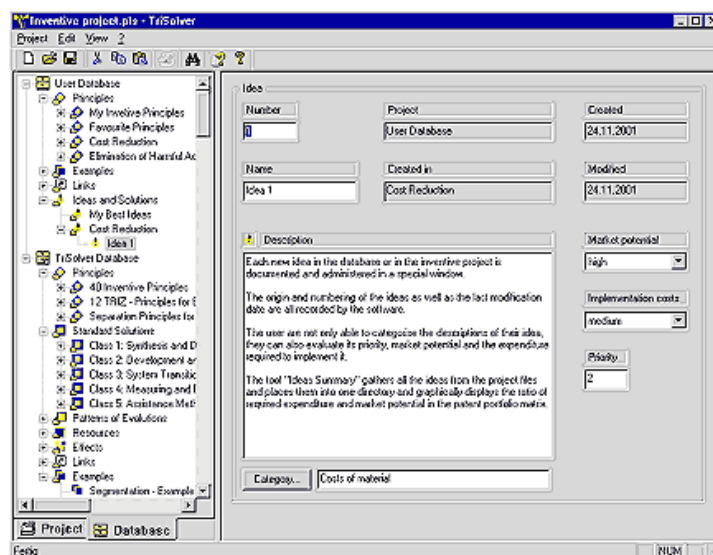


Figure 7: Trisolver tool for idea management.

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Chapter 3:

Application of TRIZ to

Graphic Design

3.1 Introduction

TRIZ forty Principles when applied to specific fields need to be specified and translated to the field, hence resulting in a subset of TRIZ forty Principles which are specific to that field. The TRIZ Principles are hence translated from generalized to specific forms (Hipple et al., 2011, Loh et al., 2006). Figure 8 shows this process.

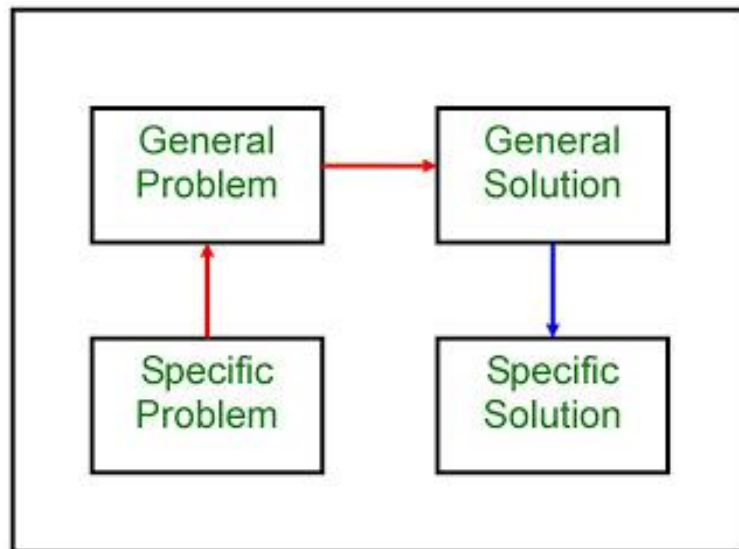


Figure 8: Application of TRIZ Principles.

In this research, the TRIZ 40 Principles (a subset of them) is translated to graphic design forms. This chapter discusses the process of translating these principles to specific field- graphic design. The methodology followed in this case comprises of many steps. Firstly, the phases where graphic design innovation is possible are highlighted and then innovative pieces of graphic design are collected and then analysed for TRIZ Principles in them. Subsequently, many questionnaires are followed with graphic designers to translate TRIZ to graphic design specific forms.

The method used in this research is in line with the figure8, but with certain specialities and modifications. First of all, typically when using TRIZ, the specific problem is translated to general problem by analysing it and finding out the contradictions in the problem. A general solution of this problem is charted out using the matrix and the TRIZ Principles. The general solution hence generated is then specialized to the problem by applying those TRIZ Principle hints to the particular problem.

In the case of this research, the approach is slightly different in various ways and can the approach can be viewed from various points of view in different ways. In this part of the research,

we are trying to innovate, while as the general case mentioned above usually tries to solve problems creatively. In this research, the right side of figure 8 is reverse engineered to create the structure of analysis for the software. The existing innovative work in graphic design field has been analysed then mapped to TRIZ Principles, this TRIZ Principles knowledge base developed is specific to the graphic design field. This TRIZ Principle knowledge base has been coded with GA's to develop the AEGIS. When the AEGIS software is used by the users of AEGIS, this TRIZ knowledge is utilized internally to generate innovative designs. The user's input information and preferences is used to decide what part of this database needs to be utilized. Hence the users of AEGIS are in other words following the right side of the figure-8 in top to down approach.

Only using the right side of image means that this software has the capability of innovating and it does not necessarily concentrate on problem solving. The future versions of this software can be enhanced to include the matrix and then the user can input a specific problem which will then be translated to general problem (in terms of matrix contradictions), hence this enhancement of software will use the left hand side of the figure 8. The selection of TRIZ Principles for current version of AEGIS is based on user feedback and different questionnaires and not using the matrix. In future, the researchers can use the matrix to test if any further principles are applicable to this field to a considerable extent. The approach was used because there was no substantial research on TRIZ applied to graphic design in genetic algorithms prior to this research.

The translation of generic TRIZ Principles has been done in this research with the help of the feedback and inputs from graphic designers. This work however can further be enhanced by talking to more designers and considering more principles. This knowledge base is then embedded and implemented in AEGIS help users to innovate without having to manually translate the principles to graphic design version again and again.

3.2 Innovative Graphic Design

Firstly, the phases where graphic design innovation is possible are highlighted in this section.

3.2.1 Probing the Scope for Innovation in GD Stages

1. Briefing: Can there be a tool to help designers quickly generate samples of different ideas (design previews) to client?

At this stage, the ideas and the creative thinking are not bound to be limited and not specific and the designer has not circled the specific details of customer's choice and requirement fully, so the designer presents few samples to the client as a briefing. In terms of the graphic tool, the tool should be able to demonstrate a wide variation of different designs circling around the rough requirements. In terms of a GA based CAI tool, this means higher mutation rate, more crossovers and large search space. These can be adjusted in settings of the GA tool usually.

2. Design: Can designer feed requirement to a system which generates TRIZ triggered design patterns?

3. At this stage, the designer has a considerable idea of what the client wants and has a substantial amount of inputs for the design. A design tool at this stage should be able to take maximum information from the user of this tool and generate specific designs. In terms of a GA based CAI tool, it means the design tool has to be set on a low mutation rate and less number of crossovers.

4. Artwork: Can there be a tool to help designer generate different TRIZ triggered previews of same design?

This level requires the designer to be able to produce professionally touched layers of the design. In terms of a GA based CAI tool. It means to be able to provide the 'work' to the user in layers so that it can be fine crafted at an artwork level and a high resolution artwork file can be created.

4. Production: This stage has not been touched by our research.

3.2.2 Collection of Innovative Graphic Design Samples

The next steps in this process have been to collect innovative pieces of graphic design work.



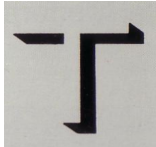
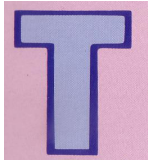
3.2.2.1 Innovative Graphic Design in Literature.


Some samples of innovative graphic designs are presented in this section (in table 1 and table 2). The inspiration/ idea came from interacting with the graphic designers and what kind of work they classify as innovative. The researcher had a look at the rough sketches they described in different meetings and then identified different sources of literature matching those ideas. The

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inspiration also came from award winning, published innovative pieces of work. The below work included in the tables 1 and 2 is the collection of innovative content of graphic design from literature review of papers, award winning work, peer reviewed recognized content and other reliable sources of information.

This work is analysed and then described in terms of the graphic design anatomy and the basic graphic design elements and characteristics. This work has been discussed with graphic designers who deemed this work innovative and agreed to the views of researcher. This work is innovative and not an incremental change because they have in the history of graphic design laid the foundation of new styles, fonts and other components for future use of graphic design.

Description	Source(s) of inspiration/ idea.
The line, shape and plane element of font component is manipulated to produce a Texture.	 (Burton, 2011) (Farkas, 2012)
<p>The planes of the Font component are divided on x-axis and y-axis.</p> <p>Furthermore, the end of planes of the Font element is cut at an angle rather than at right angle.</p>	 (Burton, 2011)
The line (outlining) of Font component has been copied and manipulated separately.	<p>[Design has been removed due to copyright restrictions] (Carter, 2002)</p>  (Swann, 1990)  (Swann, 1990)
The Font Component is elaborated / emphasized using different shapes like circle, rectangle, etc.	[Design has been removed due to copyright restrictions] (Carter 2002)
The Font Component is elaborated / emphasized by extending the different plane parts of Font component.	[Design has been removed due to copyright restrictions] (Carter 2002)
The Font Component is elaborated / emphasized using different shapes like circle, rectangle, etc.	[Design has been removed due to copyright restrictions] (Carter 2002)

Description	Source(s) of inspiration/ idea.
The Font component does not rest on same base.	[Design has been removed due to copyright restrictions] (Carter 2002)
The stem of Font is manipulated.	 (Swann, 1990)
The whole Font is added with an extra element (mainly line)	[Design has been removed due to copyright restrictions] (Carter 2002)
The whole Font is added with an extra element (mainly line)	[Design has been removed due to copyright restrictions] (Carter 2002)
The whole Font is added with an extra element (mainly line)	[Design has been removed due to copyright restrictions] (Carter 2002)
The whole Font is added with an extra element (mainly line)	[Design has been removed due to copyright restrictions] (Carter 2002)
The types have irregular spacing in Font component.	[Design has been removed due to copyright restrictions] (Carter 2002)
The types have irregular spacing and size in Font component.	[Design has been removed due to copyright restrictions] (Carter 2002)
The types have irregular spacing and size in Font component.	[Design has been removed due to copyright restrictions] (Carter 2002)

Description	Source(s) of inspiration/ idea.
The types have irregular spacing and size in Font component. Texts are copied to different size.	[Design has been removed due to copyright restrictions] (Carter 2002)
Font component as a whole is rotated slightly.	[Design has been removed due to copyright restrictions] (Carter 2002)
Font component as a whole is rotated moderately.	[Design has been removed due to copyright restrictions] (Carter 2002)
Font component as a whole is rotated diagonally.	[Design has been removed due to copyright restrictions] (Carter 2002)
Texts are rotated by different angles.	[Design has been removed due to copyright restrictions] (Carter 2002)
Texts are slanted slightly.	[Design has been removed due to copyright restrictions] (Carter 2002)
Texts are slanted moderately.	[Design has been removed due to copyright restrictions] (Carter 2002)
Texts are slanted diagonally.	[Design has been removed due to copyright restrictions] (Carter 2002)
Texts are slanted and the effect is combined.	[Design has been removed due to copyright restrictions] (Carter 2002)
Texts are made narrow.	[Design has been removed due to copyright restrictions]

Description	Source(s) of inspiration/ idea.
	(Carter 2002)
Texts are made medium.	[Design has been removed due to copyright restrictions] (Carter 2002)
Texts are made wide.	[Design has been removed due to copyright restrictions] (Carter 2002)
Text effects are combined.	[Design has been removed due to copyright restrictions] (Carter 2002)
Text is embedded in a shape.	[Design has been removed due to copyright restrictions] (Carter 2002)
Shape is introduced next to text.	[Design has been removed due to copyright restrictions] (Carter 2002)
Shape is embedded and a combination is used.	[Design has been removed due to copyright restrictions] (Carter 2002)
Symbols are used next to the text.	[Design has been removed due to copyright restrictions] (Carter 2002)
Symbols are used next to the text.	[Design has been removed due to copyright restrictions] (Carter 2002)
Symbols are used to surround text.	[Design has been removed due to copyright restrictions] (Carter 2002)
Symbols are used to surround text.	[Design has been removed due to copyright restrictions] (Carter 2002)
Images are used as background in Font component.	[Design has been removed due to copyright restrictions] (Carter 2002)
Images are used adjacent to Font component.	[Design has been removed due to copyright restrictions] (Carter 2002)

Description	Source(s) of inspiration/ idea.
Images are contained in the text of Font component.	[Design has been removed due to copyright restrictions] (Carter 2002)
Images are manipulated and introduced as background of Font component.	[Design has been removed due to copyright restrictions] (Carter 2002)
Colour transition (vertical) applied to texts.	[Design has been removed due to copyright restrictions] (Carter 2002)
Colour transition (horizontal) applied to texts.	[Design has been removed due to copyright restrictions] (Carter 2002)
Colour transition (inward) applied to texts.	[Design has been removed due to copyright restrictions] (Carter 2002)
Colour transition (combination) applied to texts.	[Design has been removed due to copyright restrictions] (Carter 2002)
The baseline is broken(Spiekermann.E. and Brody.N., 2008).	[Design has been removed due to copyright restrictions] (Carter 2002)
Axis is tilted(Spiekermann.E. and Brody.N., 2008).	[Design has been removed due to copyright restrictions] (Carter 2002)
Baseline is made spheroidal(Spiekermann.E. and Brody.N., 2008).	[Design has been removed due to copyright restrictions] (Carter 2002)
X-height is compressed(Spiekermann.E. and Brody.N., 2008).	[Design has been removed due to copyright restrictions] (Carter 2002)
X-height and baseline are interchanged(Spiekermann.E. and Brody.N., 2008).	[Design has been removed due to copyright restrictions] (Carter 2002)
Stem is mutated X-height and baseline are interchanged(Spiekermann.E. and Brody.N., 2008).	[Design has been removed due to copyright restrictions] (Carter 2002)
Axis is tilted X-height and baseline are interchanged(Spiekermann.E. and Brody.N., 2008).	[Design has been removed due to copyright restrictions] (Carter 2002)
Whole font is repeated	[Design has been removed due to copyright restrictions]

Description	Source(s) of inspiration/ idea.
	(Carter 2002)
Whole font is repeated	[Design has been removed due to copyright restrictions] (Carter 2002)
Whole font is repeated	[Design has been removed due to copyright restrictions] (Carter 2002)
Whole font is repeated	[Design has been removed due to copyright restrictions] (Carter 2002)
Multiple baselines introduced(Gordon and Gordon, 2002).	[Design has been removed due to copyright restrictions] (Carter 2002)
All axis are duplicated(Gordon and Gordon, 2002).	[Design has been removed due to copyright restrictions] (Carter 2002)
Axis tilted and multiplied(Gordon and Gordon, 2002).	[Design has been removed due to copyright restrictions] (Carter 2002)
Axis tilted and multiplied(Gordon and Gordon, 2002).	[Design has been removed due to copyright restrictions] (Carter 2002)
Color of line mutilated Axis tilted and mutilated(Elizabeth, 2003).	[Design has been removed due to copyright restrictions] (Carter 2002)
Color of line mutilated Axis tilted and mutilated(Elizabeth, 2003).	[Design has been removed due to copyright restrictions] (Carter 2002)
Color of line mutilated Axis tilted and mutilated(Elizabeth, 2003).	[Design has been removed due to copyright restrictions] (Carter 2002)
Color of line mutilated Axis tilted and mutilated(Elizabeth, 2003).	[Design has been removed due to copyright restrictions] (Carter 2002)
Color of line mutilated Axis tilted and mutilated(Elizabeth, 2003).	[Design has been removed due to copyright restrictions] (Carter 2002)
Color of line mutilated Axis tilted and mutilated(Elizabeth, 2003).	[Design has been removed due to copyright restrictions] (Carter 2002)
Color of line mutilated Axis tilted and mutilated(Elizabeth, 2003).	[Design has been removed due to copyright restrictions] (Carter 2002)



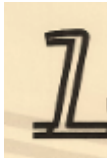


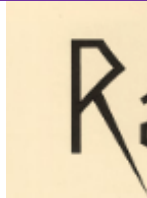

Description	Source(s) of inspiration/ idea.
Color of line mutilated Axis tilted and mutilated(Elizabeth, 2003).	[Design has been removed due to copyright restrictions] (Carter 2002)
Color of line mutilated Axis tilted and mutilated(Elizabeth, 2003).	[Design has been removed due to copyright restrictions] (Carter 2002)
Font set duplicated opposite.	[Design has been removed due to copyright restrictions] (Carter 2002)






Table 1: Innovative text samples.

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Some more examples are listed in table 2. Table 2 is just an extension to table 1 with all the details on same level as table 1.

Description	Source(s) of inspiration/ idea.
The types have irregular spacing in size in Font component.	[Design has been removed due to copyright restrictions] (Carter 2002)
Partial font set is repeated randomly.	[Design has been removed due to copyright restrictions] (Carter 2002) [Design has been removed due to copyright restrictions] (Carter 2002)
Axis is tilted and the brackets are spirally rounded.	[Design has been removed due to copyright restrictions]

Description	Source(s) of inspiration/ idea.
	(Nick Greco, 2001)
The colour of font is partially defaced.	 (Nick Greco, 2001)
The stem is split.	 (Nick Greco, 2001)  (Nick Greco, 2001)  (Nick Greco, 2001)
The stem is partially extended.	 (Nick Greco, 2001)
The stem and bar colour is mixed.	[Design has been removed due to copyright restrictions] (Nick Greco, 2001)
Irregular width of stem and bar.	 (Nick Greco, 2001)  (Nick Greco, 2001)

Description	Source(s) of inspiration/ idea.
<p>Stem and bar are curvy.</p>	 <p>(Nick Greco, 2001)</p>  <p>(Nick Greco, 2001)</p>
<p>The font letters are duplicated and the duplicates are very close to the original font.</p> <p>The stems and bases are curvy.</p> <p>The brackets are extended as curves.</p>	<p>[Design has been removed due to copyright restrictions]</p> <p>(Nick Greco, 2001)</p> <p>[Design has been removed due to copyright restrictions]</p> <p>(Nick Greco, 2001)</p>
<p>The brackets are extended as curves and the stem/base are curvy.</p>	 <p>(Nick Greco, 2001)</p>
<p>The stem is partially displaced.</p>	 <p>(Nick Greco, 2001)</p>
<p>The stem is composed of many thin lines with space in between.</p>	 <p>(Nick Greco, 2001)</p>
<p>The stem has marking and irregular extensions, and font letters are partially duplicated.</p>	<p>[Design has been removed due to copyright restrictions]</p> <p>(Nick Greco, 2001)</p>
<p>The font size is irregular in individual letters.</p>	<p>[Design has been removed due to copyright restrictions]</p>

Description	Source(s) of inspiration/ idea.
	(Nick Greco, 2001)

Table 2: More examples of font design (this is an extension to the table 1 designs).

Copyright Statement: Permission to reproduce these images has been granted respectively by the copyright holders: Roto Vision Publisher, Nick Greco –Author, Alan Swann- Author, Webdesign.org Publisher, and David. K Farkas-Author, Vitaliy Kolos-Web Admin for the respective images via different email communications the purpose of facilitation of this research.

3.2.2.2 Graphic Design from Awards and Exhibitions

While as table 1 and 2 show the innovative graphic design content from literature review, mainly award winning graphic design books and papers, the table 3 below shows the innovative graphic design which has been noted by researcher from award winning graphic design shows which is marked by graphic researchers and experts and wide range of views have appreciated these designs. These designs have further been checked by the reviewers for any duplication from old work and these designs are new and innovatively created by the designers. A visit was made to the graphic design exhibitions to depict their work. Some of the innovative samples are listed in table 3.

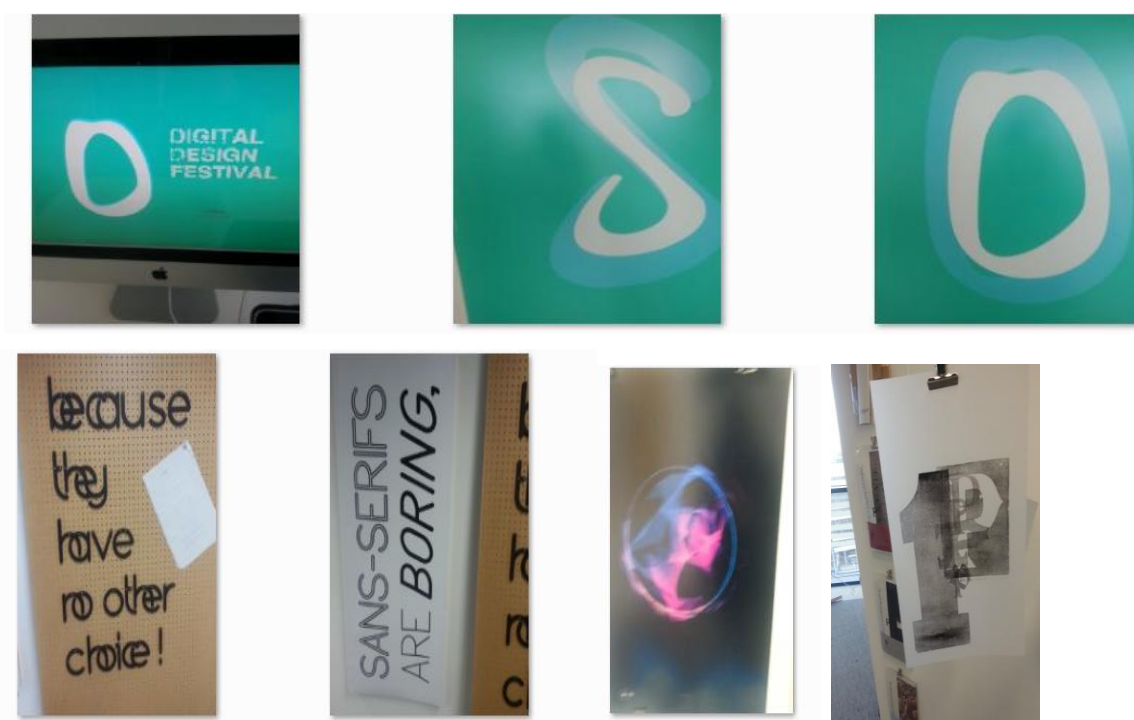


Table 3: Graphic Design Award Innovation Samples (Adele, 2012).

Copyright Statement: Permission to reproduce these images has been granted respectively by the copyright holders: Peter Jones via different meetings and different email communications the purpose of facilitation of this research. Peter Jones has allowed to discuss the samples from his exhibition and group as examples of graphic design innovation.

3.2.2.3 Graphic Design from End Users (Consumers)

A short survey was conducted at one of the supermarkets with ten staff members to identify the graphic labels they voted as best in the store. These are listed in table 4. While as table 1, 2 and 3 cover the innovative content collected from graphic literature, books, papers, exhibitions, ward

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winning works, it was also necessary to have a view from the part of the world which views the designs but is not a design expert. The consumers who are targeted by design labels and packaging design was consulted and some of their pointed out work was collected, which they deemed as innovative.



Table 4: Innovative packaging designed highlighted in consumer survey(Blythe, 2013).

Copyright Statement: Permission to reproduce these images has been granted respectively by the Store Managers/ Supervisors: Naimar Khan, via email communications and during meetings and the author has been allowed to take pictures of their stores shelves for the research purposes.

It is concluded from the evaluation and analysis of tables 1 through 4 that although the content was collected from different levels of users of graphic design, authors and designers, but in terms of preliminary design language, the font manipulation is more or less same, hence an innovation pattern can be guessed from these designs. For example, the curvature of letters in various images in table 4 can be described same way as of few images in table1 has been described. Similarly, the curvature of the different elements of few images in table 3 and duplicated font

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components can also be fitted with descriptions of few innovative designs of table 1 and 2. Hence, the innovation in different sub sectors of graphic design follows patterns which designers design. These patterns are the key for laying down the foundation of a CAI tool for graphic design.

3.3 TRIZ Principles- Application to Graphic Design

The main components of a graphic design label/ packaging design/ a proper graphic design image are:

- Fonts- this composes of the text letters which depict the main name or some major identification information of that graphic design.
- Background- this is the background of the design on which the text/ font and other components rest.
- Identity of the brand/ logo- this is the component of the design which identifies its brand or the manufacturer or marketer. It is copyrighted and trademarked usually.
- The message in addition to the identity of the brand- which supports the identity of the brand, for example the slogan of a particular company.

Out of these, the font component has been given major concentration in this research, because the TRIZ knowledge base was missing in this field particularly and when it was discussed with graphic designers, they were more interested in looking at the font application of TRIZ, as they agreed during meetings that font manipulations using TRIZ would lead to innovative graphic design (Appendix- VII). The application of TRIZ to other components was also studied under this research but the major focus was on TRIZ application to fonts. The TRIZ application to other components should be thoroughly probed and is a major research subject as under this research few AEGIS functions have been designed to manipulate the other components using TRIZ. However, in these components, the major focus was colour change Principle of TRIZ.

3.3.1 Graphic Design Elements

The main graphic design elements are (Elizabeth, 2003):

- Colour- The property possessed by an object of producing different sensations on the eye as a result of the way it reflects or emits light.
- Texture-The feel, appearance, or consistency of a surface or a substance.
- Lines- A long, narrow mark or band.
- Dots- A small round mark or spot.
- Crossings -Intersection of two elements, especially lines
- Planes- A flat surface on which a straight line joining any two points on it would wholly lie.
- Circles- Around plane figure whose boundary (the circumference) consists of points equidistant from a fixed point (the centre).
- Shapes – The external form, contours, or outline of someone or something.
- Space -A continuous area or expanse which is free, available, or unoccupied.

3.3.2 Graphic Design Anatomy

The main building blocks of a graphic design anatomy for font/ letters are depicted in figure 9 below. This was important for the researcher to understand. This helped the researcher to analyse the patterns matched above in terms of the manipulation done in anatomy of graphic design font/ letters to achieve innovation.

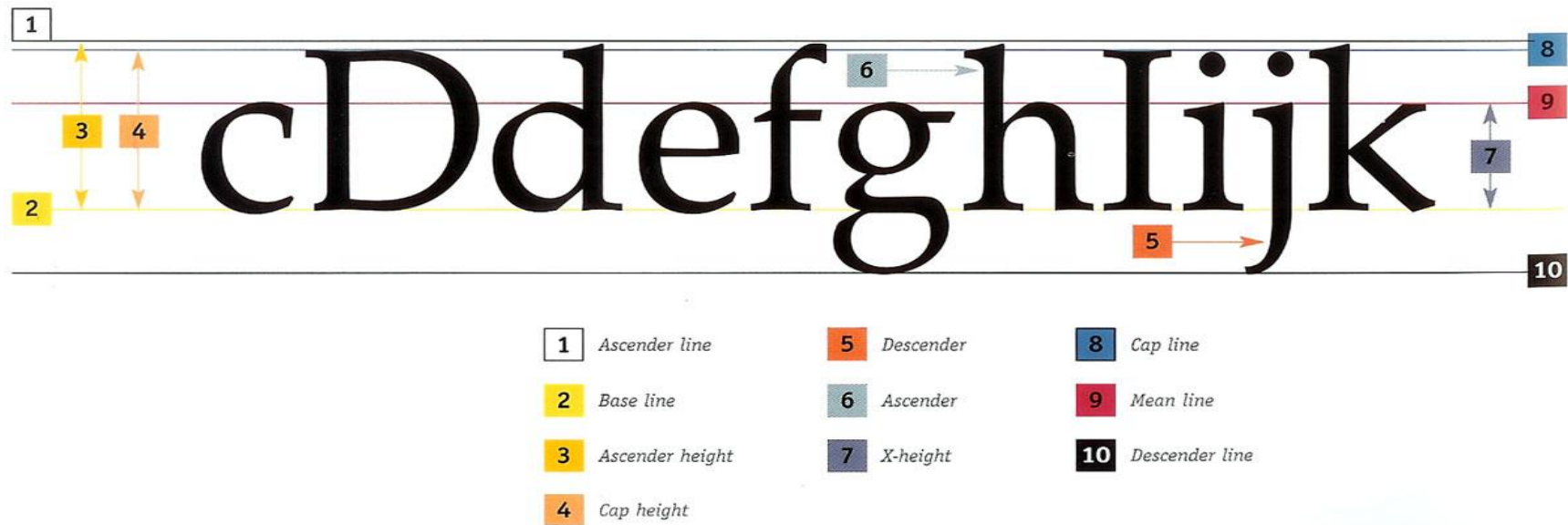



Figure 9: Graphic design anatomy(Spiekermann.E. and Brody.N., 2008).

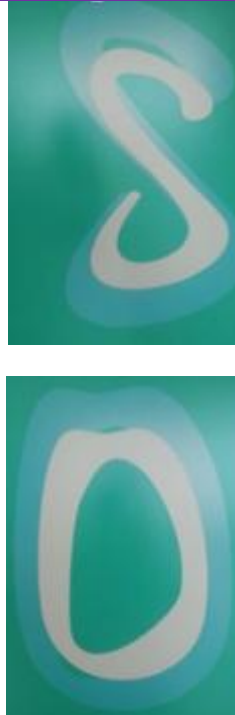

Copyright Statement: Permission to reproduce and discuss the anatomy of font granted respectively by the author: Prof. Dr.h.c. Erik Spiekermann via email communication for research purposes.

3.3.3 Analysing the Innovative Manipulation of Graphic Design Elements and Anatomy (TRIZ)



In context of section 3.3.1 and section 3.2 above, the innovative manipulation of elements of graphic design were identified and then subsequently the TRIZ Principles presence was identified in them. This is presented in the form of table 5. Table 5 below discusses the designs from table 1 through 4 in more detail in terms of graphic anatomy and graphic elements/ characteristics and manipulations. This table discusses the various manipulations of graphic design elements/ basic forms in terms of TRIZ Principle effects. Please note that each row does not discuss all the principles applicable to that design, but discusses the major/ main principle which the designers and researcher suggest were present in these designs. To make the work less redundant, some of the designs which were identified from tables 1 through 4 to have similar group manipulations were grouped in same row below. Some of the designs have been put in more than one row, this is because there was more than one major innovative effect on those designs, and hence two main Principles were identified in these designs. It is necessary to create table 5 before table 6, to avoid direct jump to TRIZ based chromosomes, hence the designs needed to be analysed more in terms of graphic design and TRIZ Principles before grouping them in similar group executable transformations for each chromosome set.

Effect/ Transformation ID	Translated Effect(s)	TRIZ Principle (Sub-Principle)	Description	Source(s) of inspiration/ idea.	Applied to the (AEGIS Component Name)	Applied to the Graphic Element (Basic Form)
TYP1.	<ul style="list-style-type: none"> Introducing shade of Line effects. Creating a Texture with Lines. <i>Monochromatic</i> variations of Colour. Repeating the cross bar. Repeating the diagonal strokes. Changing the <i>value</i> of Colour. <p>(Farkas, 2012)</p>	<p>Principle2. Taking Out (A)</p> <p>Principle 7. Nested Doll (A)</p> <p>Principle 8. Anti-Weight (A).</p> <p>Principle 35 Parameter Changes (B)</p> <p>Principle 26 Copying (B)</p> <p>Principle14. Spheriodality (A)</p>	<p>The line, shape and plane element of font component is manipulated to produce a Texture.</p>	 <ul style="list-style-type: none"> (Burton, 2011) (Farkas, 2012) 	Font	<ul style="list-style-type: none"> Line Colour Texture Planes Shape Space <p>Applied to the anatomy of Type:</p> <p>1. Cross Bars</p>

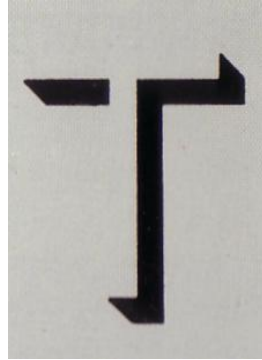
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Effect/ Transformation ID	Translated Effect(s)	TRIZ Principle (Sub-Principle)	Description	Source(s) of inspiration/ idea.	Applied to the (AEGIS Component Name)	Applied to the Graphic Element (Basic Form)
				 <p>(Adele, 2012)</p>		<p>2. Diagonal Stroke</p> <p>(Carter, 2002)</p>
TYP2.	<ul style="list-style-type: none"> Dividing a Plane in to different Planes. Cutting angles in to a rectangular plane/shape. Dividing along Axis. Dividing the Stem. Dividing the Cross bar 	<p>Principle1. Segmentation (A,B,C)</p> <p>Principle21 Skipping (A)</p> <p>Principle19 Periodic Action(A,C)</p>	<p>The planes of the Font component are divided on x-axis and y-axis.</p> <p>Furthermore, the end of planes of the Font element is cut at an angle rather than at</p>		Font	<ul style="list-style-type: none"> Plane <p>Applied to the anatomy of Type:</p> <ol style="list-style-type: none"> Stem Cross Bar Arm.


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Effect/ Transformation ID	Translated Effect(s)	TRIZ Principle (Sub-Principle)	Description	Source(s) of inspiration/ idea.	Applied to the (AEGIS Component Name)	Applied to the Graphic Element (Basic Form)
	<ul style="list-style-type: none"> Dividing the arm. 		right angle.	<ul style="list-style-type: none"> (Burton, 2011)  <p>(Nick Greco, 2001)</p> <p>[Design has been removed due to copyright restrictions]</p> <p>(Nick Greco, 2001)</p>  <p>(Nick Greco, 2001)</p>		4. Bracket (Spiekermann.E. and Brody.N., 2008) (Carter, 2002)
TYP3.	<ul style="list-style-type: none"> A variety of outlines or shadow effects on the outer Line of the Font element. Analogous Colour Manipulation scheme has been followed. 	Principle2. Taking Out (A) Principle26. Copying (A,B)	The line (outlining) of Font component has been copied and manipulated separately.	[Design has been removed due to copyright restrictions] <ul style="list-style-type: none"> (Carter, 2002) 		


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Effect/ Transformation ID	Translated Effect(s)	TRIZ Principle (Sub-Principle)	Description	Source(s) of inspiration/ idea.	Applied to the (AEGIS Component Name)	Applied to the Graphic Element (Basic Form)
	(Farkas, 2012)			<p>[Design has been removed due to copyright restrictions]</p> <ul style="list-style-type: none"> (Carter, 2002) <p>[Design has been removed due to copyright restrictions]</p> <ul style="list-style-type: none"> (Carter, 2002)  <ul style="list-style-type: none"> (Swann, 1990) 		

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Effect/ Transformation ID	Translated Effect(s)	TRIZ Principle (Sub-Principle)	Description	Source(s) of inspiration/ idea.	Applied to the (AEGIS Component Name)	Applied to the Graphic Element (Basic Form)
				 <ul style="list-style-type: none"> (Swann, 1990) 		
TYP4.	<ul style="list-style-type: none"> Elaboration of Font component by enclosing letters using a shape. Addition. 	Principle40. Composite Materials (A) Principle2. Taking Out (A)	The Font Component is elaborated / emphasized using different shapes like circle, rectangle, etc.	[Design has been removed due to copyright restrictions] <ul style="list-style-type: none"> (Carter 2002) 	Font	<ul style="list-style-type: none"> Plane Font component as a whole. Shape
TYP5.	<ul style="list-style-type: none"> Extending letter strokes. 	Principle 35. Parameter Changes. Principle22. Blessing in Disguise (A)	The Font Component is elaborated / emphasized by extending the different plane parts of Font component.	[Design has been removed due to copyright restrictions] <ul style="list-style-type: none"> (Carter 2002) 	Font	<ul style="list-style-type: none"> Plane Font component as a whole. <p>Applied to the anatomy of Type:</p> <ol style="list-style-type: none"> Stroke.
TYP6.	<ul style="list-style-type: none"> Elaboration of Font component by enclosing 	Principle40. Composite	The Font Component is elaborated / emphasized		Font	<ul style="list-style-type: none"> Plane Font component as a

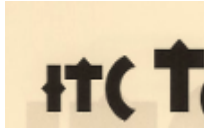
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Effect/ Transformation ID	Translated Effect(s)	TRIZ Principle (Sub-Principle)	Description	Source(s) of inspiration/ idea.	Applied to the (AEGIS Component Name)	Applied to the Graphic Element (Basic Form)
	letters using a shape . • Combination. • Filling of Bowl with colour .	Materials (A) Principle2. Taking Out (A)	using different shapes like circle, rectangle, etc.	[Design has been removed due to copyright restrictions] • (Carter 2002)		whole. Applied to the anatomy of Type: 1. Bowl. (Brody)
TYP7	• Stair Stepped • The base line is mutated to form a stair step.	Principle4. Asymmetry.	The Font component does not rest on same base.	[Design has been removed due to copyright restrictions] • (Carter 2002)	Font	Applied to the anatomy of Type: 1. Baseline. (Brody)
TYP8	• The stem is divided on axis to permit use of different colour combinations.	Principle2. Taking Out (A)	The stem of Font is manipulated.	 • (Swann, 1990)	Font	Applied to the anatomy of Type: 1. Stem. (Brody) (Carter 2002)
TYP9	• Horizontal Ruled Lines/ Typographic Support elements. • The text is highlighted using ruled lines . • A line is added in most of	Principle 40. Composite Materials (A)	The whole Font is added with an extra element (mainly line)	[Design has been removed due to copyright restrictions]	Font	Applied to the anatomy of Type: 1. Baseline. (Brody)

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Effect/ Transformation ID	Translated Effect(s)	TRIZ Principle (Sub-Principle)	Description	Source(s) of inspiration/ idea.	Applied to the (AEGIS Component Name)	Applied to the Graphic Element (Basic Form)
	the cases.			<ul style="list-style-type: none"> (Carter 2002) 		
TYP10	<ul style="list-style-type: none"> <u>Vertical Ruled Lines/ Typographic Support elements.</u> The text is highlighted using rules lines. A line is added in most of the cases. 	Principle 40. Composite Materials	The whole Font is added with an extra element (mainly line)	[Design has been removed due to copyright restrictions] <ul style="list-style-type: none"> (Carter 2002) 	Font	Applied to the anatomy of Type: 2. Baseline. (Brody)
TYP11	<ul style="list-style-type: none"> <u>Diagonal Ruled Lines/ Typographic Support elements.</u> The text is highlighted using rules lines. A line is added in most of the cases. 	Principle 40. Composite Materials Principle14. Spheriodality	The whole Font is added with an extra element (mainly line)	[Design has been removed due to copyright restrictions] <ul style="list-style-type: none"> (Carter 2002) 	Font	Applied to the anatomy of Type: 3. Baseline. (Brody)
TYP12	<ul style="list-style-type: none"> <u>Curved Ruled Lines/ Typographic Support elements.</u> The text is highlighted using rules lines. A curved line is added in most of the cases. 	Principle 40. Composite Materials Principle14. Spheriodality	The whole Font is added with an extra element (mainly line)	[Design has been removed due to copyright restrictions] <ul style="list-style-type: none"> (Carter 2002) 	Font	Applied to the anatomy of Type: 4. Baseline. (Brody)
TYP13	<ul style="list-style-type: none"> <u>Rhythm Effects.</u> Irregular rhythm is applied here. Unequal interval of space between texts. 	Principle 16. Partial or Excessive Actions. Principle 35. Parameter Changes.	The types have irregular spacing in Font component.	[Design has been removed due to copyright restrictions]	Font	Applied to the anatomy of Type: 1. Spacing.

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Effect/ Transformation ID	Translated Effect(s)	TRIZ Principle (Sub-Principle)	Description	Source(s) of inspiration/ idea.	Applied to the (AEGIS Component Name)	Applied to the Graphic Element (Basic Form)
		Principle 22. Blessing in Disguise (A)		<ul style="list-style-type: none"> (Carter 2002) <p>[Design has been removed due to copyright restrictions]</p> <p>(Carter 2002)</p> <p>[Design has been removed due to copyright restrictions]</p> <p>(Carter 2002)</p> <p>[Design has been removed due to copyright restrictions]</p> <p>(Carter 2002)</p>		
TYP14	<ul style="list-style-type: none"> Rhythm Effects. Irregular rhythm is applied here. Unequal <i>interval</i> of space between texts. Unequal <i>size</i> of lines and planes (for texts) is used here. 	Principle 16. Partial or Excessive Actions. Principle 35. Parameter Changes. Principle 22. Blessing in Disguise (A)	The types have irregular spacing and size in Font component.	<p>[Design has been removed due to copyright restrictions]</p> <ul style="list-style-type: none"> (Carter 2002) 	Font	<p>Applied to the anatomy of Type:</p> <ol style="list-style-type: none"> Spacing. X-height <p>(Brody)</p>

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Effect/ Transformation ID	Translated Effect(s)	TRIZ Principle (Sub-Principle)	Description	Source(s) of inspiration/ idea.	Applied to the (AEGIS Component Name)	Applied to the Graphic Element (Basic Form)
				<ul style="list-style-type: none"> (Nick Greco, 2001) 		
TYP15	<ul style="list-style-type: none"> <u>Rhythm Effects.</u> Irregular rhythm is applied here. Unequal <i>interval</i> of space between texts. Unequal <i>size</i> of lines and planes (for texts) is used here. 	<p>Principle 16. Partial or Excessive Actions.</p> <p>Principle 35. Parameter Changes.</p> <p>Principle 22. Blessing in Disguise (A)</p>	The types have irregular spacing and size in Font component.	<p>[Design has been removed due to copyright restrictions]</p> <ul style="list-style-type: none"> (Carter 2002) 	Font	<p>Applied to the anatomy of Type:</p> <ol style="list-style-type: none"> Spacing. X-height <p>(Brody)</p>
TYP16	<ul style="list-style-type: none"> <u>Combination.</u> <u>Rhythm Effects.</u> Irregular rhythm is applied here. Unequal <i>interval</i> of space between texts. Unequal <i>size</i> of lines and planes (for texts) is used here. Copied texts. 	<p>Principle 26. Copying.</p> <p>Principle 16. Partial or Excessive Actions.</p> <p>Principle 22. Blessing in Disguise (A)</p>	<p>The types have irregular spacing and size in Font component.</p> <p>Texts are copied to different size.</p>	<p>[Design has been removed due to copyright restrictions]</p> <ul style="list-style-type: none"> (Carter 2002) <p>[Design has been removed due to copyright restrictions]</p> <p>(Nick Greco, 2001)</p> <p>[Design has been removed due to copyright restrictions]</p>	Font	<p>Applied to the anatomy of Type:</p> <ol style="list-style-type: none"> Spacing. X-height <p>(Brody)</p>

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Effect/ Transformation ID	Translated Effect(s)	TRIZ Principle (Sub-Principle)	Description	Source(s) of inspiration/ idea.	Applied to the (AEGIS Component Name)	Applied to the Graphic Element (Basic Form)
TYP17	<ul style="list-style-type: none"> <u>Colour Alteration.</u> <u>Rhythm Effects.</u> Irregular rhythm is applied here. Unequal <i>value</i> of colour in texts. 	Principle 21. Skipping Principle 35. Parameter Changes.		[Design has been removed due to copyright restrictions] <ul style="list-style-type: none"> (Carter 2002) 	Font	
TYP18	<ul style="list-style-type: none"> <u>Rotation Effects.</u> <u>Slight glitches.</u> The Baseline is rotated. 	Principle14. Spheriodality Curvature (A)	Font component as a whole is rotated slightly.	[Design has been removed due to copyright restrictions] <ul style="list-style-type: none"> (Carter 2002) 	Font	Line Plane Applied to the anatomy of Type: 1. Baseline. (Brody)
TYP19	<ul style="list-style-type: none"> <u>Rotation Effects.</u> <u>Moderate movement.</u> The Baseline is rotated. 	Principle14. Spheriodality Curvature (A)	Font component as a whole is rotated moderately.	[Design has been removed due to copyright restrictions] <ul style="list-style-type: none"> (Carter 2002) 	Font	Line Plane Applied to the anatomy of Type: 1. Baseline. (Brody)

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Effect/ Transformation ID	Translated Effect(s)	TRIZ Principle (Sub-Principle)	Description	Source(s) of inspiration/ idea.	Applied to the (AEGIS Component Name)	Applied to the Graphic Element (Basic Form)
TYP20	<ul style="list-style-type: none"> <u>Rotation Effects.</u> <u>Diagonal movement.</u> The Baseline is rotated. 	Principle14. Spheriodality Curvature (A)	Font component as a whole is rotated diagonally.	<p>[Design has been removed due to copyright restrictions]</p> <ul style="list-style-type: none"> (Carter 2002) 	Font	<p>Line Plane</p> <p>Applied to the anatomy of Type:</p> <p>1. Baseline. (Brody)</p>
TYP21	<ul style="list-style-type: none"> <u>Rotation Effects.</u> <u>Different movements.</u> The Baseline is rotated and is bent. 	Principle14. Spheriodality Curvature (A) Principle 35. Parameter Changes.	Texts are rotated by different angles.	<p>[Design has been removed due to copyright restrictions]</p> <ul style="list-style-type: none"> (Carter 2002) 	Font	<p>Line Plane</p> <p>Applied to the anatomy of Type:</p> <p>1. Baseline. (Brody)</p>
TYP22	<ul style="list-style-type: none"> <u>Slanting Effects.</u> <u>Slightly Slanted text.</u> The axis of texts is <i>slanted</i>. 	Principle14. Spheriodality Curvature (A)	Texts are slanted slightly.	<p>[Design has been removed due to copyright restrictions]</p> <ul style="list-style-type: none"> (Carter 2002) 	Font	<p>Line</p> <p>Shapes</p> <p>Planes</p> <p>Applied to the anatomy of Type:</p> <p>1. Baseline.</p>

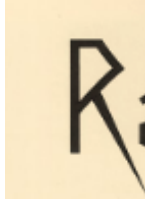

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Effect/ Transformation ID	Translated Effect(s)	TRIZ Principle (Sub-Principle)	Description	Source(s) of inspiration/ idea.	Applied to the (AEGIS Component Name)	Applied to the Graphic Element (Basic Form)
						2. Axis 3. Crossbar 4. Stem (Brody)
TYP23	<ul style="list-style-type: none"> <u>Slanting Effects.</u> <u>Moderately Slanted text.</u> The axis of texts is <i>slanted</i>. 	Principle14. Spheriodality Curvature (A)	Texts are slanted moderately.	[Design has been removed due to copyright restrictions] <ul style="list-style-type: none"> (Carter 2002) 	Font	Line Shapes Planes Applied to the anatomy of Type: 1. Baseline. 2. Axis 3. Crossbar 4. Stem (Brody)
TYP24	<ul style="list-style-type: none"> <u>Slanting Effects.</u> <u>Diagonally Slanted text.</u> The axis of texts is <i>slanted</i>. 	Principle14. Spheriodality Curvature (A)	Texts are slanted diagonally.	[Design has been removed due to copyright restrictions] <ul style="list-style-type: none"> (Carter 2002) 	Font	Line Shapes Planes Applied to the anatomy of Type: 1. Baseline. 2. Axis 3. Crossbar 4. Stem (Brody)
TYP25	<ul style="list-style-type: none"> <u>Slanting Effects.</u> <u>Combined Slanted text.</u> The axis of texts is <i>slanted</i>. 	Principle14. Spheriodality Curvature (A)	Texts are slanted and the effect is combined.	[Design has been removed due to copyright restrictions]	Font	Line Shapes Planes Applied to the anatomy of Type: 1. Baseline.

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Effect/ Transformation ID	Translated Effect(s)	TRIZ Principle (Sub-Principle)	Description	Source(s) of inspiration/ idea.	Applied to the (AEGIS Component Name)	Applied to the Graphic Element (Basic Form)
				<ul style="list-style-type: none"> (Carter 2002) 		2. Axis 3. Crossbar 4. Stem (Brody)
TYP26	<ul style="list-style-type: none"> Width / Horizontal Scaling Width of text is made narrow. 	Principle 35. Parameter Changes	Texts are made narrow.	[Design has been removed due to copyright restrictions] <ul style="list-style-type: none"> (Carter 2002) 	Font	Line Plane Shape Applied to the anatomy of Type: 1. Crossbar 2. Counter 3. Bowl (Brody)
TYP27	<ul style="list-style-type: none"> Width / Horizontal Scaling Width of text is made medium. 	Principle 35. Parameter Changes	Texts are made medium.	[Design has been removed due to copyright restrictions] <ul style="list-style-type: none"> (Carter 2002) 	Font	Line Plane Shape Applied to the anatomy of Type: 1. Crossbar 2. Counter 3. Bowl (Brody)
TYP28	<ul style="list-style-type: none"> Width / Horizontal Scaling Width of text is made wide. 	Principle 35. Parameter Changes	Texts are made wide.	[Design has been removed due to copyright restrictions] <ul style="list-style-type: none"> (Carter 2002) 	Font	Line Plane Shape Applied to the anatomy of Type: 1. Crossbar

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Effect/ Transformation ID	Translated Effect(s)	TRIZ Principle (Sub-Principle)	Description	Source(s) of inspiration/ idea.	Applied to the (AEGIS Component Name)	Applied to the Graphic Element (Basic Form)
						<ol style="list-style-type: none"> Counter Bowl (Brody)
TYP29	<ul style="list-style-type: none"> Width / Horizontal Scaling <i>Width</i> of text is combined (effects narrow medium and wide). The stems and bases are irregular and non uniform in some examples of these samples. 	Principle 35. Parameter Changes	Text effects are combined.	<p>[Design has been removed due to copyright restrictions]</p> <ul style="list-style-type: none"> (Carter 2002)  <ul style="list-style-type: none"> (Nick Greco, 2001)  <ul style="list-style-type: none"> (Nick Greco, 2001) 	Font	<p>Line Plane Shape</p> <p>Applied to the anatomy of Type:</p> <ol style="list-style-type: none"> Crossbar Counter Bowl <p>(Brody)</p>
TYP30	<ul style="list-style-type: none"> Shapes Introduction Shape is introduced in <i>inverted</i> style. 	<p>Principle 40. Composite Materials (A)</p> <p>Principle 7. Nested Doll.</p>	Text is embedded in a shape.	<p>[Design has been removed due to copyright restrictions]</p> <ul style="list-style-type: none"> (Carter 2002) 	Font	Shape

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Effect/ Transformation ID	Translated Effect(s)	TRIZ Principle (Sub-Principle)	Description	Source(s) of inspiration/ idea.	Applied to the (AEGIS Component Name)	Applied to the Graphic Element (Basic Form)
TYP31	<ul style="list-style-type: none"> Shapes Introduction Shape is adjacent. 	Principle 40. Composite Materials (A) Principle 7. Nested Doll.	Shape is introduced next to text.	[Design has been removed due to copyright restrictions] <ul style="list-style-type: none"> (Carter 2002) 	Font	Shape
TYP32	<ul style="list-style-type: none"> Shapes Introduction Shape is introduced in combination. 	Principle 40. Composite Materials (A) Principle 7. Nested Doll.	Shape is embedded and a combination is used.	[Design has been removed due to copyright restrictions] <ul style="list-style-type: none"> (Carter 2002) 	Font	Shape
TYP33	<ul style="list-style-type: none"> Symbols Introduction Symbols are introduced in <i>normal</i> style. 	Principle 40. Composite Materials. Principle 35. Parameter Changes.	Symbols are used next to the text.	[Design has been removed due to copyright restrictions] <ul style="list-style-type: none"> (Carter 2002) 	Font	Lines Shapes
TYP34	<ul style="list-style-type: none"> Symbols Introduction Symbols are introduced in <i>manipulated</i> style. 	Principle 40. Composite Materials. Principle 35. Parameter Changes.	Symbols are used next to the text.	[Design has been removed due to copyright restrictions] <ul style="list-style-type: none"> (Carter 2002) 	Font	Lines Shapes
TYP35	<ul style="list-style-type: none"> Symbols Introduction Symbols are introduced in <i>normal</i> style. 	Principle 40. Composite Materials. Principle 35. Parameter Changes.	Symbols are used to surround text.	[Design has been removed due to copyright restrictions] <ul style="list-style-type: none"> (Carter 2002) 	Font	Lines Shapes


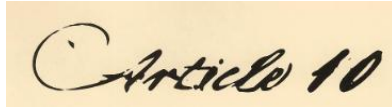
Engineering Innovation (TRIZ based Computer Aided Innovation)

Effect/ Transformation ID	Translated Effect(s)	TRIZ Principle (Sub-Principle)	Description	Source(s) of inspiration/ idea.	Applied to the (AEGIS Component Name)	Applied to the Graphic Element (Basic Form)
TYP36	<ul style="list-style-type: none"> Images Introduction Images are introduced in <i>manipulated</i> style. 	Principle 40. Composite Materials. Principle 35. Parameter Changes.	Symbols are used to surround text.	[Design has been removed due to copyright restrictions] <ul style="list-style-type: none"> (Carter 2002) 	Font	Lines Shapes
TYP37	<ul style="list-style-type: none"> Images Introduction Images are introduced in background. 	Principle 40. Composite Materials.	Images are used as background in Font component.	[Design has been removed due to copyright restrictions] <ul style="list-style-type: none"> (Carter 2002) 	Font	Lines Shapes Texture
TYP38	<ul style="list-style-type: none"> Images Introduction Images are introduced adjacent. 	Principle 40. Composite Materials.	Images are used adjacent to Font component.	[Design has been removed due to copyright restrictions] <ul style="list-style-type: none"> (Carter 2002) 	font	Lines Shapes Texture
TYP39	<ul style="list-style-type: none"> Images Introduction Images are contained. 	Principle 13. Other Way Round (A) Principle 32. Color Changes	Images are contained in the text of Font component.	[Design has been removed due to copyright restrictions] <ul style="list-style-type: none"> (Carter 2002) 	Font	Lines Shapes Texture
TYP40	<ul style="list-style-type: none"> Images Introduction Images are manipulated and in background. 	Principle 13. Other Way Round (A) Principle 32. Color Changes	Images are manipulated and introduced as background of Font component.	[Design has been removed due to copyright restrictions]	Font	Lines Shapes



Engineering Innovation (TRIZ based Computer Aided Innovation)

Effect/ Transformation ID	Translated Effect(s)	TRIZ Principle (Sub-Principle)	Description	Source(s) of inspiration/ idea.	Applied to the (AEGIS Component Name)	Applied to the Graphic Element (Basic Form)
				(Carter 2002)		Texture
TYP41	<ul style="list-style-type: none"> <u>Blend: Gradient Transitions in Tone and Colour.</u> <u>Linear Blend</u> Applying Texture. 	<p>Principle 22. Blessing in Disguise (A)</p> <p>Principle 21. Skipping</p> <p>Principle 32. Color Changes</p> <p>Principle 35. Parameter Changes.</p>	<p>Colour transition (vertical) applied to texts.</p>	<p>[Design has been removed due to copyright restrictions]</p> <ul style="list-style-type: none"> (Carter 2002) 	Font	<p>Colour</p> <p>Texture</p> <p>Colour</p> <p>Texture</p>
TYP42	<ul style="list-style-type: none"> <u>Blend: Gradient Transitions in Tone and Colour.</u> <u>Linear Blend</u> Applying Texture. 	<p>Principle 22. Blessing in Disguise (A)</p> <p>Principle 21. Skipping</p> <p>Principle 32. Color Changes</p> <p>Principle 35. Parameter Changes.</p>	<p>Colour transition (horizontal) applied to texts.</p>	<p>[Design has been removed due to copyright restrictions]</p> <ul style="list-style-type: none"> (Carter 2002) 	Font	<p>Colour</p> <p>Texture</p>
TYP43	<ul style="list-style-type: none"> <u>Blend: Gradient Transitions in Tone and Colour.</u> <u>Radial Blend</u> Applying Texture. 	<p>Principle 22. Blessing in Disguise (A)</p> <p>Principle 21. Skipping</p> <p>Principle 32. Color Changes</p> <p>Principle 35. Parameter Changes.</p>	<p>Colour transition (inward) applied to texts.</p>	<p>[Design has been removed due to copyright restrictions]</p> <ul style="list-style-type: none"> (Carter 2002) 	Font	<p>Colour</p> <p>Texture</p>




Engineering Innovation (TRIZ based Computer Aided Innovation)

Effect/ Transformation ID	Translated Effect(s)	TRIZ Principle (Sub-Principle)	Description	Source(s) of inspiration/ idea.	Applied to the (AEGIS Component Name)	Applied to the Graphic Element (Basic Form)
TYP44	<ul style="list-style-type: none"> <u>Blend: Gradient Transitions in Tone and Colour.</u> <u>Combination Blend</u> Applying Texture. 	<p>Principle 32. Color Changes</p> <p>Principle 35. Parameter Changes.</p> <p>Principle 22. Blessing in Disguise (A)</p> <p>Principle 13. Other Way Round (A)</p>	Colour transition (combination) applied to texts.	<p>[Design has been removed due to copyright restrictions]</p> <ul style="list-style-type: none"> (Carter 2002) 	Font	<p>Colour</p> <p>Texture</p>
TYP45	<ul style="list-style-type: none"> <u>Curvature/ Spirals Introduction</u> Curvature in Line effects. Bending the cross bar. 	<p>Principle 14. Spheriodality</p> <p>Principle 26 Copying (B)</p>	Curvy effects are applied to text/ Font Component	 <p>(Nick Greco, 2001)</p>  <p>(Nick Greco, 2001)</p> <p>[Design has been removed due to copyright restrictions]</p>	Font Component.	<p>Line</p> <p>Shape</p> <p>Texture</p> <p>Shape</p> <p>Applied to the anatomy of Type:</p> <ol style="list-style-type: none"> Descender Bracket Shoulder / Arm Ear <p>(Spiekermann.E. and Brody.N., 2008)</p> <p>(Carter, 2002)</p>



Engineering Innovation (TRIZ based Computer Aided Innovation)

Effect/ Transformation ID	Translated Effect(s)	TRIZ Principle (Sub-Principle)	Description	Source(s) of inspiration/ idea.	Applied to the (AEGIS Component Name)	Applied to the Graphic Element (Basic Form)
				<p>(Nick Greco, 2001)</p> <p>[Design has been removed due to copyright restrictions]</p> <p>(Nick Greco, 2001)</p>  <p>(Nick Greco, 2001)</p> <p>[Design has been removed due to copyright restrictions]</p> <p>(Nick Greco, 2001)</p> 		

Engineering Innovation (TRIZ based Computer Aided Innovation)

Effect/ Transformation ID	Translated Effect(s)	TRIZ Principle (Sub-Principle)	Description	Source(s) of inspiration/ idea.	Applied to the (AEGIS Component Name)	Applied to the Graphic Element (Basic Form)
TYP46	<ul style="list-style-type: none"> Distortion Introduction Distortion in Line effects. 	<p>Principle22. Blessing in Disguise</p> <p>Principle1. Segmentation</p> <p>Principle21 Skipping (A)</p> <p>Principle19 Periodic Action (A,C)</p>	The text is distorted in various ways.	 (Nick Greco, 2001)  (Nick Greco, 2001)  (Nick Greco, 2001) <p>[Design has been removed due to copyright restrictions]</p> <p>(Nick Greco, 2001)</p>	<p>Font Component</p> <p>Background</p>	<p>Line</p> <p>Shape</p> <p>Colour</p> <p>Texture</p> <p>Planes</p> <p>Applied to the anatomy of Type:</p> <p>1. Bowl</p> <p>2. Ascender</p> <p>(Spiekermann.E. and Brody.N., 2008)</p> <p>(Carter, 2002)</p>

Engineering Innovation (TRIZ based Computer Aided Innovation)

Effect/ Transformation ID	Translated Effect(s)	TRIZ Principle (Sub-Principle)	Description	Source(s) of inspiration/ idea.	Applied to the (AEGIS Component Name)	Applied to the Graphic Element (Basic Form)
TYP47	<ul style="list-style-type: none"> Introduction of line distortion effects Line is broken 	Principle4. Asymmetry	The text axis is manipulated and half of text is dislocated.	 (Nick Greco, 2001)		Line Planes Shape Space Applied to the anatomy of Type: 1. Ascender 2. Stem (Spiekermann.E. and Brody.N., 2008) (Carter, 2002)
TYP48	<ul style="list-style-type: none"> Introduction of spiral/ curvy effects on text Line is curved 	Principle14. Spheriodality (A) Principle2. Taking Out (A) Principle22. Blessing in Disguise (A)	The text is made curvy.		Font Component	Line Colour Shape Applied to the anatomy of Type: 1. Bowl 2. Axis (Spiekermann.E. and Brody.N.,

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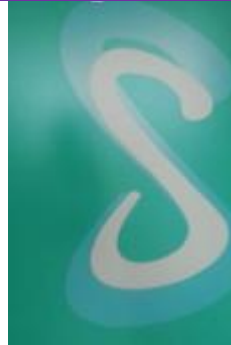

Effect/ Transfor- mation ID	Translated Effect(s)	TRIZ Principle (Sub-Principle)	Description	Source(s) of inspiration/ idea.	Applied to the (AEGIS Component Name)	Applied to the Graphic Element (Basic Form)
				  (Adele, 2012)		2008) (Carter, 2002)

Table 5: Analysis of innovative element manipulation in graphic designs (TRIZ).

Copyright Statement: Permission to reproduce these images has been granted respectively by the copyright holders: Roto Vision Publisher, Nick Greco –Author, Alan Swann- Author, Webdesign.org Publisher, and David. K Farkas-Author for the respective images via different email communications the purpose of facilitation of this research.

Engineering Innovation (TRIZ based Computer Aided Innovation)

From table 5, it was concluded that behind each innovative design, the researcher could identify at least one major TRIZ Principle. Hence, the next step identified was to categorize the content above according to the TRIZ Principles. In this table, the researcher has been able to map the innovative manipulations to TRIZ Principles. The next section discusses this in detail the grouping of the TRIZ Principle based effects and sketches the idea of chromosomes for each group.

3.3.4 Defining TRIZ Graphic Design Forms

Since it is possible that an innovative graphic design can have many innovative technical design variations, hence it was essential to group various technical design varieties of innovative graphic design under the same heading. This was determined by analysing the various variations and effects on basic graphic design elements and if they were variations of element in a particular way but in different styles, they were grouped in same innovative pattern family. Hence the last step was necessary. The last step to translate TRIZ Principles to graphic design was to group the same effects together to define the graphic design specific forms for TRIZ. This is shown in table 6. One example is a letter can have its ascender in variety of shades, or split, hence all these variations come under the category of same innovative pattern (hence later related to same TRIZ Principles). The table 5 and table 6 are linked using the transformation ID's.

Chromosome	Transformation ID's	TRIZ Principles Pool (Sub-Principle)	Description of the Main Transformation Effects Considered For Each Category
Spheroidality Trait	<ul style="list-style-type: none"> • TYP45 • TYP48 	Principle 14. Spheroidality(A)- Main Principle Principle 26 Copying (B) Principle 35 Parameter Changes (B) Principle 32 Color Changes(A) Principle 7. Nested Doll (A) Principle 8. Anti-Weight (A)	<p>In this category, the major principle identified is 14. The various graphic elements are subject to curvature in various styles and positions.</p> <p>However, after curvature, the text copying effects are observed in some of the images. At the stage of chromosome design, it was decided not to include the text copying effects in this chromosome as a separate chromosome is reserved for this in this table below to take care of these effects.</p> <p>The colour change and nested doll effects are also observed in these images, but again the copying</p>

Chromosome	Transformation ID's	TRIZ Principles Pool (Sub-Principle)	Description of the Main Transformation Effects Considered For Each Category
			chromosome and the colour chromosome take care of those effects.
Outlining	<ul style="list-style-type: none"> • TYP1. • TYP3 • TYP8 	Principle2 Taking Out(A)-Main Principle Principle 7. Nested Doll (A) Principle 8. Anti-Weight (A). Principle 35 Parameter Changes (B) Principle 26 Copying (A, B) Principle14. Spheriodality (A)	<p>In these images, the line of text is duplicated or the edge of line colour is changed. This automatically also makes the text look like as nested doll as well. The anti weight effect is observed when the outer line of text has lighter colour.</p> <p>It also gives copying effect to the text as the lines in text look like duplicated in various colours.</p>
Segmentations	<ul style="list-style-type: none"> • TYP2 	Principle1 Segmentation (A,B) Principle21 Skipping (A) Principle19 Periodic Action(A,C) Principle22. Blessing in Disguise (A)	<p>These images have the lines of text segmented in various ways. Hence it can also be called as skipping, or periodic action applied as the colour may be missing in some places matching the background colour). This effect also leads to distortions sometimes hence leading to note that principle 22 may be applied.</p>
Extensions And Shortenings	<ul style="list-style-type: none"> • TYP5 	Principle 35 Parameter Changes(B)	<p>In these examples, the letters are randomly shortened or extended (only a part of the letter), with respect to other font types. This looks odd hence classified as</p>

Chromosome	Transformation ID's	TRIZ Principles Pool (Sub-Principle)	Description of the Main Transformation Effects Considered For Each Category
		Principle 22. Blessing in Disguise (A)	blessing in disguise too.
Fragmentations	<ul style="list-style-type: none"> TYP47 	Principle 1 Segmentation (A) Principle 4 Asymmetry Principle 2 Taking Out(A) Principle 22. Blessing in Disguise (A)	In these examples, the letter lines are fragmented bny parts and at various places, hence it also creates the asymmetric effects and it seems a part of the text letter has been taken out or moved. Sometimes it looks odd hence classed as principle 22 as well.
Shapes Introduction	<ul style="list-style-type: none"> TYP30 TYP31 TYP32 TYP6 	Principle 40 Composite Materials (A) Principle 7 Nested Dolls.	Introduction of shapes like: circles, rectangles etc is observed in these types of designs. In some cases where the size of the shape is more than the text size, it looks like a nested doll effect automatically.
Symbols Introduction	<ul style="list-style-type: none"> TYP33 TYP34 TYP35 TYP36 	Principle 40 Composite Materials (A) Principle 35. Parameter Changes.	Introduction of symbols (non alpha numeric) etc is observed in these types of designs.
Repetition(s)/ Copy	<ul style="list-style-type: none"> Typ16 	Principle 26 Copying (B)	Copying of letter is observed in these designs, whereby some or all the text letters are duplicates or triplicates or repeated n times in different ways. This effects is important because this effects has been

Chromosome	Transformation ID's	TRIZ Principles Pool (Sub-Principle)	Description of the Main Transformation Effects Considered For Each Category
			observed in conjunction with various other effects in various other categories of examples of this table.
Slanting	<ul style="list-style-type: none"> • TYP22 • TYP23 • TYP24 • TYP25 	Principle 14 Spheriodality Curvature (A)	In this type of effect, some or all of the text is slanted at varied angles.
Scaling	<ul style="list-style-type: none"> • TYP26 • TYP27 • TYP28 • TYP29 	Principle 35. Parameter Changes.	In this type of effect, some or all the font letter text is scaled either on reduction or enlargement basis.
Rotation	<ul style="list-style-type: none"> • TYP18 • TYP19 • TYP20 • TYP21 	Principle 14 Spheriodality Curvature (A)	<p>In this type of effect, some or all of the text is rotated at varied angles.</p> <p>Difference between scaling and rotating is that the whole plane of font component of one letter type is rotated in this case.</p>
Colour/Toning	<ul style="list-style-type: none"> • TYP44 	Principle 32 Color Changes (A)	In this case, the colour of text is manipulated in various uniform, non uniform and random/ mixed ways. This is important because colour change effect has been observed in many other categories of the transformations in this table.

Chromosome	Transformation ID's	TRIZ Principles Pool (Sub-Principle)	Description of the Main Transformation Effects Considered For Each Category
Distortion Colouring	<ul style="list-style-type: none"> • TYP41 • TYP42 • TYP43 	<p>Principle22. Blessing in Disguise (A)</p> <p>Principle 21. Skipping</p> <p>Principle 32. Color Changes</p> <p>Principle 35. Parameter Changes.</p>	These effects are observed whereby the text colouring is distorted by various means. Examples are: faded text, non uniform text etc. sometimes, it looks odd, hence the principles 35, and 22 are also a key part of this transformation,
Distortion Mutilating	<ul style="list-style-type: none"> • TYP46 	<p>Principle 22 Blessing in Disguise (A)</p> <p>Principle1. Segmentation</p> <p>Principle21 Skipping (A)</p> <p>Principle19 Periodic Action (A,C)</p>	These effects are observed whereby the text itself is distorted by various means. Examples are: non disciplined text, missing part of text etc. sometimes, it looks odd, hence the principles 35, and 22 are also a key part of this transformation,
Plane Manipulation of Font Component Background	<ul style="list-style-type: none"> • TYP7 • TYP9 • TYP10 • TYP11 • TYP12 • TYP13 • TYP14 • TYP15 • • 	<p>Principle 40. Composite Materials</p> <p>Principle14. Spheriodality</p> <p>Principle4. Asymmetry.</p> <p>Principle 16. Partial or Excessive Actions.</p> <p>Principle 35. Parameter Changes.</p> <p>Principle22. Blessing in Disguise (A)</p>	In these kinds of design example, the font component as a whole is manipulated. For example, the letters are irregularly spaced, some letters have odd sizes, whole font component is rotated etc.

Chromosome	Transformation ID's	TRIZ Principles Pool (Sub-Principle)	Description of the Main Transformation Effects Considered For Each Category
Component Addition	<ul style="list-style-type: none"> • TYP37 • TYP38 • TYP39 • TYP40 	<p>Principle 40. Composite Materials.</p> <p>Principle 13. Other Way Round (A)</p> <p>Principle 32. Color Changes</p>	In some of the examples, it was found that a new component has been added to the whole design (in the form of an additional textured image).

Table 6: Grouping of graphic manipulations to TRIZ Principles.

Chapter 4 discusses the AEGIS software using GA's based on this chapter analysis. This chapter 3 has hence laid down the basis of a theoretical framework for a computer aided innovation tool, which utilizes genetic algorithms to implement TRIZ Principles in graphic design. Hence at the end of chapter 3, this research has been able to draw the TRIZ manipulations of graphic design basic forms knowledge base and a definition set of the GA based CAI tool for graphic design.

Chapter 4:

Genetic Algorithms and AEGIS

4.1 Introduction

In the software AEGIS (Accelerated Evolutionary Graphic Interface System), TRIZ is being applied to graphic design.

This chapter discusses the previous versions followed by application of TRIZ to graphic design using Genetic Algorithms and the datasheets produced in the previous chapter.

4.1.1 Goals of AEGIS

Many questions have been formulated to be answered by this research. Some of the general questions are: Is it possible to automate innovation using TRIZ up to 100%? If not, then how much? Can the DNA of Innovation be captured (using TRIZ)? What percentage and how effectively?

Some specific research questions under AEGIS are: Can TRIZ Principles be implemented through CAI tools (automated) in case of graphic design/ (packaging design)? Specifically, can a tool be developed to help graphic designers innovate? Can TRIZ Principles be used to guide this tool and help in step-changes? If yes then how much and at which stage and can this process be automated?

AEGIS project is also aimed to find out that what will be the impact of CAI implementation on the speed/quality of graphic designs as compared to the designs by graphic designers using existing tools?

The first objective of this research while developing the AEGIS toolkit is to attempt the manufacture, design and testing of a software toolkit which helps automate the process of innovative design generation to a certain extent. The objective of AEGIS is also to assist the graphic designers while generating innovative packaging designs. The testing of AEGIS on sample data is an important aspect of AEGIS project, as it helped the research team to address many research questions.

The research questions asked section need to be answered through the testing of AEGIS on data and collecting regular feedback from graphic designers. NB: The possibility of combining the AEGIS with existing tools to enhance the initial innovative idea generation is also not being ruled out in this research.

One of the important properties the researcher and supervisory team wanted the AEGIS to have was the capability to learn and self adapt. The knowledge base in AEGIS needs to develop more and more it is used, to help generate and develop an experienced and rich source of information about the evolution of the solutions from time to time. This requirement was subsequently added to the original specifications after a series of meetings with supervisory team and the graphic designers.

4.1.2 Selection of TRIZ Principles

The rationale to choose the selected TRIZ Principles for AEGIS was twofold. One reason to choose these principles was that during many questionnaire sessions, the graphic designers were made aware of the TRIZ framework and many of them highlighted some of the principles that they suggested would be useful for the graphic design. The designers suggested these principles by demonstrating rough sketches of the graphic design elements to the researcher and also filling the questionnaire sheets and healthy professional discussions were held in group sessions (Appendix-VII).

Second reason to choose the selected principles were that after analysing the innovative contents (see chapter 3), some principles were identified after discussion between the researcher and graphic designer. However, it is recommended to go through the rest of principles to identify their potential in graphic design to take this research further.

4.2 Previous Work (2010)

4.2.1 Software Requirement Specifications

Functionality :To be able to mutate images; Iterative mutations based interface

Outputs: In the form of finalized design (picture formats); Intermediate images used and generated (for research and future use)

Inputs: Initial sketches or seed image(s); User preferences

Performance: It will be designer's attempt to make its performance better as compared to commonly used graphic design tools like Adobe PS in certain aspects such as speed, choice of mutations, etc.

Design constraints: Most of the design patterns, algorithms should be guided by TRIZ Principles; Manual interpretation of users should be kept to minimum in case of guiding the design

External interfaces: It may be later used as a plug-in or a connection to other tools; It can take outputs from other tools like handwriting alphabet generation based tool.

4.2.2 Design and Development (previous sections)

These sections are from the previous research which was carried on by April 2010(Shahdad, 2010).

The AEGIS concept started with the idea of application of TRIZ to packaging of products especially of washing products. The following of TRIZ Principles/ Trends were of specific interest in this R&D project.

- Surface Segmentation
- Space Segmentation
- Asymmetry
- Geometric Evolution

Some of the functional implementations in terms of above TRIZ were done in AEGIS. These were framed after mapping the general TRIZ in to the specific graphic design problems. TRIZ Principles are specified in general in the TRIZ literature and manuals. Every problem solver or innovation consultant needs to map these to their personal problem and frame the specific solution set. In context of this discussion, the following functional implementation framework was drafted and implemented in AEGIS.

However, as mentioned this was earlier part of the research and the below was a result of group discussion between supervisory team and the research at the outset of this research. At the outset of this research, TRIZ trends were also considered to be applied to graphic design as all possibilities were being charted out, this is mainly because the possibility of 3D graphic design was also considered at beginning, but later only label and packaging (2D designs) were included in the first part of the research (this report). It is recommended to analyse the 3D graphic design with respect to TRIZ trends in detail to take this research to the next level. Some of the discussions held are listed below, but not taken further to a detailed level after.

- Introducing curves

This is the specific implementation of space segmentation. It was concluded after the implementation of version1.0 that the space segmentation should be applied in a graphic design specific manner rather than simply introducing space segmentation concepts like holes in trivial format. Hence, after considering specific implementation of space segmentation, the curves were identified as one of the project specific implementation goals of AEGIS. The curves in case of this tool can be of many types like curves on edges, curves in middle of the pack, curves cutting the middle of edges. Figure 11 shows the introduction of curves implementation as obtained in version 2 of AEGIS.

- Introducing concave gaps on corners

This is the specific implementation of curves in this tool. When the curves are applied to corners, concave gaps are created on the packs which vary in size, shape, positions and angles. Figure 12 (row 1, column 3 image) shows this implementation as obtained in version 3.

- Double curving

A double curve is a special case of curve in which two curves are placed next to each other.

- Colouring intelligently text change

This has been implemented in version 6.x series at this stage of research. Mutating the layers separately has enabled this type of effect implementation in AEGIS. Detailed discussion of these implementations is available in this chapter in section 3.4.

- Horizontal holes, vertical holes, diagonal holes

Oval shaped holes are being implemented as a specific mapping of space segmentation to the AEGIS tool. (see figure 10)

- Parallelogram oriented shapes

The whole package design or a part of it is deformed to a parallelogram shape. The effect varies in terms of angle, size, proportional ratio of length and width. This is a specific implementation of asymmetry trend. The initially symmetrical system is subject to partial and then matched asymmetry in this case. (see figure 10)

- Inverting colour of half of object or a proportionate colour inversion

This is the implementation of traversing the colour evolution trend in reverse direction, whereby some of the colour elements of the packaging design are deprived of some of the colours in original image. (see figure 10)

- Rectangular holes

This is also a part of specific implementation of space segmentation TRIZ trend. The rectangles vary in size, proportional size to original size of package design, ratio of width and height and position on package design. (see figure 10)

4.2.2.1 *Original Idea/ Sketches*

The idea of AEGIS started Image-Breeder (Image Breeder 2009), which was the basic and first step towards an automated 'wow' design capability. What was desirable about the site, that it allowed users to mutate and create new images in a nice and user-friendly format? What was undesirable about it is was that the mutations were random and therefore it took too long to generate an attractive (useful) image. One of the things desirable in this project was to make a

better version of image breeder. Rather than have it as a tool for making just pretty pictures, making to do a more useful design job. A considerable step was to integrate some of the TRIZ Principles into the mutation algorithms so that instead of being random they are much more guided towards the 'wow' direction.

4.2.2.2 *Technology Platforms*

Different versions of the AEGIS have been developed in different technologies. C#.NET, Aforge.NET and Mathematica (Wolfram Research Group 2009) are the technologies used. A brief description of these technologies employed is given below.

C#.NET

C# is one of the main languages being used in AEGIS project. C# (pronounced "see sharp") is a multi-paradigm programming language encompassing imperative, functional, generic, object-oriented (class-based), and component-oriented programming disciplines (C# 2010). It was developed by Microsoft within the .NET initiative and later approved as a standard by Ecma and ISO. C# is one of the programming languages designed for the Common Language Infrastructure (C# 2010). C# is intended to be a simple, modern, general-purpose, object-oriented programming language. Its development team is led by Anders Hejlsberg. The most recent version is C# 4.0, which was released in April 12, 2010 (C# 2010).

This language was used in the implementation of AEGIS tool. C# has different functions and handlers using which the images can be read as pixel data, pixels can be manipulated and the transformed outputs can be displayed easily. This language allows the programmer to manipulate the images at pixel level. Besides, using visual studio IDE from Microsoft, user friendly and good interfaces can be made by developers in a convenient way. Furthermore, the object oriented approach followed in this language allows the user to re-use the code easily, write a better structured code and manipulate different functions in an organized way.

The image read using the input image function, can be conveniently stored as bitmap objects and can be passed on to class specific functions as parameters. These features strongly support and allow the developers of future versions can easily develop the software to a further higher level, if needed.

Mathematica

Mathematica is split into two parts, the "kernel" and the "front end". The kernel interprets expressions (Mathematica code) and returns result expressions (Mathematica 2010). The front end, designed by Theodore Gray, provides a GUI, which allows the creation and editing of Notebook documents containing program code with prettyprinting, formatted text together with results including typeset mathematics, graphics, GUI components, tables, and sounds (Mathematica 2010). All contents and formatting can be generated algorithmically or interactively edited. One level of "undo" is supported, along with most standard word processing capabilities (Mathematica 2010). Documents can be structured using a hierarchy of cells, which allow for outlining and sectioning of a document and support automatic numbering index creation. Documents can be presented in a slideshow environment for presentations. Notebooks and their contents are represented as

Mathematica expressions that can be created, modified or analyzed by Mathematica programs (Mathematica 2010). This allows conversion to other formats such as TeX or XML(Mathematica wiki 2009).

The front end includes development tools such as a debugger, input completion and automatic syntax coloring (Mathematica wiki 2009). The kernel and the front end communicate via the MathLink protocol. It is possible to use the kernel on one computer and the front end on another. The standard front end is used by default, but alternative front ends are available (Mathematica 2010). They include the Wolfram Workbench, an Eclipse based IDE, introduced in 2006. It provides project-based code development tools for Mathematica, including revision management, debugging, profiling, and testing. Mathematica also includes a command line front end(Mathematica wiki 2009).

Mathematica 7 is supported on various versions of Linux, Apple's Mac OS X, NT-based Microsoft Windows, and Sun's Solaris platforms. All platforms are supported with 64-bit implementations. Earlier versions of Mathematica up to 6.0.3 supported other operating systems, including AIX, Convex, HP-UX, IRIX, MS-DOS, NeXTSTEP, OS/2, Ultrix and Windows Me (Mathematica 2010). The Mathematica Home Edition is a 32-bit application on Microsoft Windows, Linux and Mac OS X (Intel).

Mathematica was chosen for one of the version of AEGIS as an experiment to determine its potential to develop full-fledged working model/version of AEGIS. During the investigation of the tools potential to develop AEGIS, many advantages were found and many features were used in the development of one of the versions of AEGIS. Many high level functions (as compared to pixel level) are available in Mathematica which were utilized for implementation in Mathematica. Furthermore, the notebook programs developed by many users of Mathematica are easily available on Wolfram website in community development section and are free to be used by other developers. Despite the advantages listed above, the research team conclusively decided not to work further in this language to develop AEGIS tool. The main reason for this decision was that the Mathematica does not support the development of a strong interactive interface (event driven) as compared to c#.NET or .NET in general.

AForge.NET

AForge.NET is a computer vision and artificial intelligence library originally developed by Andrew Kirillov for the .NET Framework, however it remains compatible with other CLR implementations including Mono and the .NET Compact Framework (Aforge Net wiki 2010). The source code and binaries of the project are available under the terms of the Lesser GPL license(Aforge Net wiki 2010)..

API supports:

- Computer vision, Image processing and Video processing;
 - Including a comprehensive image filter library;
- Neural networks;
- Genetic programming;
- Fuzzy logic;

- Machine Learning;
- and libraries for a select set of robotics kits:
- Lego Mindstorms NXT and RCX kits;
- TeRK Qwerk kit;
- Surveyor SRV-1 and SVS kits.

The framework is provided not only with different libraries and their sources, but with many sample applications, which demonstrate the use of this framework, and with documentation help files, which are provided in HTML Help format. The documentation is also available on-line (Aforge Net wiki 2010). This technology allows the use of some inbuilt functions for image processing. Based on .NET technology, this technology has some customized and readymade functions built in c#.net code. The libraries can be used through image manipulation functions. In view of above discussion, a number of tools were studied, investigated and the potential of these tools for developing AEGIS was investigated. These tools were initially considered after discussion with project team members and/or research engineer with reference to few examples which were available as a capability of these tools to be used in image processing. However, after investigation as discussed above, it was conclusively decided to carry on the development of AEGIS in c#.net at this stage to develop further advanced level of AEGIS versions. Mathematica and Aforge.NET had good functionalities of image processing coding, but after investigation those functionalities were revealed in detail and were not found to be exactly satisfying the requirements of AEGIS project.

4.2.2.3 Non Genetic Algorithm Versions

The AEGIS history started with versions 1 through 6. Version 1 was a simple program which read the sample image, applied primitive mutations to that parent image. The resulting images contained three basic mutations – holes, asymmetry and vertical rotations implemented in a simple manner.

Version 1 was implemented in C#.NET Technology. The AEGIS concept started with the idea of applying TRIZ to packaging of products, particularly washing products. The following TRIZ were originally specified as appropriate to this project:-

Surface Segmentation, Space Segmentation, Asymmetry and Geometric Evolution. Some of the functional implementations in terms of above TRIZ are:-

Introducing curves, introducing concave gaps on corners, double curving, colouring intelligently text change, Space segmentation – includes horizontal holes, vertical holes, diagonal holes, parallelogram oriented shapes, inverting colour of half of object or a proportionate colour inversion and rectangular holes

See Figure 12.

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Figure 10: Showing three examples using AEGIS V1, implemented in C#.NET Technology.

Basic mutations had been achieved in this version hence a starting point without any iterations. The picture controls and the bmp objects have been successfully implemented and mutation has been applied to them in this version. As compared to the evaluation criteria, the answering of the research question needed further work. The 3x3 or 4x4 grid has not been implemented in this version, hence the grid needed to be implemented in Version 2.

Version 2 produced 7 mutations of the parent image. Mutations included: rounding of corners, oval shaped perforations, compression, curves and vertical rotation. See Figure 11.



Figure 11: AEGIS V2 showing rounding of corners, oval shaped perforations, compression, curves and vertical rotation

More advanced mutations have been achieved in this version. Curves, corner curves and compression have been achieved here. Again, the 3x3 or 4x4 grid has not been fully implemented yet. Version 3 contains a grid and some more features.

Version 3 produced 9 mutations of the parent image. Mutations included: rounding of corners, oval shaped perforations, compression, curves and vertical rotation, asymmetry, introduction of foreign shapes (triangles) at various positions, encircling the parents image with different colours, changing the conjure of half of the parent image, half parallelogram, rectangular holes were the effects implemented in this version. See Figure 12.



Figure 12: AEGIS V3 showing examples of rounding of corners, oval shaped perforations, compression, curves and vertical rotation, asymmetry, introduction of foreign shapes (triangles) at various positions, encircling the parents image with different colours, changing the conjure of half of the parent image, half parallelogram, rectangular holes

Varied implementation of the various TRIZ Principles has been achieved in this version. The iterations feature has not yet been implemented in this version. Hence, the iteration feature has to be implemented and hence next version has to be made. Version 4 produced many mutations, the algorithm names of which are listed below. The mutations in this version exclusively are of the colour mutation scheme.

This version has been implemented in Mathematica (Mathematica wiki 2009). Algorithms used: _ Charcoal effect, Gaussian noise, Noise (General standard RGB channel noise), Oil painting, Salt pepper noise, Solarization (1988) See figure 13.

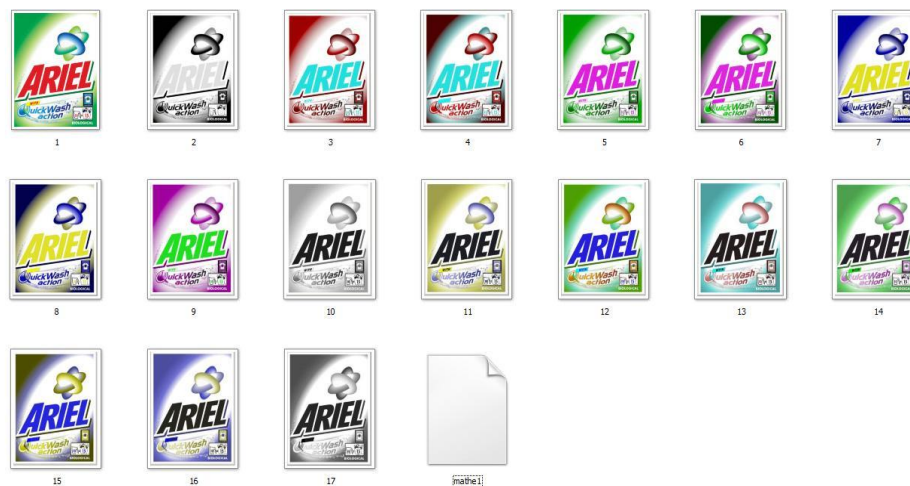


Figure 13 shows implementation in Mathematica with the effects such as charcoal effect, Gaussian noise, Noise (General standard RGB channel noise), Oil painting, Salt pepper noise, Solarization.



Figure 14: The AEGIS 2.1 implemented in Mathematica 7.0 (obtained by application of charcoal effect algorithm).



Figure 15: The AEGIS 4.2 implemented in Mathematica 7.0 (obtained by application of Gaussian noise effect algorithm).



Figure 16: The AEGIS 4.3 implemented in Mathematica 7.0 (obtained by application of noise effect algorithm).



Figure 17: The AEGIS 4.4 implemented in Mathematica 7.0 (obtained by application of oil-painting effect algorithm).



Figure 18: The AEGIS 4.5 implemented in Mathematica 7.0 (obtained by application of salt pepper noise effect algorithm).



Figure 19: The AEGIS Sub-4.6 implemented in Mathematica 7.0 (obtained by application of solarisation noise effect algorithm).

This version was an experimentation to check if Mathematica can be more useful in implementation of as compared to .NET. The conclusion (already submitted in 2009) was that two features were missing:-

- Iterations- Mathematica does not support the mechanism of iterations which is the basic design specification of AEGIS
- Shapes- Mathematica does not easily support shape mutations which are related to TRIZ directly.

However, this version produced a good variety of colour mutations with some standard algorithms. Shifting back to .NET was preferred for further versions.

Version 5 has been implemented in C#.NET Technology (Versions 5.1, 5.2 and 5.3). In this version of AEGIS, all the mutations implemented change the colour channels of the input image through various well defined standard algorithms. They are achieved using a 3x3 convolution matrix. The algorithms used are:-

- Convolution Matrix
- Gamma Function
- Smooth Function
- Color
- Gaussian Blur
- Mean Removal
- Emboss Laplacian

In version 5.1, the parent image is being subjected to the primary mutations listed above. On subsequent clicking on one of the images, the user is taken to second screen where the previously used algorithm is applied in variety of forms by using different parameters. Each of these mutations depend on various mathematical functions as listed below is implemented by using one of the following mutation functions:-

- Sin
- ASin
- IEEERem
- Random
- Cos
- DivRem
- Mod

The above process is continuously repeated as the user goes on clicking on the preferred image.

In version 5.2, the only difference here is that the parent image being clicked becomes the source image of the next iteration and so on.

In version 5.3, the, the version 5.2 is implemented with the difference that the image clicked becomes the parent image but the algorithm implementations remain the same as on first screen. This is observation is important so as to compare it with the different versions of a single algorithm. An improvised version under development is to change the parameters of the same algorithms with the number of clicks. This is being done to investigate the effect of this implementation (varied parameters) on the Version 5.3 and compare these two implementations.

Figure 20,21, and 22 show the implementations in version 5.1.

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Figure 20: This shows the first screen of mutations as implemented in Version 5.1.



Figure 21: This shows the implementation of Smooth algorithm, which is achieved after clicking the cell number 2 of first screen. This is implemented in Version 5.1



Algorithm- Smooth parameter(rweight=511)

Figure 22: Noise case AEGIS 5.1

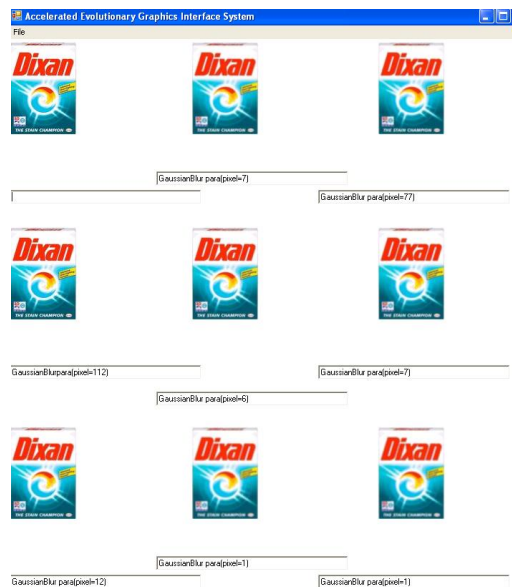


Figure 23: This shows the implementation of Gaussian Blur algorithm, which is achieved after clicking the cell number 7 of first screen. This is implemented in Version 5.1



Figure 24: Failure case: AEGIS 5.x

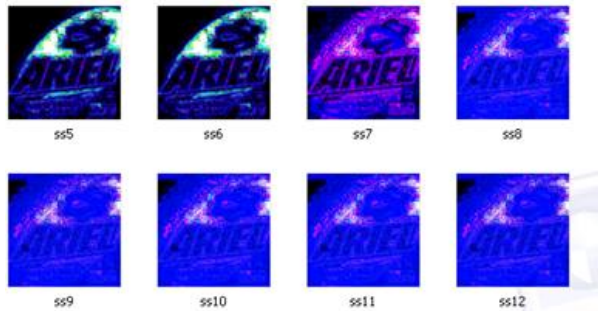


Figure 25: Failure case: After application of selected offspring back as parent image in Versions 5.x.

In this version, the colour / channel mutations have been achieved through different standard algorithms. 3x3 matrixes has been implemented and iterations have been achieved,

Further versions implement the shapes in the similar way as Version 5.

Version 6 – Layers Embedded Version

From discussion with the project supervisory team, it was revealed that the implementation of this project at some stage or phase in layers is crucial to achieve outstanding commercially potential results. Hence, considering this and the feedback from Peter Jones, it was primarily concluded that an external mechanism can be either initially or finally used (either the sample image be passed initially through it or the results be passed finally through it).

Layered version of software seemed to have more potential as compared to previous versions. This discussion is supported by many operational facts and by the discussion and feedback by the graphic designers. The layered version allows the separation of operation on each component (layer) independent of each other. Application of mutation on any layer does not affect other layers. This is an efficient way to apply innovative effects separately on each layer. In previous versions, the effect was applied to whole of the image, hence the variations produced were limited and quality of image in some cases effected because a mutation could be suitable for one layer while as not suitable for other layer.

In case of layering system, the image quality can be improved as compared to previous versions of software. Moreover, the permutations and combinations of output images is highly increased in case of layering system, hence giving more choices to designer to select from and generates a more varied set of samples and can help reach a design decision quickly.

Eight layered implementation has been successfully implemented in Version 6. This software tool is aimed to help the graphic designers wanting to innovate. At the present stage, the research team proposes that this tool can help graphic designers to innovate in many ways, especially as compared to traditional tools with graphic designers. However, it is out of the scope of this research to try to

make a comprehensive tool which serves all the functions as needed by graphic designers. The successive questionnaires will make it clear as to in what specific way the graphic designers will be helped by this tool in order to innovate. However at present, many possible ways are proposed in which the graphic designer may be aided to innovate including speedy outputs, quick displays, image breeder style clicks and aid to innovate using display of TRIZ directed based mutations.

The question, whether the innovation can be automated or not, can only be answered after obtaining a conclusive detailed questionnaire from graphic designers in the second phase of questionnaires. The answers can be analysed in different ways. As the TRIZ principles/ are being implemented in an automated manner in this software tool, any benefit to graphic designers from this tool could imply that the tool has succeeded in automating innovation (automating implementation of TRIZ- an innovation methodology). Another perspective to this problem is to be able to achieve some effects or any feature which the graphic designers would consider as helping/aiding/assisting their ideas to innovate or in the best case generate ideas for graphic designer. This case has been proved to a certain extent in the questionnaires in which the graphic designers agree that AEGIS displays quick ideas assisting outputs for focus groups.

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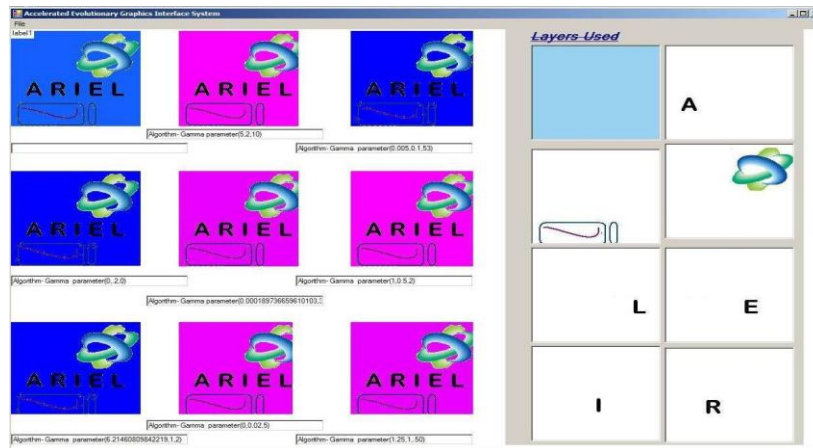


Figure 26a: Eight layer implementation in Version 6- First screen.

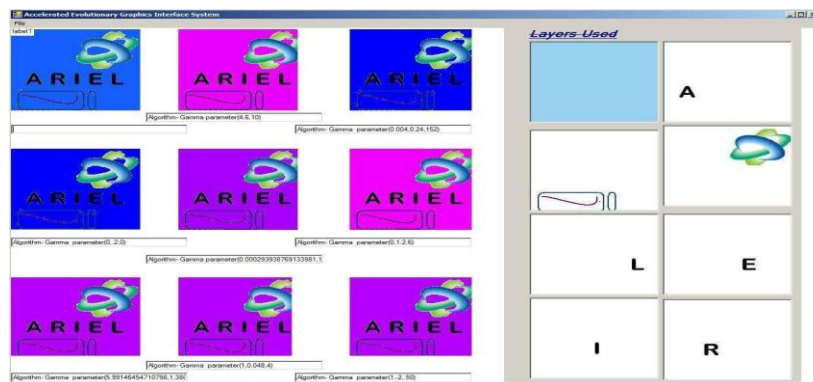


Figure 26b: Eight layer implementation in Version 6- Second screen after clicking fourth cell.

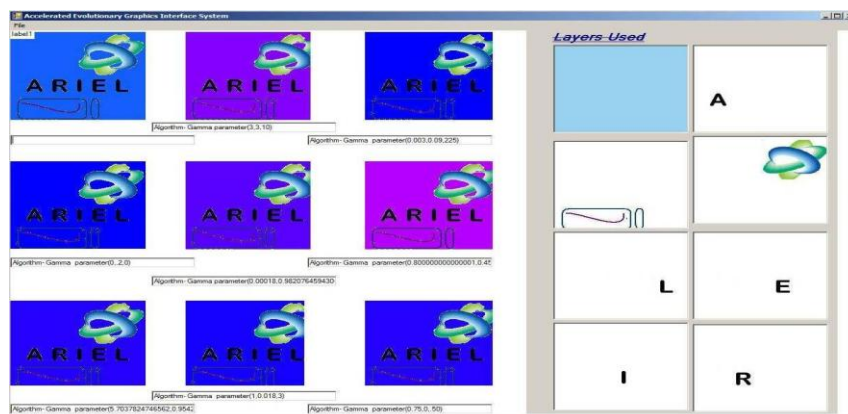


Figure 26c: Eight layer implementation in Version 6- third screen after clicking fourth cell and then second cell.

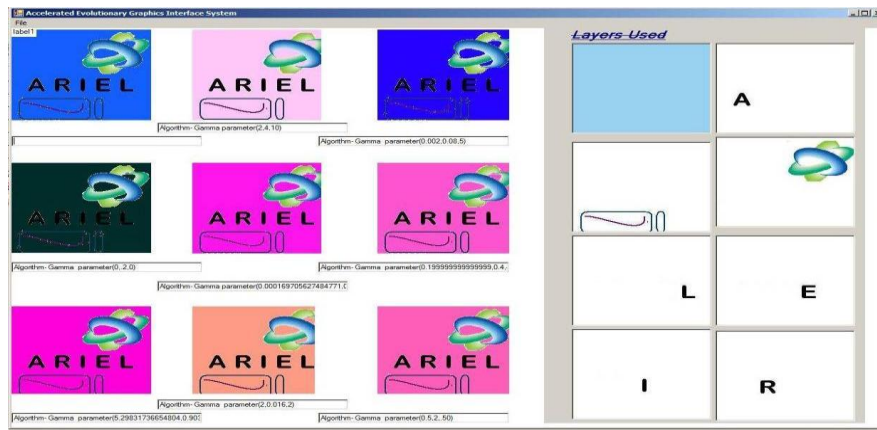


Figure 27: Eight layer implementation in Version 6- second screen after clicking second cell.



Figure 28: Eight layer implementation in Version 6.

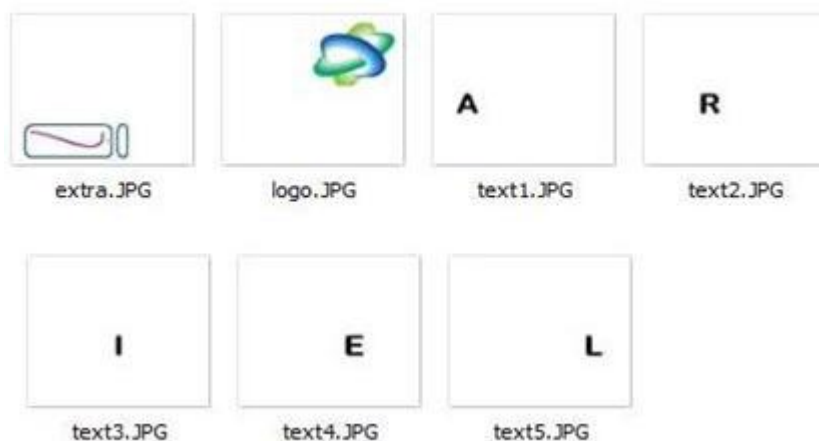


Figure 29: layers used for testing in Version 6.0

4.2.2.4 Previous Questionnaires and interviews (Graphic Designers) (Up to April 2010)

In this research, questionnaires were drafted and interviews held with a number of Graphic Designers. The questionnaire data is summarized in the Appendix-VII (section AEGISP1, AEGISP2, AEGISP3).

All the persons interviewed were graphic designers. Lee Mattock is a graphic designer for print section (DRP) of the University of Plymouth. He is mainly responsible to design print enabled graphic designs in various domains of the university. Having substantial experience in this field, he was able to throw light on various general aspects of the graphic designs including the role and benefits of modern tools as compared to the traditional tools. In the interview with Lee Mattock, other graphic design experts (from his team) also contributed to the questionnaire response.

At the end of the session with him, it was concluded that the role of innovative (Computer Design) tools is a very big one in modern times, but the attempt to automate graphic design using the CAI tools has yet to be seen and experimented.

Simon Standing is the program leader in University of Plymouth for graphic design at doctorate level. He is not directly involved in any form of packaging design methodologies involved in industries, but he was able to give a feedback based on his general graphic design experience. He suggested the use of this tool in generating ideas for graphic design idea focus groups.

Peter Jones is the program leader in Communication Design in University of Plymouth. Further meetings were held with him at many stages of AEGIS project. During each meeting, the outputs were evaluated and further feedback was collected from him. Meetings with him have contributed to a considerable extent to this research. Many samples including diagrams have been collected from him to help better understand the process of communicating the idea to the viewer of a graphic design of any packaged product.

A graphic designer many a times uses previous knowledge to design a packaging. This can include his experience from previous projects as well as his experience and observations from other products and user interactions. Example, a graphic designer can have the knowledge that a particular pattern of colors is proffered in a specific industry. It is also extremely important for a graphic designer to collect feedback from user focus groups of that product from time to time during the execution and deployment of graphic packaging design. Hence, as iterative approach is followed by graphic designers in designing a graphic design packaging, improving the package design after each stage of input from user.

However, a graphic designer also has to be creative in his work, this requirement being especially true in the initial stages of his designing. First of all, the graphic designer should start and come up with an idea/theme based initial design which later is improved at every stage. In many cases, the customer also gives an idea of what should be in that packaging design.

A graphic designer wants an easy to use interface in a graphic designing software package. The package should be quicker to use, and the designing process should be easy to handle. Besides,

the functions which can be mathematically measured and implemented in software packages, the graphic designers also have to consider characteristics (brand specifications). Some examples of these characteristics are tone, color, shape, form, fabric, time, style, demeanor, voice, language, geography and feel.

In another questionnaire, which was conducted with four graphic designers, the designers suggested that the tool provides quick range of alternatives or ideas, while working with number of different elements semi-automatically. As compared to Photoshop CS, the tools comes up with radically varied outputs/ideas in a very short span of time which otherwise would have taken more time in Photoshop CS. According to the designers, it will help the designers to finalize a design template for further processing and help them to choose a basic idea for design.

4.2.2.5 Questionnaire held to evaluate version AEGIS 6.0

A group questionnaire (semi structured, semi focus group)(Burgess, 2013, Canada), 2012, Hague, 1993) was conducted on 21st June 2010. Some brief results are provided below. (Also, please refer to Appendix-VII -section AEGISQ4). This questionnaire was held with 3 designers. The questionnaire data was recorded from three designers, but apart from this there were several informal meetings and conversations with graphic designers and users, which are in line with the feedbacks below. The below questionnaire was also discussed with supervisory team and various issues were discussed in that meeting. The genetic algorithms option was considered and discussed.

The designers provided confident and positive feedback about this version:

- Quickly provides a range of ideas.
- AEGIS would help designers to better reach a decision on the overall design options in a time saving manner.
- This tool would be better for junior level designers to quickly go through prototypes.
- Some of the designers confidently consider AEGIS like tools to be the future of design industry.

The designers also commented on the creative aspects of AEGIS, and the reaction was mixed:

- AEGIS helps designers to generate ideas
- AEGIS should not be considered to replace the actual designer itself; it will impact the design industry.
- Too easy to reply on, what would happen to human talent or their skillset will gradually fade away because of less manual interpretation.

The layering system in AEGIS6.0 was considered to help the design process in many ways:

- Various layers changing meant that the prototype changed variably and in various permutations and combinations hence further speeding up the process.
- The changes in one layer would be kept independent of the changes in another layer hence resulting in better design varieties.

Some future suggestions and drawbacks are below:

- Friendlier interface (but they also claim this is windows interface fault not especially the AEGIS problem).
- Improved navigation system.
- Be able to move layers.
- Be able to edit layers.
- The present version transforms and propagates the effects very fast, this is because of the fact that the selected image file itself is made the parent for next generation and its effects are again implemented on itself.
- One more important feedback was there was no way of saying that the user likes more than one design and wants to see their combinational effects.
- There was no control of how fast the transformations should go, for example when the user is close to selecting a final design, the user should be able to slow down the speed of changes going on to select slightly modified versions of the same result.

Some TRIZ Principles recommend for use in AEGIS are:

- Segmentation- the designers suggested various useful parts of images/ text can be segmented and discussed this with the help of sketches roughly drawn in front of the researcher.
- Extraction (Taking out)- this principle was mainly linked to raising of text, or to do something with the text which would make it look out from the rest of the text.
- Counterweight (raised text)-this was suggested to be considered more or less same as extraction.
- Prior action-this was linked to taking out something before combining with other things, example cutting of a piece of text before putting it with rest of the image (hints to layering concept too).
- Move to a new dimension (3D text)-in context of 2D images, it means raised effects of text.
- Convert harm in to benefits-mix with random noisy objects/ images/ text
- Changing the colour-this is a very universally applicable principle for graphic design
- Other way round- invert text, invert part of image.
- Feedback- this has to do with the process of inputting continued feedback from user while the image is being altered (through window pane option panel and multiple generations)
- Homogeneity- making the design look homogenous using the colour combinations
- Rejecting and regenerating- this means allowing the rejected images to 'die' and selected images to regenerate (indicates more than one parent)
- Composite materials-addition of other aspects like a start or different signs in the image.

The useful of images lies around approximately 40% on an innovative scale as marked by the graphic designers. The designers have marked AEGIS probability more than 50% to help designers to make better packaging designs. All designers in this questionnaire have agreed to recommend AEGIS to others, but have recommended further improvement.

4.2.2.6 Personal Meetings Held to Discuss the Learning Module of AEGIS

Two meetings were held with Dr. Phil Culverhouse and Thomas Weekeners (refer to Appendix-VII-AEGIST5 and Appendix-VII-AEGISP7). Different possibilities were chalked out to include a learning module in AEGIS through which the software would learn and improve itself through use by different users.

It was decided to include an XML based logging system in the first phase as a mini experiment to check the trends of users and to check whether current system was an efficient and correct design to be coded further with learning module.

Subsequently, AEGIS 6.6 XML was coded, which had a logging mechanism whereby user activity and usage logos were recorded and analysed. A user testing session was held (refer to Appendix-VII-AEGIST8). The logs suggested that the user was presented by a fixed subset of values which was used to change the image sets, hence the user had limited solution set in front of them. Example see figure 30a.

```

<deviationFactor />
<cellNumber>2</cellNumber>
</textmutation1>
<textmutation1>
  <name>vItalics</name>
  <textNumber1>1</textNumber1>
  <deviationFactor />
  <cellNumber>3</cellNumber>
</textmutation1>
<colormutation>Algorithm- Gamma parameter(R,G,B=.2 .2 10)</colormutation>
<colormutation>Algorithm- Gamma parameter(R,G,B=10 10 10)</colormutation>
<colormutation>Algorithm- Gamma parameter(R,G,B=.2 .2 .2)</colormutation>
<colormutation>Algorithm- Gamma parameter(R,G,B=-5000 .2 .2)</colormutation>
<colormutation>Algorithm- Gamma parameter(R,G,B=.2 5 10)</colormutation>
<colormutation>Algorithm- Gamma parameter(R,G,B=5 .2 .2)</colormutation>
<colormutation>Algorithm- Gamma parameter(R,G,B=10 5 10)</colormutation>
<colormutation>Algorithm- Gamma parameter(R,G,B=5 .2 10)</colormutation>
</molecularMutation>
<molecularMutation>
  <start>
    <date>2011-10-27</date>
    <time>15:19:09</time>
  </start>

```

Figure 30a: Sample log from AEGIST8 user session.

Figure 30a indicates that the user is repeatedly presented by some static number based solutions hence the solution base was limited in this version. The software is not able to add more flexibility to the generated outputs; the outputs revolve around a fixed range of numbers.

Some of the samples obtained from this user session are shown in figure 30b.

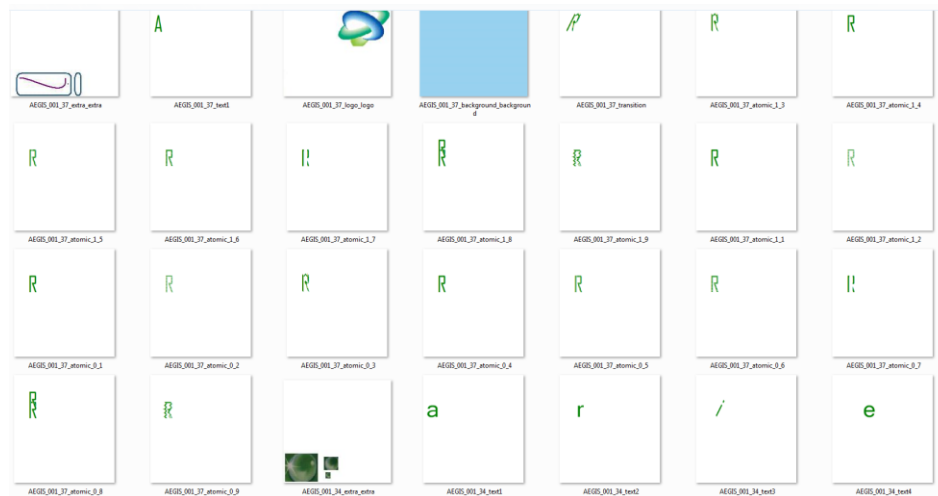


Figure 30b: Sample outputs files from session AEGIST8.

The researcher observed that the software was not capable of taking advantage of 9x9 concept of grid to the fullest extent. On one hand many times the variations were too slow and on other hand the selection of same effect over iterations would put lot of noise to entire generation. Subsequently, various versions of AEGIS were developed which are not discussed in detail here.

4.2.2.7 Conclusion from questionnaire and the analysis of log data

As seen in figure 30, AEGIS version 6, is not as much dynamic as is needed for a research based design tool. The tool should besides the predictable outputs also give some unpredictable outputs which is a weak case here.

Additionally, the feedback from the designers and supervisory team was summarized and analysed, the main drawbacks and the hint for further work were noted down. The main issues were highlighted and needed attention. AEGIS 6.x series transformations from one generation to other/ produces the results to fast to be chased by the designers, the results were extreme transformations and hence would become useless if the designers were not able to slow them down and switch the speed of transformations. The designers were not able to combine more than one result to see the combination outputs in next generation. In AEGIS 6.x, the outputs were becoming more predictable with the values in log files rotating around the same range. It was predictable what the value would be in next generation on selection of a particular value in the previous generation.

These issues seem less in number, but they were very important as far as a research based CAI tool is concerned. A proper and structured self adapting learning mechanism was missing in this version.

4.2.2.8 Rationale behind developing multiple versions of AEGIS

As far as the software development is concerned, the development was marked at various stages by different version series of the AEGIS. Starting from the version 1 through 7, the software saw a series of significant changes and drastic improvements. The slight modifications were developed in same version but different subversion, example: version 6.1, 6.2, etc. But, when a major change occurred, the version was upgraded. This is due to many reasons, one reason is to keep backup trail of the minor changes hence subversions were made, this enabled to keep a track of the improvements in software during the development and also made it easy to revert back to previous versions if the coding technique employed resulted in failure in any way. The details of all these sub versions could not be discussed in this report; this would unnecessarily make the report longer. The reason to include many versions are to preserve the coding and the classes used and employed in structured way, so that any alteration in them would not result in losing them in previous versions, this will allow future researchers to utilize the libraries created in any way they want, for example someone might want to take further the version 5 in a different direction than version 6 and 7. This is to emphasize that different Microsoft .NET libraries were used for different versions due to different requirements in coding, and when the software approached to higher versions some libraries and code was dropped while as new code was developed, hence using of new versions ensured that the software did not become unnecessarily bug time and memory complexity wise and at the same time old code was preserved for future use.

4.3 TRIZ Guided Genetic Algorithm to Graphic Design (AEGIS)

The decision to employ Genetic Algorithms was taken in a supervisory meeting after discussing the drawbacks and the need for further work on AEGIS. The AEGIS needed improvement at this stage to reach its research goals and user satisfaction. Evolutionary algorithms are generally used to solve the problems which cannot be solved easily; this project was a good problem candidate for such a method. Evolutionary algorithms are used to solve the problems which humans usually find difficult to achieve. This was the case in this project, as the graphic designers often found it difficult to mathematically explain what a good innovative design candidate should fit with.

Evolutionary algorithms were a solution forward to this problem, because the change in the designs from one screen set to another would be 'evolutionary' in nature, which could be slower and based on natural evolution as compared to the AEGIS 6.x software version. Allowing more than one parent selection for next generation is more logical in genetic algorithms; this is because combining the pixel data of two images would not result in a result oriented output set. But genetic algorithms allow this process logically where the genotypes of the two images are combined using cross over techniques to produce a new phenotype. Genetic algorithms are considered to be slow and often produce varied and combined featured results and that fitted the problem and requirement here. Similarly, chromosomes and genes are coded in computer systems to control particular aspects of the solution sets. The representation of genes in genetic algorithms in the simplest form is as binary string (01010.....) (Eiben and Smith, 2012). This feature of GA's allowed the researcher to be able to build a knowledge base which was more structural and could be easily used by the researchers in future (because the language of this knowledge base is universally recognized by GA experts, for example the chromosome structure).

Mutation of genes takes place by flip flop operations (changing zero to one and vice versa). The parents for next generation are selected using a fitness function; all parents who pass a fitness function survive to the next generation and crossover with each other to form children. This allowed the software to produce varied, slowly transformation/ evolving and combined results. This seemed to be perfect solution when discussed with graphic designers too. A learning mechanism was defined from beginning whereby the software would adapt to the user and create an experienced usage for future users. Using the chromosomes presented a perfect solution for this problem.

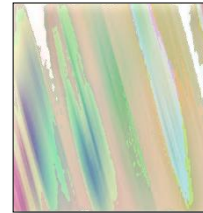
The global optimum definition in case of AEGIS is a matter of debate. It depends on many issues. It is a fuzzy problem, difficult to be defined in a mathematical language. Hence, the designer is allowed to select the parent images for next generation (fitness function). However, to further strengthen the framework of this software, the designer is asked at the end of the session to specify details about the purpose to obtain the outputs (See Appendix-VIII). Similarly, the questionnaire contains a section to rate the outputs according to what was expected.

These kinds of add-ons to the software can be used to develop a chromosome based knowledge base to work in coordination with the already existing system to reach a global optimum Appendix-VII/ B5).

Once again here the measurable outputs would be that the software fits at some stage in CAI and it is able to automate innovation to some extent. The software should fit with other tools at some stage and to some extent be either quicker or more varied than other tools.

4.3.1 Definition of TRIZ Genetic Algorithm Structure

Chromosomes of the AEGIS GA are the TRIZ functions (methods in c#.net) which introduce TRIZ effects on the images and text.

Name of process/ element type	Equivalent in AEGIS_6.6_GA	Example
Gene	Function/Method Parameters in c#.net	In the method Segmentation (00111111,) 00111111,1,1 and 000011 are the genes.
Chromosome	Function/ Method	The method Segmentation (001111, 001111, 000011.....) altogether is called a chromosome.
Gene controlled property	The size, shape and degree of different mutations in AEGIS	Curvature of an alphabet.
Allele	Different colours, sizes, shapes of the gene controlled property	The gradient colour of base. 
Locus	The point where the parameters of a function end.	In the method above, the ‘,’ represents a locus separation point as it marks the end of one gene and start of another.



Phenotype/Individual	The image	One of the images in generated generation. 
Population	Group of all individuals (images) generated.	Images generated in each iteration (9). 
Genome	Collection of all chromosomes for an individual (image).	Summation of all methods and their parameters for an image generated at point 3 of the 3x3 grid of AEGIS.

Table 7: Genetic Algorithm Structure of AEGIS 7.1.

4.3.2 Technical Summary of Genetic Algorithms in AEGIS

The chromosome structure details for TRZ transformations are as follows (for Fonts):

Name of Chromosome	C# Method	Bit Length	Genes
Colour	ColorImg	0-32	ColorA,ColorR,ColorG,ColorB
Slanting	SlantImg	32-50	degree, curvature, vertical_degree, vertical_curvature, direction, vertical_direction
Outlining	OutliningImg	50-88	axis, direction, colorA, colorR, colorG, colorB, thickness
Fragmentation	FragmentImg	88-99	point, thickness
Copying	CopyImg	99-141	copy_x, copy_y, colorA, colorR, colorG, ColorB
Segmentation	Segmentation	141-209	angle, min_thickness, frequency, ervals, erval_gradient, colorA, colorR, colorG, colorB, color_gradient, color_gradient_increment
Spheriodality	spheriodality_curve	209-214	angle, min_bend, bend_gradient, frequency, ervals, erval_gradient, width, width_gradient
Symbols	Img_Symbols_Intro	214-313	imageText, colorA, colorR,

			colorG, colorB, size, position_x, position_y, font, style
Shapes	Img_Shapes_Intro	313-374	imageType, colorA, colorR, colorG, colorB, size_a, position_x, position_y, size_b, size_c, size_d, size_e

Table 8: Genetic Algorithm Technical Summary of AEGIS 7.1.

4.4 AEGIS 7.1

4.4.1 AEGIS 7.1 Technical Summary

4.4.1.1 AEGIS Forms (version 7.1)

Standard interface designing procedures have been followed while designing AEGIS. The cognitive psychology of designing interactive human interface systems, user interface styles and grouping of functions have been taken in to consideration while designing this system(1998). The theory of recognition of human brain model has been employed and hence mostly combo boxes have been used wherever possible (Vincent and Mann, 2002, Winograd, 1986). The user interfaces of standard software packages have been studied and various human interaction factors considered.

AEGIS has three main forms:

- AEGIS Introductory Form (figure 31)
- AEGIS Main Form (figure 32)
- AEGIS Atomic Transformations Form (figure 33)

The screenshot shows the 'AEGIS Introductory Form' window. It features a 'User Preference Form' section with 'Font Chromosome Preferences'. There are eight checkboxes for different text effects, each with a preview box showing the letter 'A'. The preferences are:

- Would you like text outlining effects: ☐ (Preview: A with outline)
- Would you like the colouring effects: ☐ (Preview: A with color)
- Would you like fragmented text: ☐ (Preview: A with fragmentation)
- Would you like spheroidal effects: ☐ (Preview: A with spheroidal shape)
- Would you like duplicated text: ☐ (Preview: A with duplication)
- Would you like slanted text: ☒ (Preview: A slanted)
- Would you like segmented text: ☒ (Preview: A with segmentation)
- Would you like symbol introduction: ☐ (Preview: A with symbol)
- Would you like shapes introduction: ☐ (Preview: A with shape)

 To the right of the preferences is a large 'start' button. Below it is a text input field for 'Enter Your Questionnaire Personal Code' with the value 'AEGIS000W0001'. Below that is a dropdown menu for 'Select Your Speciality'. Further down are two dropdown menus for 'Mutation % Age' (set to 3) and 'Cross Over Points' (set to 2). At the bottom right is a green 3D button that says 'Aegis 7.0 is Activated on your System on OEM Basis.'.

Annotations with arrows point to various elements:

- An arrow points to the 'start' button with the text: *Finally press the start button to go*
- An arrow points to the personal code input field with the text: *Enter Questionnaire Personal Code here*
- An arrow points to the 'Mutation % Age' and 'Cross Over Points' dropdowns with the text: *Select the mutation and crossover rate*
- An arrow points to the green 3D button with the text: *Enter your AEGIS key here*
- An arrow points to the preview boxes for 'Would you like segmented text' and 'Would you like shapes introduction' with the text: *Select the effects you want in text*

Figure 31: AEGIS Introductory Form.

This form is used to enter the:

1. Questionnaire personal code (this code is generated from Design for Wow) website after user registration.
2. Select your field of expertise from the drop down list below the Questionnaire Code box.
3. Select the mutation percentage and crossover rates from the drop down boxes respectively (these will be used for font transformations later on).
4. User preferences for font transformations can be selected from the 9 mini sections on the left of form (these will be used for font transformations later on).
5. User Key (enter user key if user are installing your software for first time or the key has expired, the form will indicate if the key has expired).
 - a. This key is supplied by researcher and is valid for 31 days and for 1000000 uses.
 - b. The key is case sensitive so be careful while copy pasting key.
6. Finally press the start button and user are ready to go to next form.

This form uses the windows registry to manage the licenses of the users.

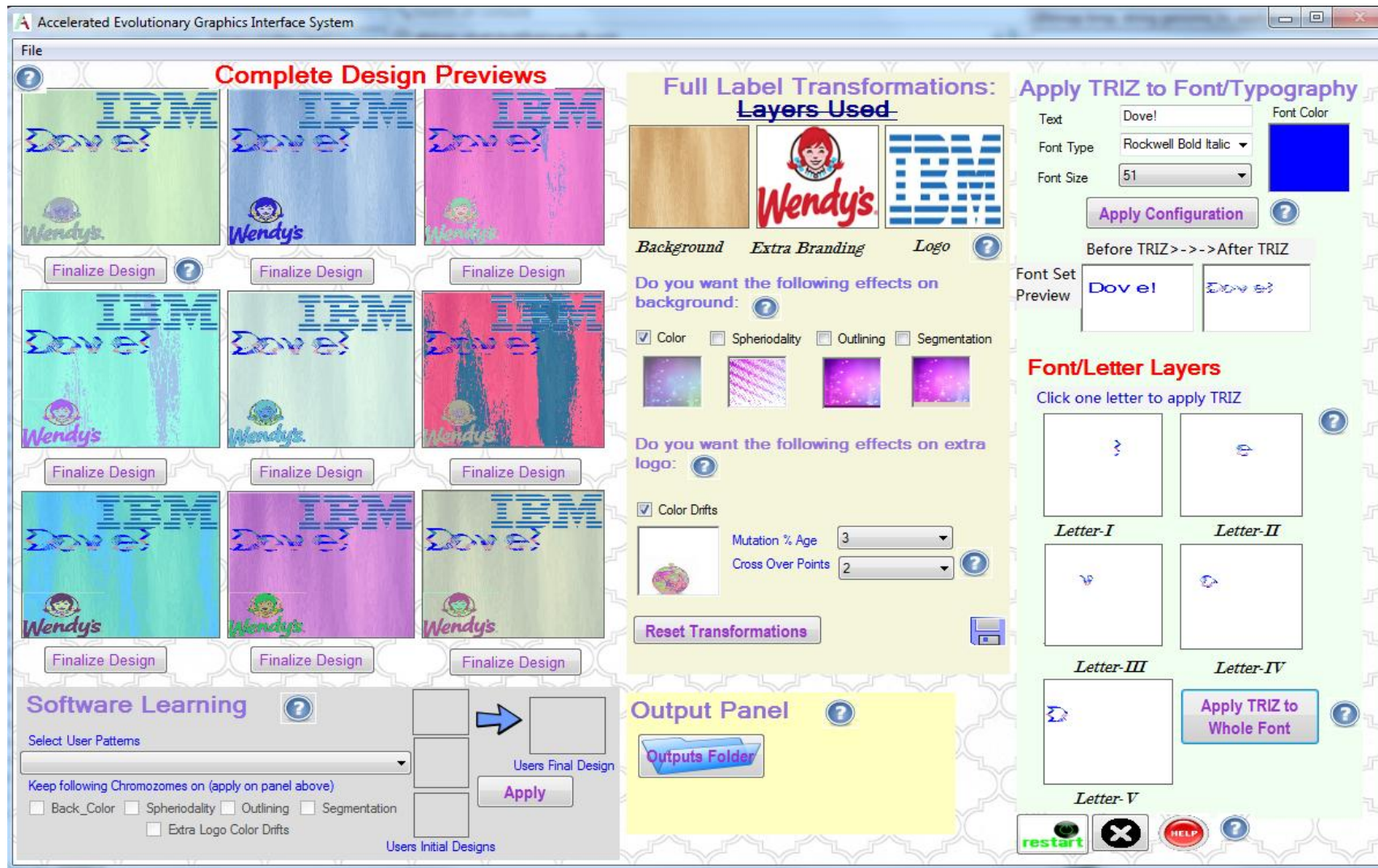


Figure 32: AEGIS Main Form.

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After entering this form through the introductory form, user need to follow following steps to configure the text and apply TRIZ Principles to the font letters.

1. First step is to select the font configuration on this form. User can select/ provide following information for your font.
 - . (Text- Input five letters example the brand name);
 - . (Font Type- Select from the list);
 - . (Font size- optimum is approximately 50);
 - . (Font color- choose from the advanced pallet);
2. Then press the button- Apply Typography.
3. After this step, the form will display 5 letter layers and user can choose which letter user want to take through different iterations/ generations for TRIZ application.
4. This will take user to the letter transformation form which is explained on the next page.

Once the control is returned after following the instructions next page, After selecting the finalized font on font form, user will be redirected to main form.

1. User need to apply the effects to all letters to your design-word (all five letters).
2. This can be done by pressing the "Apply to Whole Font" button on right hand side as shown below.
3. After this user need to load your initial design files for the components- Background Image, Logo Image and Extra Branding Information Image (example slogan text, etc.). This can be done by clicking on file menu -> Load

The minimum width x height dimensions acceptable is (in px): Background (150,161) Logo (40x40) Extra Logo (40x40). The images should be uploaded in above sequence as the software will prompt user every time about this sequence to guide user promptly.

4. After this step all your files will be loaded. If user are satisfied with any of the complete designs on left, user can press the finalize design button below it (user will also need to provide the information that what purpose this output can be used for). This can be done on the Output panel as shown below.

5. If user are not satisfied with the output, user can select three parents by clicking on the images (not on any button) and to generate the next generation user need to press the next generation button as shown below. User can start with a random first generation any time by clicking on the "Reset Transformations" button as shown below.
6. During each generation, user can change your preferences as follows:
 - --User can change the chromosomes which are active during each generation.
 - --User can change the mutilation rate and crossover rate.

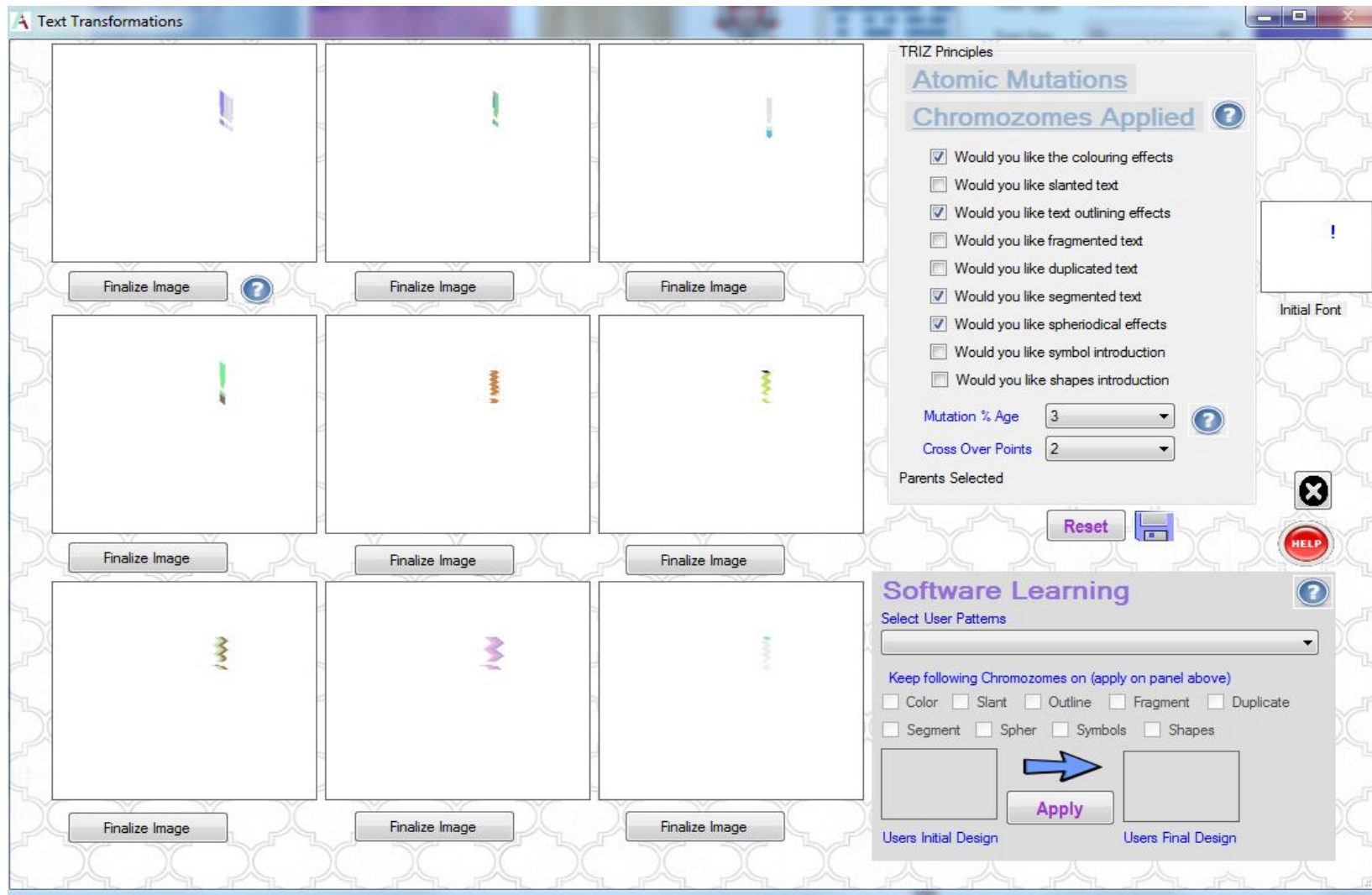


Figure 33: AEGIS Atomic Mutations Form.

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After entering this form through the main form, user will find nine transformations of your letter on the left hand side (this is called as generation one).

1. If user already like some letter format (and want to stop here), then user can click the "Finalize Image" button as shown below.
2. If user like few images and want to explore further generations based on their genomes, then user need to select three parents. Selection of parents is done by clicking on the image itself (not on any button) as shown below.
3. When user have completed selecting the three parents, user can then proceed for next generation by clicking the "Generate New Generation" button on the right side of this form as shown below.

During each iteration, user can also change the mutation rate, chromosome applied and crossover points rate for the parents crossover and mutation. Once user are satisfied with any output, user can go to step 1.

User can any time press reset button to restart the first generation randomly again.

4.4.1.2 AEGIS Self Learning Intelligent Software Module

Special AEGIS Software Learning Module:

While user are on the text transformations page, user can also checkout what how others have utilized this software.

1. Press the load experience button, that will enable user to view and select from the user sessions list- what patterns/ designs have they created using this software.
2. If user like any of the user designs, user can apply these genes to your design by clicking the apply button.
3. Once user click the apply button, these genes will be applied to the box number 2 (of the 3x3 grid on the left).
4. User can repeat as many times as user want.

The screenshot shows a web-based interface titled "Software Learning". At the top, there is a button labeled "Load Experience List". Below this is a section titled "Select User Patterns" with a dropdown menu. Underneath the dropdown is a text label "Keep following Chromozomes on (apply on panel above)". This is followed by two rows of checkboxes: the first row contains "Color", "Slant", "Outline", "Fragment", and "Duplicate"; the second row contains "Segment", "Spher", "Symbols", and "Shapes". At the bottom of the form, there are two large empty rectangular boxes. The left box is labeled "Users Initial Design" and the right box is labeled "Users Final Design". Between these two boxes is a button labeled "Apply" with a large blue arrow pointing from the left box to the right box.

Figure 34: AEGIS Atomic Learning Form.

Special AEGIS Software Learning Module:

While user are on the complete design transformations page, user can also checkout how others have utilized this software.

1. Press the Load Experience button, that will enable user to view and select from the user sessions list- what patterns/ designs have they created using this software.
2. If user like any of the user designs, user can apply these genes to your design by clicking the apply button.
3. Once user click the apply button, these genes will be applied to the box number 2 (of the 3x3 grid on the left).
4. User can repeat as many times as user want.



Figure 35: AEGIS Molecular Learning Form.

4.4.1.3 AEGIS Classes and Components (version 7.1)

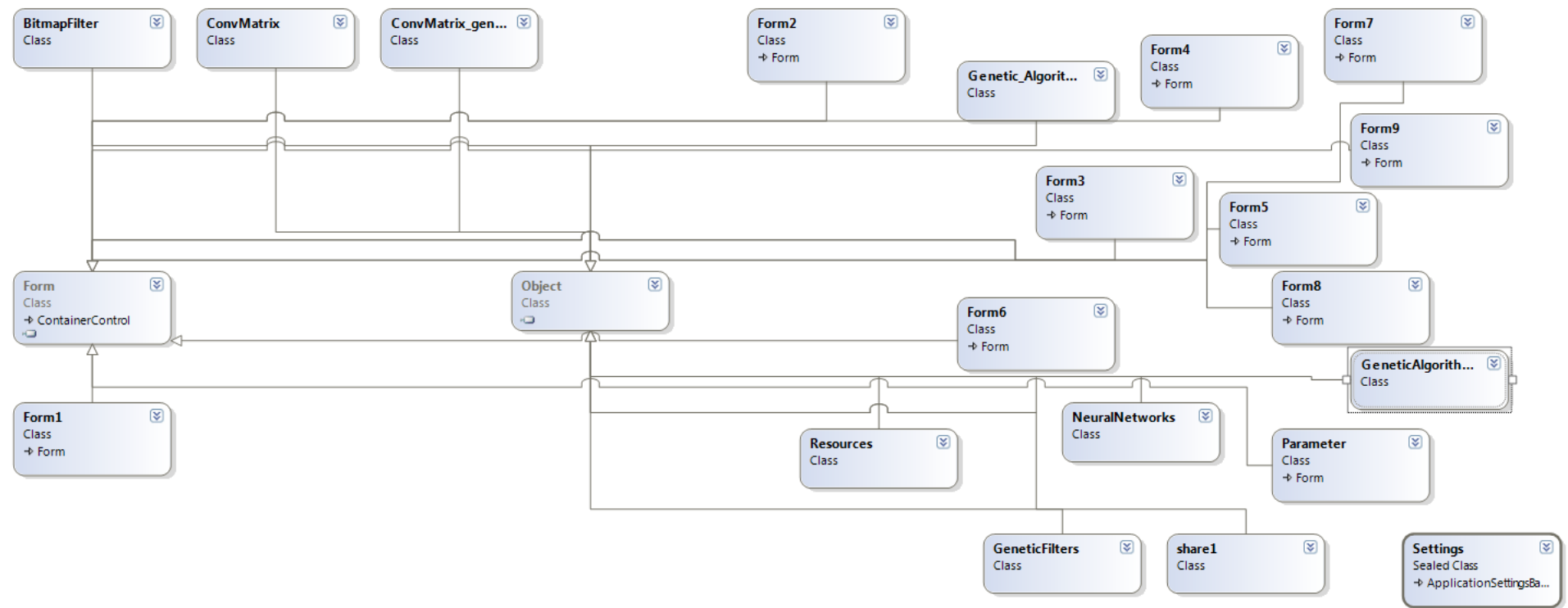


Figure 36: AEGIS Overview of Class Diagram.

4.4.1.4 AEGIS Special Classes and Methods

There are various classes and methods worth mention here. Please refer to Appendix-II to see the code samples of these modules.

- GeneticAlgorithms
- Crossover
- Mutation
- GeneticAlgorithms_Molecular
- GeneticFilters
- Key Generator and Validator
- Logging System for Learning and Experimental Purposes.

4.4.1.5 AEGIS Key and Trials

For extensive testing, 31 day and 1000,000 uses key is being provided by the researcher using a separate program which is coded in c#.net by the researcher. The source code, exe and keys are included in the CD enclosed with this thesis.

4.4.1.6 Logging System for Learning and Experimentation

Extensive logging system has been built in this software to allow users to take advantage of previous uses by previous users of this software. Appendix-III lists such sample files for logs.

4.4.2 AEGIS Sessions with Users (6.6 GA, 7.0 TX, 7.1 TX)

AEGIS latest versions have been tested thoroughly with the users and by the researcher using group questionnaires (please refer to Appendix-VII-AEGISQ12 and Appendix-VII-AEGISQ11).

4.4.2.1 Methodology

The semi structured questionnaire sessions have been conducted to evaluate the latest version of AEGIS with more than 100 persons. The userlog samples are presented in this section and in Appendix-III/ VII. The users are from different expertise fields and were briefed about the project details and the working of software in a group and then were guided to use the software on their respective computers. At the end of the session their logs were collected and a questionnaire was filled by them. Informal interviews were part of the process and a small focus group session was a part of this questionnaire where the users were asked to make a brand visual asset.

4.4.2.2 User Types

The user types involved were:

- IT Engineers
- Fashion Designers
- Graphic Designers
- Business Managers

Please refer to AEGISQ11 for details.

4.4.2.3 Session Outputs and Samples

Some of the innovative rated outputs obtained in this session are depicted in table 9.

The detailed logs are provided in Appendix-VII/III.

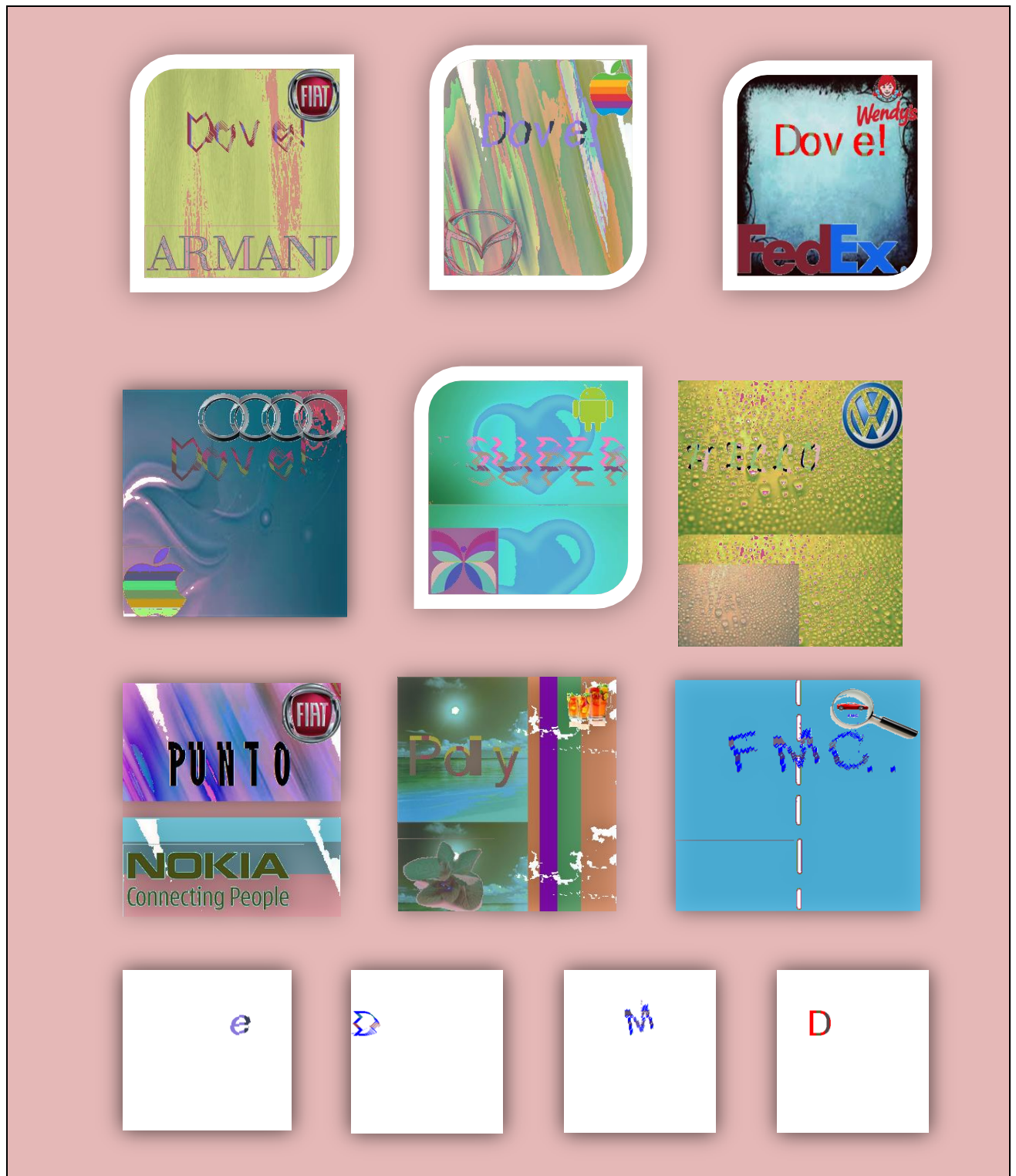


Table 9: Some of the outputs of AEGIS v7.1

4.4.2.4 Comparative Evaluation of AEGIS with Other Tools (Speed)

In addition to the modules developed and coded for the end user (graphic designer), a special module has been created in AEGIS called as Atomic Transformation (Manual) Testing Form(s). This module is especially used by the researcher to check the boundaries and the fitness function limits of the specific chromosomes. Figure 37 below show the testing form with few of the chromosomes being tested.

The module has the capability to allow the developer to:

- Test specific chromosomes for various data test sets.
- Define the extreme boundaries of after the results start becoming useless or irrelevant.
- Test more than one chromosome at a particular instant of time.
- Test the genome on each letter type (by applying each chromosome one after other at the same instant of time).
- Test the efficiency and error probability when all chromosomes work together.

These test results are being used to improve the genetic algorithm structure as whole when the software is being used by the designers.

The specific test-form instance in figure 37 has following data set being implemented: (this test has been conducted using previous version of AEGIS)

Letter	R
Time taken to reach the output	6.49 Seconds
Chromosome under test	Slant_Img

Genes Alleles applied (in decimals) Degree-2, Curvature-4, Vertical Degree-0, Vertical Curvature-1

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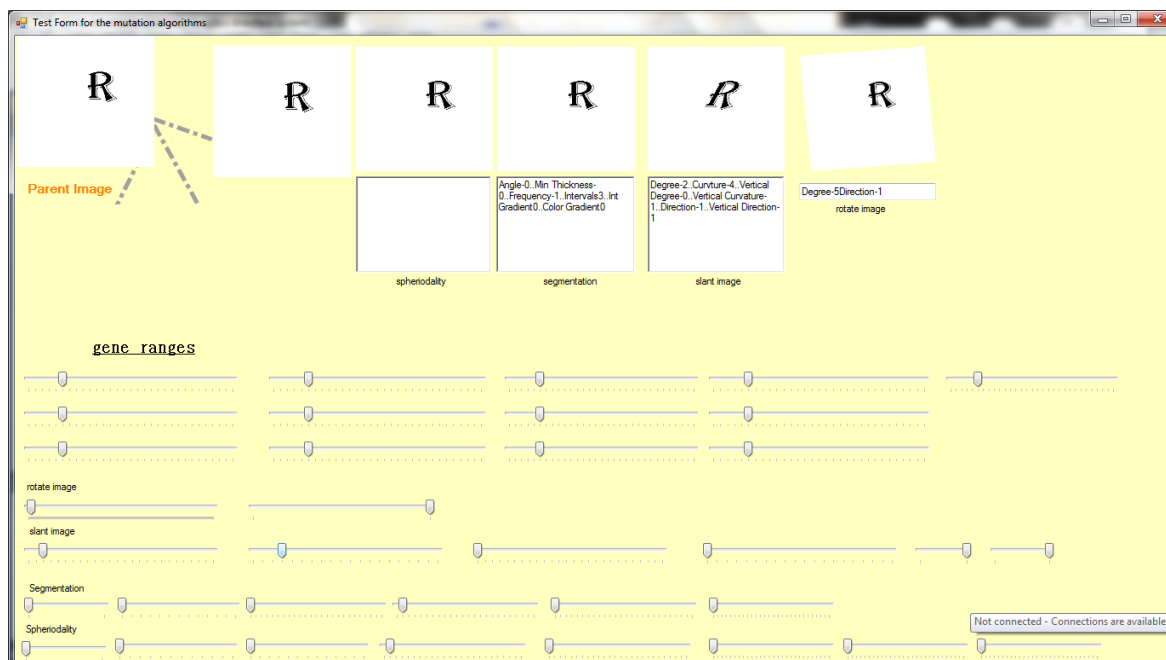















Figure 37: One of the forms of testing module in AEGIS, used to test chromosome effects on the letter fonts.

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Original Font	Rotate Chromosome Applied	Rotate Output	Slant_Img Chromosome Applied	Slant_Img Output	Segmentation Chromosome Applied	Segmentation Output
 Font Letter Generated Originally	Degree-15 Direction-1 Total Time: 16.2 Seconds		Degree-2 Curvature-6 Vertical Degree-0 Vertical Curvature-1 Direction-1 Vertical Direction-1 Total Time: 7.1 Seconds		Angle-0. Min Thickness-1 Frequency-3 Intervals-3 Int Gradient-0 Color Gradient-0 7.2 Seconds Step-1	
	Degree-58 Direction-1 Time Taken: 3.5 Seconds Total Time: 19.7 Seconds		Degree-2 Curvature-6 Vertical Degree-2 Vertical Curvature-2 Direction-1 Vertical Direction-1 Time Taken: 11.1 Seconds Total Time: 18.2 Seconds		Angle-0 Min Thickness-1 Frequency-10 Intervals-3 Int Gradient-0 Color Gradient-0 6.8 14.0 Seconds Step-2	
	Degree-10 Direction-0 Time Taken: 8.9 Seconds Total Time: 28.6 Seconds		Degree-2 Curvature-6 Vertical Degree-2 Vertical Curvature-2 Direction-0 Vertical Direction-1 Time Taken: 6.9 Seconds Total Time: 25.1 Seconds		Angle-0 Min Thickness-9 Frequency-10 Intervals-3 Int Gradient-6 Color Gradient-21 18.1 32.1 Seconds Step-3	
	Degree-10 Direction-1 Time Taken: 2.7 Seconds Total Time: 31.3 Seconds		Degree-2 Curvature-6 Vertical Degree-2 Vertical Curvature-2 Direction-1 Vertical Direction-0		Angle-0 Min Thickness-6 Frequency-13 Intervals-3 Int Gradient-1-7 Color Gradient-0	

Font library/ Typography:

Font Type: Algerian

Text: Bernhard Fashion BT

Font Color: Black

Back Color: White

Font Size: 75

Font Specification Input by the




Original Font	Rotate Chromosome Applied	Rotate Output	Slant_Img Chromosome Applied	Slant_Img Output	Segmentation Chromosome Applied	Segmentation Output
User			Time Taken: 6.4 Seconds Total Time: 31.5 Seconds		17.5 49.6 Seconds Step-4	
Degree-25 Direction-1 Time Taken: 3.5 Seconds Total Time: 34.8 Seconds		Degree-2 Curvature-9 Vertical Degree-5 Vertical Curvature-14 Direction-1 Vertical Direction-0 Time Taken: 18.5 Seconds Total Time: 50.0 Seconds		Angle-0 Min Thickness-8 Frequency-13 Intervals-17 Int Gradient-2 Color Gradient-15		

Table 10: Output samples from different chromosomes using the Manual Testing Module of AEGIS.

Table 11 below shows the comparison of the outputs and the time and efforts taken to create the outputs as compared to other tools (Macromedia Fireworks). It was concluded after various sessions, that AEGIS was able to create the outputs much faster than the other tool. Similar experiment was done using adobe Photoshop/ Microsoft paint and other tools and AEGIS came up with faster, varied and efficient outputs.

Table 11: Showing various outputs obtained during a sampling session by the researcher with combined partial application of genome. Various performance/ productivity factor data readings are included in the table.

4.4.2.5 Questionnaire Analysis for AEGIS v7.0 and v7.1

Figure 38 shows the average score versus expectations of the output as far as the output rating parameters are concerned. The graph reveals promising outputs of AEGIS which overall does not fail to meet the average user expectations (see Appendix VII) for questionnaire data. Standard procedures were followed to draft the questionnaire (Burgess, 2013, Hague, 1993, Oppenheim, 1992, Su et al., 2011). Here the results obtained can be analysed in terms of three scenarios. If the tools are being used under research perspective and innovation perspective, then the tool should also include unexpected results (hence it should be a CAI rather than just a CAD or CAx series general design tools), because this tool is supposed to innovate and is supposed to search the solutions which were known or exhaustive for humans to search. However, if this tool is being used just for design purposes then the good results will be the average points to be above 2.0 as it should then work according to expectations of what the user wants (fine tuning the crossover and mutation rates during the operation will maintain that score in this software).

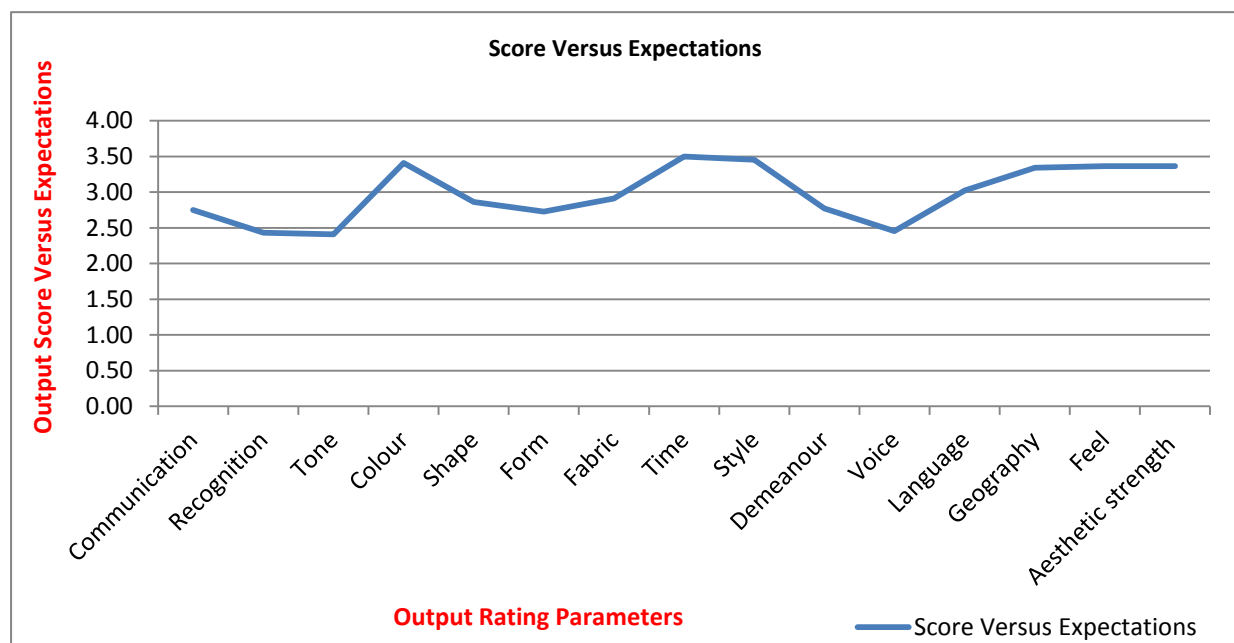


Figure 38: AEGIS Average rating of output versus expectations of users.

Figure 39 reveals that the AEGIS outputs are equally innovative and meet the expectations of user on a average. However, the users have appreciated the text outputs more and appreciated the dynamic way it displays the versatile outputs in very short span of time.

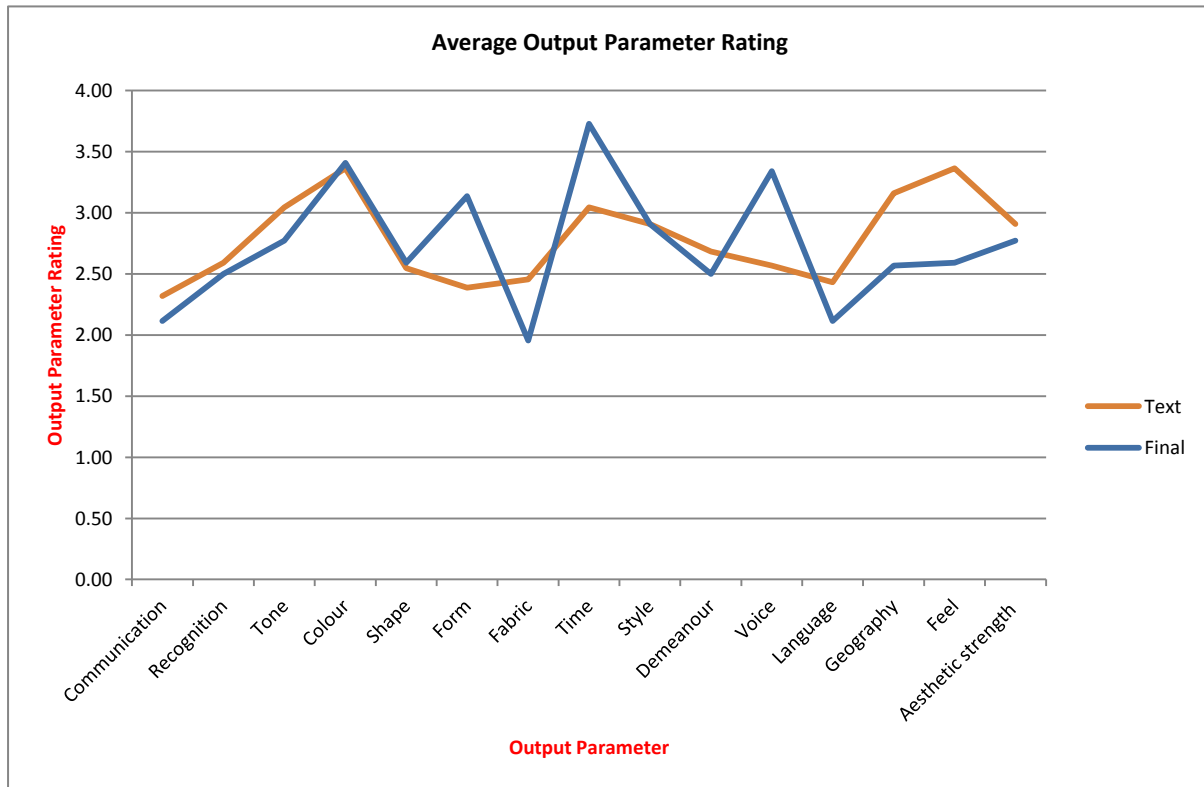


Figure 39: AEGIS .average output parameter rating.

4.5 Summary

Few of the key points concluded from the questionnaire (AEGISQ11) are listed below:

100% of all participants' designers and other users considered AEGIS a very useful tool for design phases (briefing to client).

- The text section has attracted all types of users and 80% of users have come up with positive feedback about this section (Some comments from Appendix-VII indicate this).
- The background and molecular transformations need refining and the images need to be cleaned after the combination of layers (Some informal comments and comments from Appendix-VII at various places in feedback/ drawback columns indicate this).
- The text (without the other layers) has been rated the most innovative part of this software by the users. (Appendix-VII-AEGIS Q11 Part D Group2 Questionnaire data reveals this).
- This tool can mostly be used to generate innovative fonts for graphic labels or other purposes. (Appendix-VII AEGIS Q11- Part C lists all the purposes designers and other uses have suggested this software could be used for).
- The users are attracted to software because it generates prototypes quickly while keeping the variation speed slow to allow the users to some extent control the direction of outputs. The time efficiency of the software as compared to other tools is discussed in the data given in section 4.4.2.5. (Appendix-VII AEGIS Q11 Part B /C show the feedback of the users regarding this issue).
- As per the latest questionnaire (see appendix-VII), the colour and demeanour is the most innovative output parameter which has met the expectations of the proposed design by users. This is illustrated in figure 38 where these two parameters have gained the score of 3.50 which is the highest amongst all other parameters. This was also unanimously agreed by majority percentage of participants by marking these parameters to more than 4 on a scale of (0-5) for expectation.

Chapter 5:

Design for 'Wow'

5.1 Design for Wow Web 2.0 Presence Hypothesis

Design for Wow is the online presence of wow contents on www. In this web portal of Design for Wow, the users can upload of what they categorize as 'wow' or a successful invention/design/ product in many forms. The users can rank, rate and comment of these contents. On the internal side, the research team can categorize these contents and relate them to TRIZ Principles. TRIZ is meant to be a powerful tool as indicated by previous research papers in the innovation field. The research objective in this project is to explore the practical elements and applications of TRIZ in the innovative designs. The designs submitted to this portal will be examined by the expert group of TRIZ and the possibility of TRIZ principles in them will be explored and explained. Hence the potential of TRIZ in context of the content on web portal will be evaluated.

The need for web 2.0 design and development for "Design for Wow" was illustrated by Darrell Mann in his book Systematic Software Innovation(Mann, 2008). www.designforwow.com is a web 2.0 presence for rating the 'wow' contents submitted by users of the site. This tool is intended to be published widely across academic institutions and innovation groups. The main theme of this site is 'wow'. A 'wow' effect may be felt by viewer seeing a good innovation and if that happens, the user can submit their contents to the site for others to view and discuss. Hence, it is a platform for all the innovation researchers of the world to try and distinguish the wonderful innovations from the millions of so called innovation products. However, to clearly distinguish what is 'good' and what is 'bad', the site contains two sections namely 'wow' examples and poor 'wow' examples.

The site contains mechanisms for the users to submit, review, rate and report abuse of the contents. Contents can be pictures, books, articles, videos and music. The R&D concept of this site is further extended by including a reviewer section for reviewers (Innovation researchers) on the site. The reviewers review the content and group them into specific innovation principles. For example, a product/ invention could be the result of the surface segmentation Inventive Principle of TRIZ. An evaluation of this inventive tool will help to correlate inventions across the world to the Inventive Principles of TRIZ. We hope to be able to conclude, with the help of the reviewers work, whether every genuinely classified invention/ innovation can be mapped to an Inventive Principle, and hence answer the research question of whether computer aided innovation is possible. Hence this part of research focuses on finding out if TRIZ 40 Principles are enough to give an answer to the 'wow' content, if yes then it is possible to make a CAI tool based on TRIZ Principles which can automate innovation. If not then CAI based on TRIZ Principles can prove to be lacking in certain aspects of innovation. But, in that case the 41st Principle can be laid down to answer the missing innovative aspects of TRIZ Principles and hence again the CAI tool can be fitting the purpose and so on.

5.2 Analysing TRIZ in Innovation

5.2.1 TRIZ 40 Principles Hypothesis and Previous Work

Right from the birth of TRIZ, TRIZ inventor and the followers have been claiming about the potential of TRIZ 40 Principles (Altshuller, 1984). Many theories and hypothesis claim that TRIZ is a toolkit consisting methods which cover all aspects of problem understanding and solving (Ilevbare et al., 2013, Hipple et al., 2011). Altshuller's initial insight about the patterns of inventive solutions and one of the first analytical tools was published in the form of 40 inventive principles, which could account for virtually all of those patents that presented truly inventive solutions. Some of the research literature suggest that TRIZ Principle set can be used as one of the key toolset for solution generation phase of problem solving (Sheu and Lee, 2011).

Further down the timeline, some research teams have tried to identify the potential of TRIZ Principles by analysing different problems, especially for example the patents database. Furthermore, some of the innovation solution providers have developed tools like EvPOT and other software tools which help the problem solvers to solve problems quickly and efficiently with the help of these tools which utilize TRIZ Principles as their core part (Ltd, 2011). Tools like these have been developed and are maintained by analysing thousands of patents regularly and analysing the TRIZ Principles potential in them. Some studies also suggest the analysis of patents with TRIZ to identify the future direction of technologies (Loh et al., 2006). Some surveys suggest that amongst other tools, TRIZ Principles was the first choice and used most (Ilevbare et al., 2013) as shown in figure 40. Figure 40 suggests that the TRIZ Principles were used by 30 out of 40 respondents often or always, and 24 out of 40 respondents used the matrix often or always. This means that small percentage of TRIZ users sometimes used the TRIZ Principles without matrix sometimes.

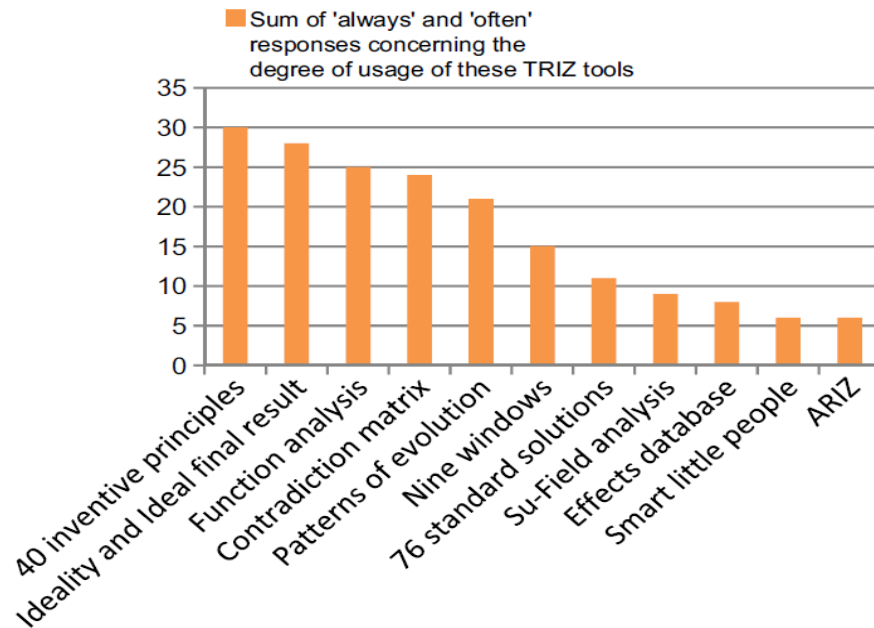


Figure 40: Popularity of TRIZ Principles among users (Ilevbare et al., 2013).

Copyright Statement: Permission to reproduce this image has been granted Imoh ILEVBARÉ via email communication for the purpose of facilitation of this research.

5.2.2 Concept of Wow

As suggested in the introduction of this chapter, the Wow site enables users to upload the content. The content is then reviewed by the review team and finally the reviews data is analysed to comment about the potential of TRIZ Principles and Physical Contradiction subsets of TRIZ toolset. Figure 41 briefly depicts the flow of site with respect to different users.

Context Level (1.0) Data Flow Diagram of Design For WOW Site

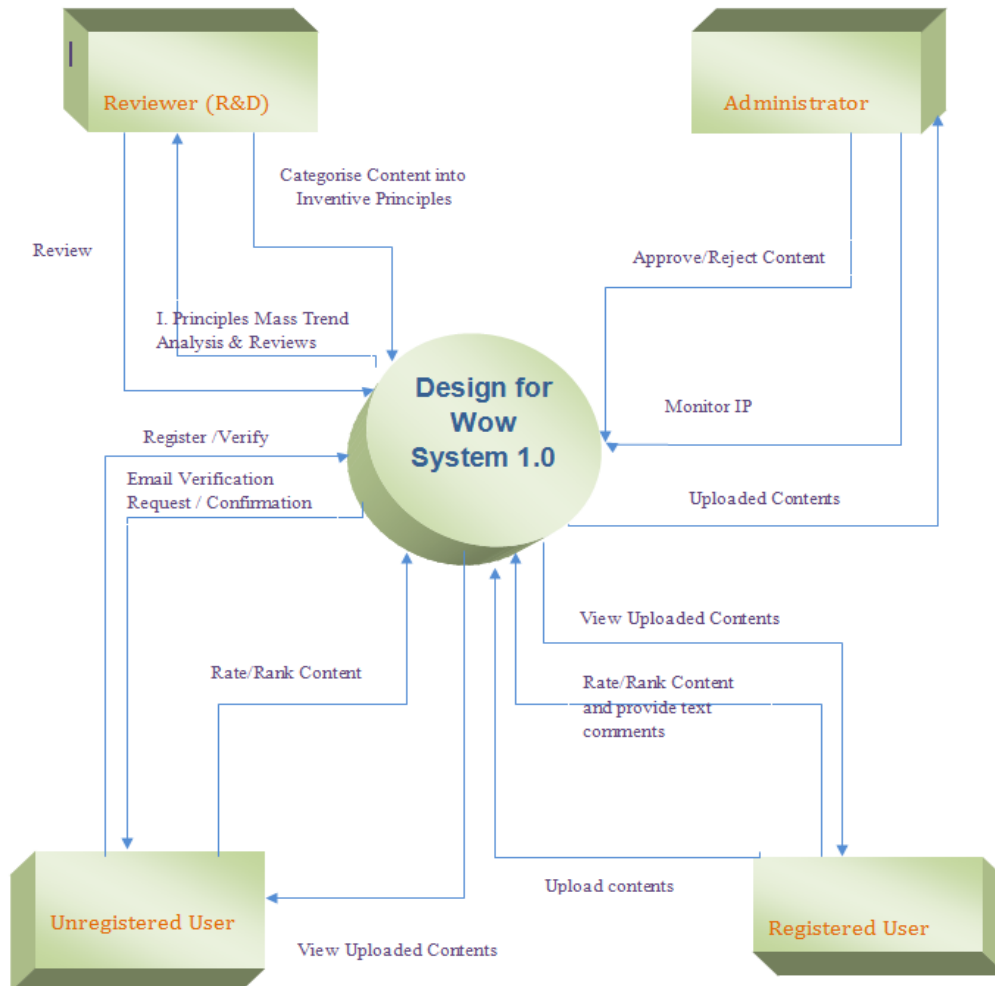


Figure 41: Data Flow Diagram for Design for Wow.

5.2.3 Previous Design & Development (previous version of portal)

DFD for Design for Wow: To ensure an efficient design and layout of the site, the overall system was first designed using a data flow diagram. The framework of this system can then be understood by analysing the data flows in and out of the site. The DFD for the D4W is shown in Figure 41 on previous page.

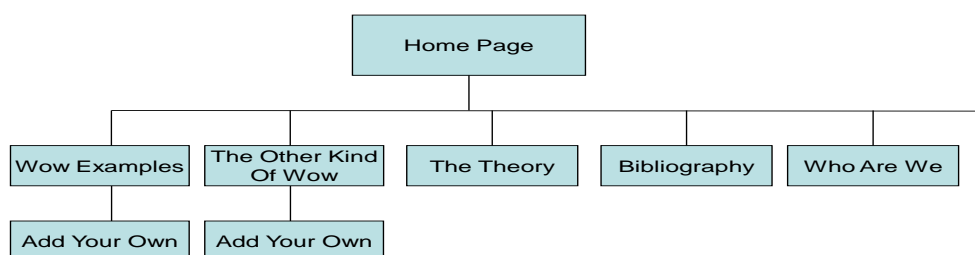
There are four types of actors in this DFD:

1. Reviewer (R&D team)- they are given access to the data through backend login (CMS panel) of the web portal. They then analyse the data and submit their reviews in an MS excel file.
2. Administrator- can do all actions which Reviewer can do and in addition can approve or reject contents uploaded by the users.
3. Registered user- can edit data.
4. Non registered user can send upload requests and like data on Facebook.

The page structure/ layout of this web portal have been shown in figure 42. This diagram depicts the design level which has been implemented by programming in to a functional web portal at designforwow.com domain. The mapping from TRIZ conceptualization to web portal design level design has been discussed in subsequent sections of this document with the help of TRIZ diagrams.

The entry to site goes through home page. The site operates on a drop down menu system whereby multiple dropdown options are available from menu links. The main menu links of the site for navigation are wow examples, other kind of wow examples, the theory, bibliography, who we are, educator resources. The menu links further contain sub menu dropdown links. Under wow examples menu link, “add your own” link allows the users to add the content on this portal. The “add your own” link is also present under “other kind of wow” to add non-innovative kind of content on web portal. The teacher resources contains drop down links which are namely “death by a million tools” and “molecules/atoms”.

Page Structure





All the pages need some nifty-looking graphics.
All I've done in this spec is written the words that go on each page

Figure 42: Original proposed layout of the web pages for Design for Wow website as approved, designed and discussed with project team during the design period.

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Figure 43 shows the initial example page concept for one of the categories called as “wow in music”. The wow examples page displays the preview of music picture, composer, artist and wow concept in the music. Similarly, other categories of wow have been enabled on these portals which are documents, videos, graphic designs, websites and online video links.

Wow in Music					
Piece	Composer / artist	Track timing	What the listener expects	What is done to create the 'WOW' response	Listen here
You Make Loving Fun	Fleetwood Mac (Christine McVie) (live version)	0.45 – 1.16	A continuing 8-beat quaver drum rhythm and a similar shape of melody to the verse.	The drums go to half time; the guitar plays a counter melody to a far 'jumper' bridge vocal. The chorus line is only revealed, curiously, in a coda at the very end of the piece. This bridge, consequently takes centre stage in the song, which is rare.	
Rock The Casbah	The Clash	2.13 – 2.22	The second chorus as normal.	The second chorus does return, though with a highly amplified and reverberating scream on the final note of the second verse, enhancing the already potent and playfully insinuating chorus.	

↓ List continues

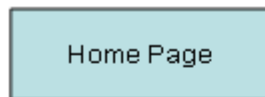
(ideally we allow people to download the clips here – might be copyright problems of course (or we could link to i-Tunes?))

(same basic format for the other wow categories)

Figure 43: Original proposed layout of the References/ Bibliography web page for Design for Wow website as approved, designed and discussed with project team during the design period (Mann, 2008).

Figure 44 shows the concept and text designed for home page at initial stage. At the later stages of development, the home page was modified and text altered after meetings with the supervisory team. Considering the importance and potential of “wow examples” page, it was decided that a link to “wow examples” page will be placed on home page so as to attract visitors and divert their attention to “wow examples”, this will help to keep the visitor on this portal for a longer time.

As a strategic design decision to attract visitors to this portal, home page text is written in clearly demarcated questions and quick tips to gain knowledge about the concept of this portal. This helps users to quickly understand the concept of this portal, hence increasing the possibility of encouraging them to visit the other sections of this portal, so as to increase their involvement in the portal on all important pages.



When was the last time you saw something or heard something that made you go 'wow'?

A piece of music? A film? A book? A product? A building?

Every composer, director, actor, design, architect is trying in some way or other to elicit that 'wow' reaction from y

Why is it then that we don't get that wow feeling so often?

Is it because 'wow' only happens when creators get lucky?

Or is it that no-one ever thought to try and work out the underlying phenomena behind 'wow'?

Is such a thing possible?

Can we really capture and reproduce the DNA of 'Wow'?

Should we want to? (Might it take away the mystery and fun?)

This site is dedicated to the idea that design-for-wow is systematically possible.

It is about the output of 2000 person years of research and the study of close to 3 million breakthrough innovation from all forms of human endeavour.

It is about tools to help you do it without taking the fun out of what you do when you create something new.

It is about helping you to evolve your creative capabilities to a new level.

Figure 44: Original proposed layout of the Home web page for Design for Wow website as approved, designed and discussed with project team during the design period (Mann, 2008).

5.2.4 Original Work Sketch/ Ideas

It is worth mentioning in this report about the sketches and original ideas generated by University of Plymouth and Systematic Innovations Ltd, UK.

Figure 45 shows the title, date of proposed start, sponsor, projected outputs and other aspects of D4W project. The basic success of this project depends on the number of cumulative hits and its popularity among TRIZ community and acceptance by them, because these factors will help accumulate more and more data progressively in many forms which will help to analyze and conclude the research questions effectively. The template shown marked the commencement of a real project to build a real website. The underlying theme of 'Design4wow' was to build on some earlier research in to the underlying dynamics of what makes people go 'wow' when they hear a particular piece of music, read a book or poem, or see a video. The very idea of this website was to enable 'wow' experience recording facility to a vast majority of people through a website.

The main things to note down from this template are the number of different type of customers and the high level of intangibility of their drivers compared to the tangible target of the web design team to achieve a certain number of hits per fixed period of time. With this kind of 'fuzzy' intangible problem, the biggest challenge is to find any kind of logical way in to the problem and to define the problem tangibly .

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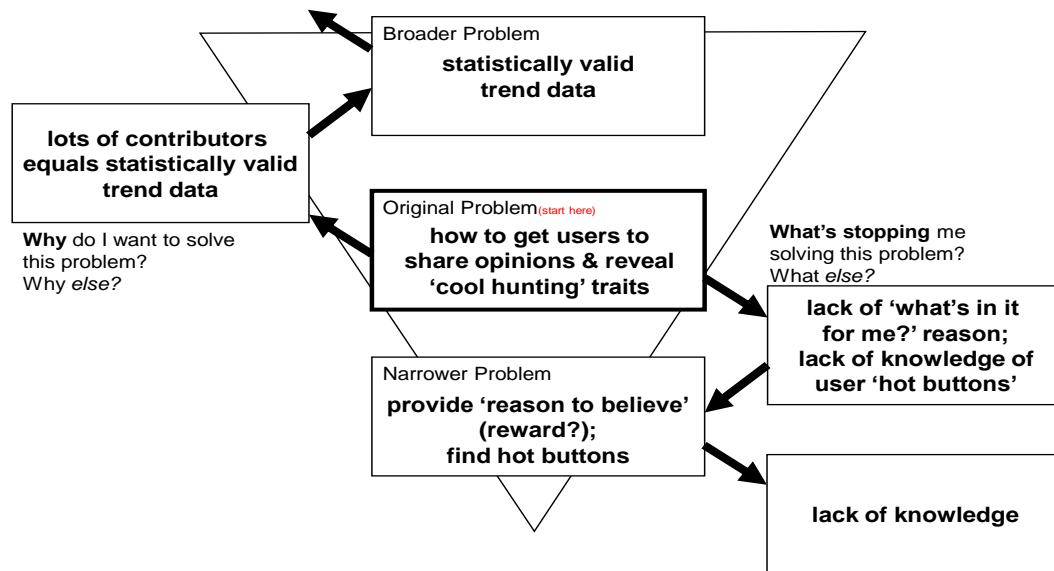
Project Title	Design 4 Wow Website		Date	08/08/08													
Project Sponsor	SI Ltd	Project Team	DLM, PD, CN, PS														
Project Customers	anyone interested in creativity	Non-Customers (target)	schools, colleges, musicians artists, authors, advertising														
Benefits	Where are we trying to get to (what are the desired outcomes)?		How will we know when we've got there (measures of success)?														
Sponsor	sustained, contributing traffic. trend patterns		10,000 hits/month after 4 months 500 contributions/month														
Customers	<table border="1"> <tr> <td>Collective/ Social</td> <td>knowledge sharing trend patterning</td> <td>opinion sharing 'cool hunting'</td> </tr> <tr> <td>Individual</td> <td>informative content creativity insight</td> <td>like-mind finding</td> </tr> <tr> <td></td> <td>Tangible</td> <td>Intangible</td> </tr> </table>		Collective/ Social	knowledge sharing trend patterning	opinion sharing 'cool hunting'	Individual	informative content creativity insight	like-mind finding		Tangible	Intangible	<table border="1"> <tr> <td>'can you see a trend?' input</td> <td>'polar opposite' views controversy?</td> </tr> <tr> <td>hit rate contribution rate</td> <td>conversation rate</td> </tr> </table>		'can you see a trend?' input	'polar opposite' views controversy?	hit rate contribution rate	conversation rate
Collective/ Social	knowledge sharing trend patterning	opinion sharing 'cool hunting'															
Individual	informative content creativity insight	like-mind finding															
	Tangible	Intangible															
'can you see a trend?' input	'polar opposite' views controversy?																
hit rate contribution rate	conversation rate																
Team	some form of unique feature		patentable? 'wow' user feedback														

Figure 45: Design for Wow website- Initial definition template (Mann, 2008).

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Figure 46a shows the “why what’s stopping” analysis of the D4W. Sharing of knowledge can be one of the major motivating factors to help attract more and more users to the site. The challenge here in this case is the lack of knowledge as compared to contradiction as depicted. If there would have been any contradiction in this problem, that could have been easily solved by matrix tool of TRIZ. But, in this case the main factor which stands in the way of getting a solution to this problem is the lacking of some knowledge element of this project. Further analysis suggested that the lack of knowledge was the lack of understanding of the expected customer base for this project.

WHY-WHAT'S-STOPPING ANALYSIS



Chapter 3

Sheet 6

Figure 46a: "Why what's stopping" model for the "Design for Wow" web site (Mann, 2008).

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On way to solve this problem of lack of knowledge was to survey the potential customer base at stage 1. This solution was not an ideal solution because the ideal number of customers to be surveyed would be in thousands. However, this could be achieved by understating the market and customer trends, but still in this case a large number of data has to be collected, managed and analyzed.

A good way to manage this situation is to use perception mapping tool. Figure 46b shows how this tool has been used to help understand how a number of potentially relevant trends are related to one another when examined in the context of 'Design4Wow'. In other problems, an analysis may incorporate many more than the 23 used in this analysis. At the end of this exercise, the first useful insights into the innovation task ahead began to appear. The first, referring to the D-W loop, is the need to be careful about the environmental and anti-corporate issues. The second insight relates to the U-O-V-F-P-J-C loop and the L collector point.

The problem later was analyzed using a third template called "Where to innovate" as shown in figure 46b. Figure 46b illustrates the findings obtained during this part of the analysis. In this template, a search was done for other innovations that had happened in and around the field of on-

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line creativity. This revealed that apart from some innovations, for example- distance learning, on-line thinking tools, etc- there hadn't been too much innovation in the domain.

Perception Mapping? (for situations where sparse, missing, fuzzy or opinion-based data is hindering meaningful understanding)

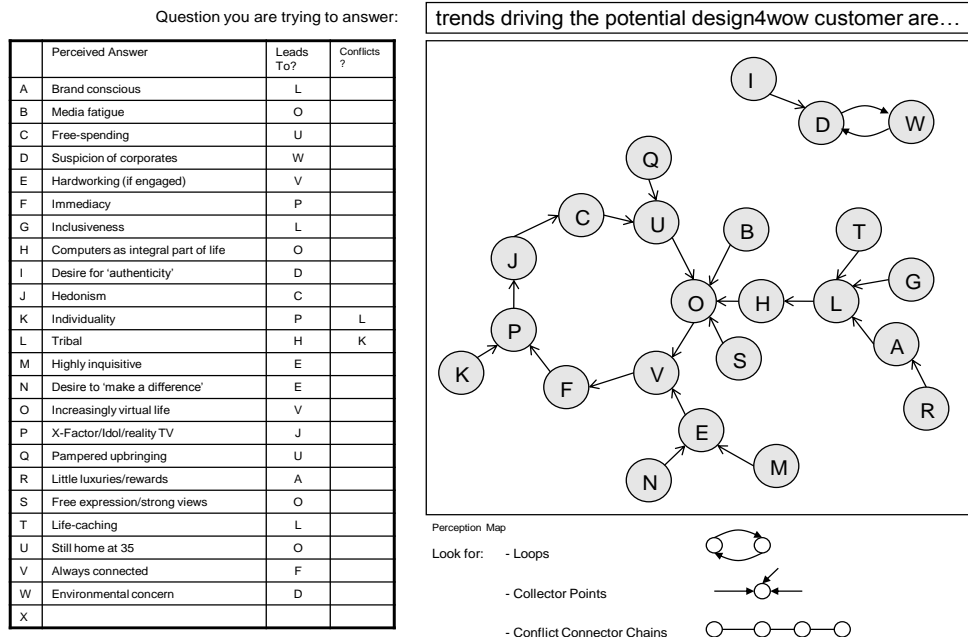


Figure 46b: Perception mapping model for the Design for Wow website (Mann, 2008). Copyright Statement: Permission to reproduce this image has been granted Darell Mann for the purpose of facilitation of this research.

WHERE TO INNOVATE (Identify where other players have been innovating in order to identify possible 'white spaces')

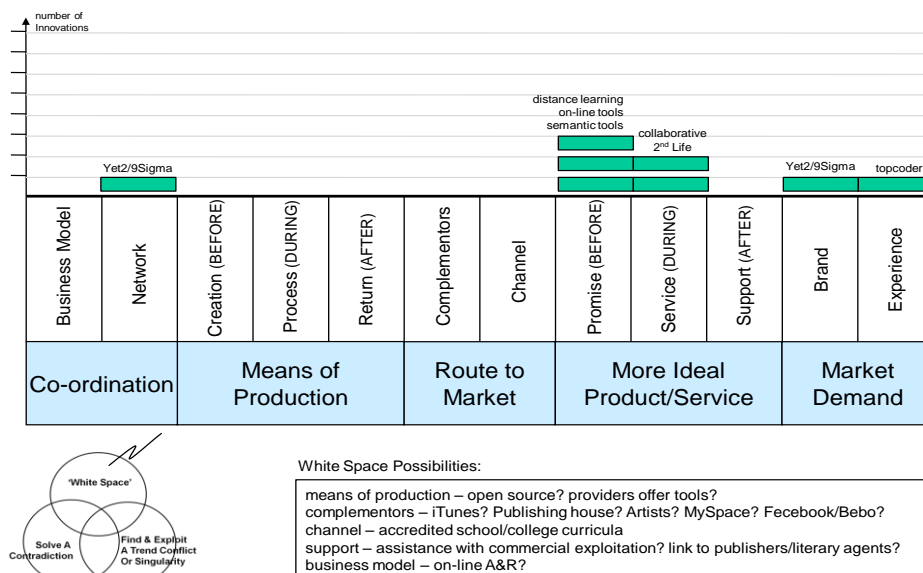


Figure 46c: Business Process model for the Design for Wow website (Mann, 2008).

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The bottom of figure 46c depicts how the ‘white spaces’ uncovered by the analysis have been used as triggers for generating additional thoughts about what and where the website should be looking to innovate. Connecting to schools, colleges and education curricula entered into the story as a potentially significant driver during this part of the analysis.

The detailed design and development of Design for Wow website is discussed technically in Appendix-IV of this thesis. The latest layout of Design for wow is discussed along with site maps and other features in Appendix-IX of this thesis.

5.3 The Goals and Contribution of 'D4W'

The objective of the Design for Wow project is to collect content on the site. The definition of content in this context is any “innovative design/good or bad innovation”. After the content has been uploaded by users of the site, the research team’s task is to link the contents to TRIZ Principles (if any links exist within each particular upload). TRIZ is being used across many industries and this research project aims to find the innovative capability of TRIZ in the content uploaded by users on the site. .

The Design for Wow (<http://www.designforwow.com>) is an attempt to summarize the successful inventions/ designs from all over the world on a web portal which has multiple capabilities. These designs/innovations are then linked to the TRIZ Principles in order to determine whether innovative aspects of these successful innovations are fully covered by the forty TRIZ principles. In Design for Wow, a framework is created which is implemented through a review tool. The Design for Wow website includes this tool which has been used by researcher and the users of the site and reviewers to analyse the uploaded data in terms of strength of TRIZ Principles linked to them.

The tool created in Design for Wow is based on the framework of analysing the TRIZ links in the uploaded content. The ‘Wow’ concept discussed in the section 5.1 and 5.2 is the basis of the concept of Design for Wow website, whereby the users upload the content they classify as ‘Wow’. This content then is further analysed for the ‘Wow factor’ and then mapped to TRIZ Principles as TRIZ tagging methodology is framed (section 5.5).

Besides analysing the innovative potential in terms of wide variety of innovative content, second objective of D4W is to present a tool to the research world which has the capability of summing the innovative content from various types of users, filtering and categorising it, presenting it to the researchers for innovation tagging with respect to the TRIZ. Hence, a knowledgebase framework is created in D4W with a new concept taken from theory to practical stage called as ‘Wow’.

5.4 Analysing TRIZ in 'Wow'

This research mainly involves analysing TRIZ in 'Wow'. Firstly, the content is analysed for any contradictions which would have been solved to present the solution in 'Wow'. Then the content is also analysed for the presence of TRIZ Principles in it. Lastly, some very small attention is also paid to the presence of any physical contradictions in the problem. The process is basically reverse engineered. This is because the 'Wow' content does not present a problem, it presents an innovation/ solution which has been already applied to solve the problem, hence the original problem is identified and the solution reverse engineered the 'triz way' and assumed that TRIZ was used to analyse the problem.

5.4.1 TRIZ Tagging Methodology

Part A. The reviewers were asked rate the content on innovation on a scale of 1-5. After that they were asked to identify the innovative parameters based on which the content is deemed as innovative. After this the Principle lying behind this innovation is identified with a surety rating from 0-3. They were also advised to mark any of the innovative parameters which were not covered by TRIZ.

Part B. The reviewers were asked to analyse any physical contradictions in the content and then map it to a corresponding TRIZ Principle, this was also don't with the rating of surety from 0-3. Two reviewers have been involved in this research, one of the reviewer having little experience in TRIZ and other reviewer having no experience in TRIZ. One day training program was followed by the researcher to fully train them on TRIZ and showing them examples how TRIZ can be applied to problem. This methodology is reverse engineered (finding how TRIZ could have been unknowingly used by the inventors of these innovative designs to come to an innovative solution).

This research attempts to measure the strength of TRIZ Principles in one phase and potential of TRIZ Physical Contradictions in the second phase. This was done in order to probe the claims by TRIZ experts that TRIZ Principles cover all innovations of the world. The TRIZ Physical contradictions probe was conducted to verify various claims in various versions of ARIZ. Some versions of ZRIZ suggest using TRIZ Principles first and if they do not succeed in delivering an ideal solution; then applying TRIZ Physical Contradictions (hence stating that TRIZ Physical Contradictions are stronger than directly applying TRIZ Principles). While as some theories suggest that TRIZ Physical Contradictions are stronger than TRIZ Technical Contradictions hence should be able to deliver more robust problem analysis.

The reviewers were involved (including the main researcher) to check the potential of TRIZ Principals and TRIZ Physical Contradictions in the sample innovation database (from DesignforWoW website). The conclusions are presented in the last section of this chapter5.

5.4.2 TRIZ Tagging Surety

Each reviewer was advised to tag the wow content according to the surety level they were confident with. The surety levels are shown in table 12. The same applies to the TRIZ Physical Contradictions section of reviews. Several meetings were held with supervisory team to discuss the levels of surety about TRIZ tagging as listed in table 12. Considering the fact that the review team consisted of a mix of experienced and inexperienced people, the below surety levels were fixed. The results were then analysed and further filtered by the researcher as an experienced TRIZ user. This is because the problem was added by the fact that this kind of methodology was not devised in the research world before this, and hence the process needed to be followed step by step.

The surety indicates how strongly the TRIZ Principle is believed to be behind that particular innovative piece of work. This does not represent the strength of that principle in general (or out of context of this problem), but represents the relation strength of this content with the particular TRIZ Principle. For example, one piece of work can have more than one TRIZ Principles behind its design/innovation, but the level of the relation of each principle and the piece of work can be different (one can be heavily responsible and other can be just a slight touch of an idea). Accordingly, each TRIZ principle can be responsible to solve its own set of contradictions from the problem in question (where there is more than one pair of contradictions in the problem in question).

How much sure are you the TRIZ Principle linked is accurate and represents the solution to this problem.	
0- Not sure at all	1- Little bit sure
2- Sure	3- Pretty much sure

Table 12: Surety of TRIZ Principles being tagged to content (this is also called as Principle Strength).

5.4.3 Points Mechanism for TRIZ Principles

Based on the strength of Principles in the content as marked by reviewer (as explained in section 5.5.2), each TRIZ Principle gains an average strength in the entire wow content. This forms the basics of judging the Principles presence in wow. This is explained in details in the section 5.6 of this chapter.

5.4.4 Points Mechanism for TRIZ Physical Contradictions

Based on the strength of Physical Contradictions in the content as marked by reviewer (as explained in section 5.5.2), each TRIZ Physical Contradiction gains an average strength in the entire

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wow content. This forms the basics of judging the Physical Contradiction presence in wow. This is explained in detail in the section 5.6 of this chapter.

5.5 Data on Wow Website

5.5.1 'Wow' Uploads

Currently, 391 uploads exist on the server, please go to design for wow for an exhaustive and a detailed list of these uploads contributed by the user. A summary of the uploads is also available at <http://designforwow.com/d4wcontent>. Maximum uploads are in image category, this is because the users feel that easiest way to upload anything is through an image (example taking a screen shot of an innovative product and upload it). This is followed by website uploads.

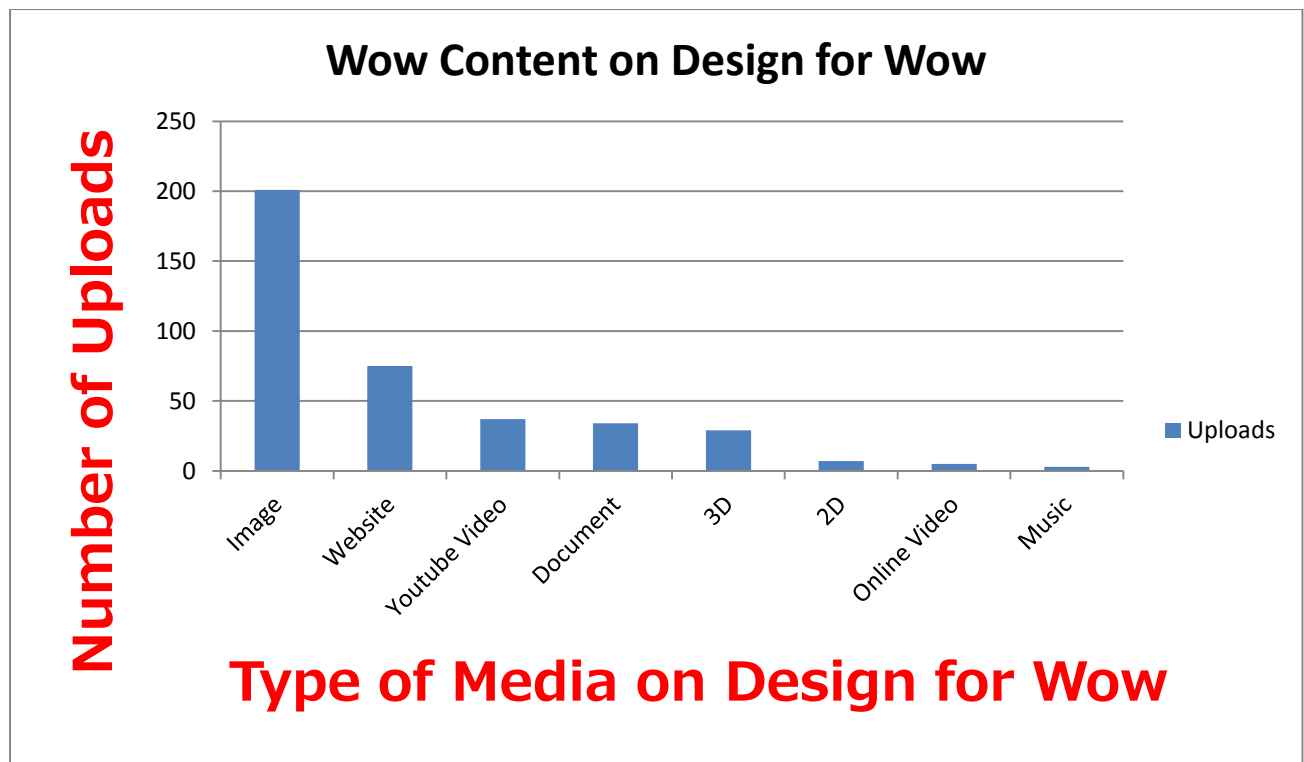


Figure 47: Uploads on Design for Wow website (media category wise-as on 30 October 2013).

5.5.2 'Wow' Visitor Information

As anticipated, the website has been loaded up with visitors from around the world (according to the distribution of global visitors from year 2012 to 2013). The site saw approximately as number of 16,000 visitors from the last one year. There are 16768 total visitors since last one year and they hit the site in total of 90,921 times (information valid till 30th October 2013).

Each visitor hence visited on an average of 6 to 7 pages per visit.

5.5.3 Search Engine Optimization

As a standard procedure for web 2.0 projects, SEO tactics were followed, the site has a standard site maps in all 5 formats, the Meta tags, etc. are generated dynamically per content to allow maximum use of Google and other search engine crawling.

Figure 48 shows the sample meta tags generated dynamically for ZPO tower image wow.

```
<!DOCTYPE html>
<html lang="en">
<head>
  <title>ZPO Tower Wow Examples-Images</title>
  <meta charset="utf-8">
  <meta name="description" content="From the land of opulence : Dubai comes another amazing feat of architecture and engineering to add to the majority of the building materials will come from recycled sources.. Engineering and beauty are merged together. On one hand the tower looks like a
  <meta name="keywords" content="Architecture Engineering Industry,Design for Wow, Image wow,2D wow, 3D wow, innovation, Systemmatic Innovation

  <meta property="og:title" content="ZPO Tower-Design for Wow Images Graphics" />
  <meta property="og:type" content="article" />
  <meta property="og:url" content="http://www.designforwow.com/imagesview.php?id=1&type=Images&min=0" />
  <meta property="og:image" content="http://www.designforwow.com/content/all12PO-Tower.jpg" />
  <meta property="og:site_name" content="Design for Wow-Images Graphics" />
  <meta property="fb:app_id" content="428043367250493" />
  <meta property="og:image" content="http://www.designforwow.com/content/all12PO-Tower.jpg"/>

  <link rel="stylesheet" href="css/reset.css" type="text/css" media="screen">
  <link rel="stylesheet" href="css/style.css" type="text/css" media="screen">
  <link rel="stylesheet" href="css/grid.css" type="text/css" media="screen">
  <script src="js/jquery-1.6.3.min.js" type="text/javascript"></script>
  <script src="js/cufon-yui.js" type="text/javascript"></script>
  <script src="js/cufon-replace.js" type="text/javascript"></script>
  <script src="js/superfish.js" type="text/javascript"></script>
  <script src="js/jquery.hoverIntent.js" type="text/javascript"></script>
  <script src="js/FF-cash.js" type="text/javascript"></script>
  <script src="js/script.js" type="text/javascript"></script>
  <script src="js/jquery.easing.1.3.js" type="text/javascript"></script>
  <script src="js/jquery.color.js" type="text/javascript"></script>
```

Figure 48: Sample meta tags for 'ZPO Tower' image 'Wow'.

As per Google Webmaster analytics, the site is healthy and depicts some remarkable search engine rankings ranging from position 1 in Google search rankings. Figure 49 shows just few of the thousands of queries on which the site is hit and impressions are created.

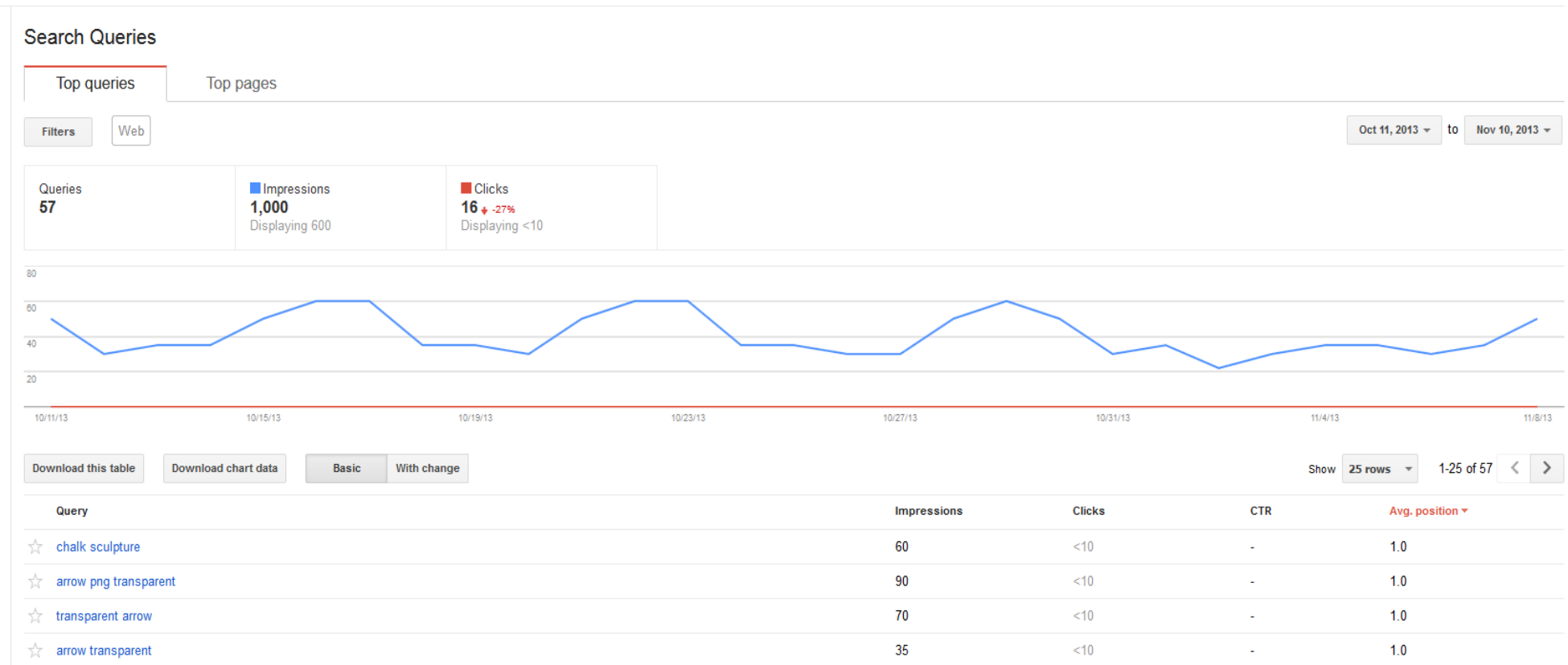


Figure 49: Webmaster Healthy Site panel.

5.6 Data Analysis of Wow

5.6.1 TRIZ Principles Tagging – Data by Junior TRIZ Reviewers

Two reviewers' data was combined; they reviewed it jointly after reviewing it individually. They marked Principles as shown in figure 50.

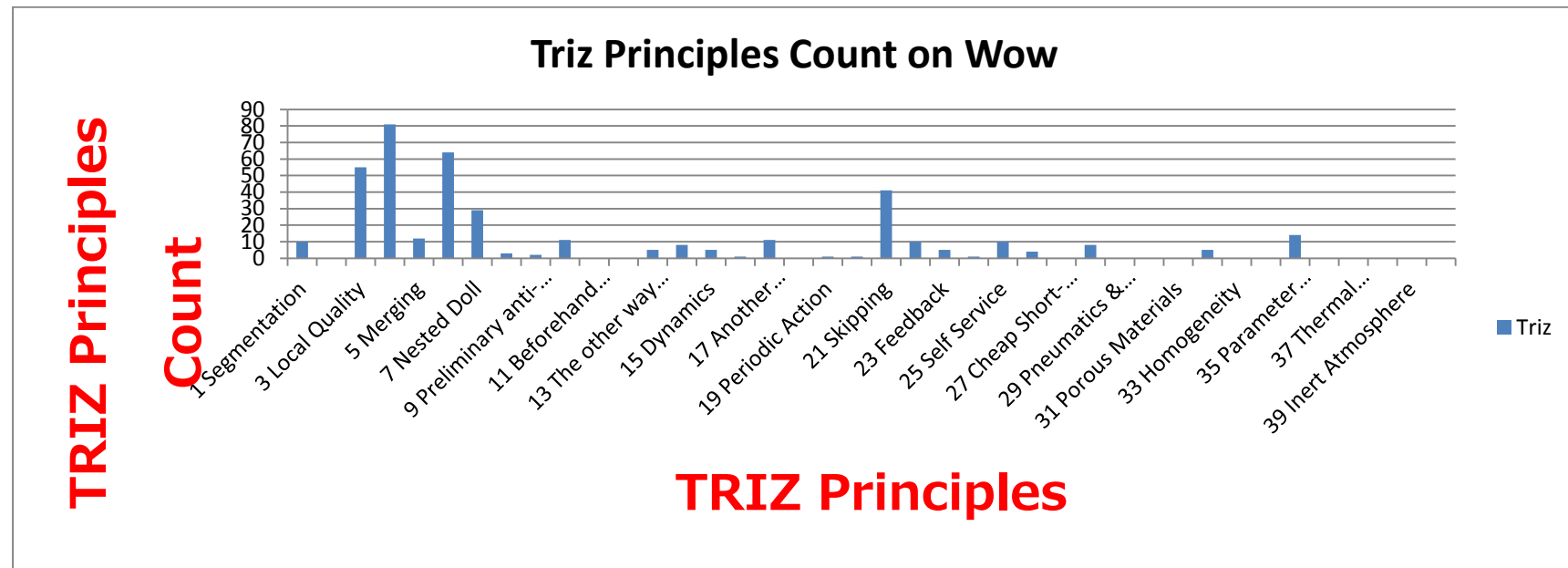


Figure 50: TRIZ Principles tag count in wow.

From figure 50, it is evident that the following Principles are more popular: Asymmetry, Universality, Local Quality, Skipping, Nested Doll, etc.

5.6.2 TRIZ Principles Strength - Data by Junior TRIZ Reviewers

The strength of same data when studied depicted a different popularity trend in TRIZ Principles. The points based system for each Principle works as follows:

$$\frac{\sum_{i=1}^n (S_i)}{n}$$

where: n = number of times the Principle is tagged in the whole content and S_i is the strength or the surety with which the reviewer tagged the Principle to a particular 'wow' solution on the web portal. According to figure 51, the following Principles are stronger as far as the points based system is concerned (Segmentation, Local Quality, Preliminary Action, Self Service, etc). Hence, comparing figure 50 and 51, it can be inferred that the confidence or the solution potential of a Principle does not depend on how many times the reviewers considered applying the TRIZ to solution, but it depends on how sure the reviewers are or how much confidence they have (which comes with going in to the details of problem and probing whether the solution first the problem specifications, this factor is also increased when both the reviewers agree to the same discussion. TRIZ Strength hence is the average of the surety levels of the principle associated with different 'Wow' pieces of work.

To make sure the data analysis is not affected by the difference of experience between the reviewers, all the data analysis was again analysed by the experienced TRIZ researcher and the differences in opinions were then put in a short version in the conclusion of this chapter. This will also help the future researchers to analyse the differences of level of usage in TRIZ between non experienced and experienced users. Additionally, it made sure that the more used TRIZ Principles were not confused by the ones which were easily recognized by TRIZ inexperienced users.

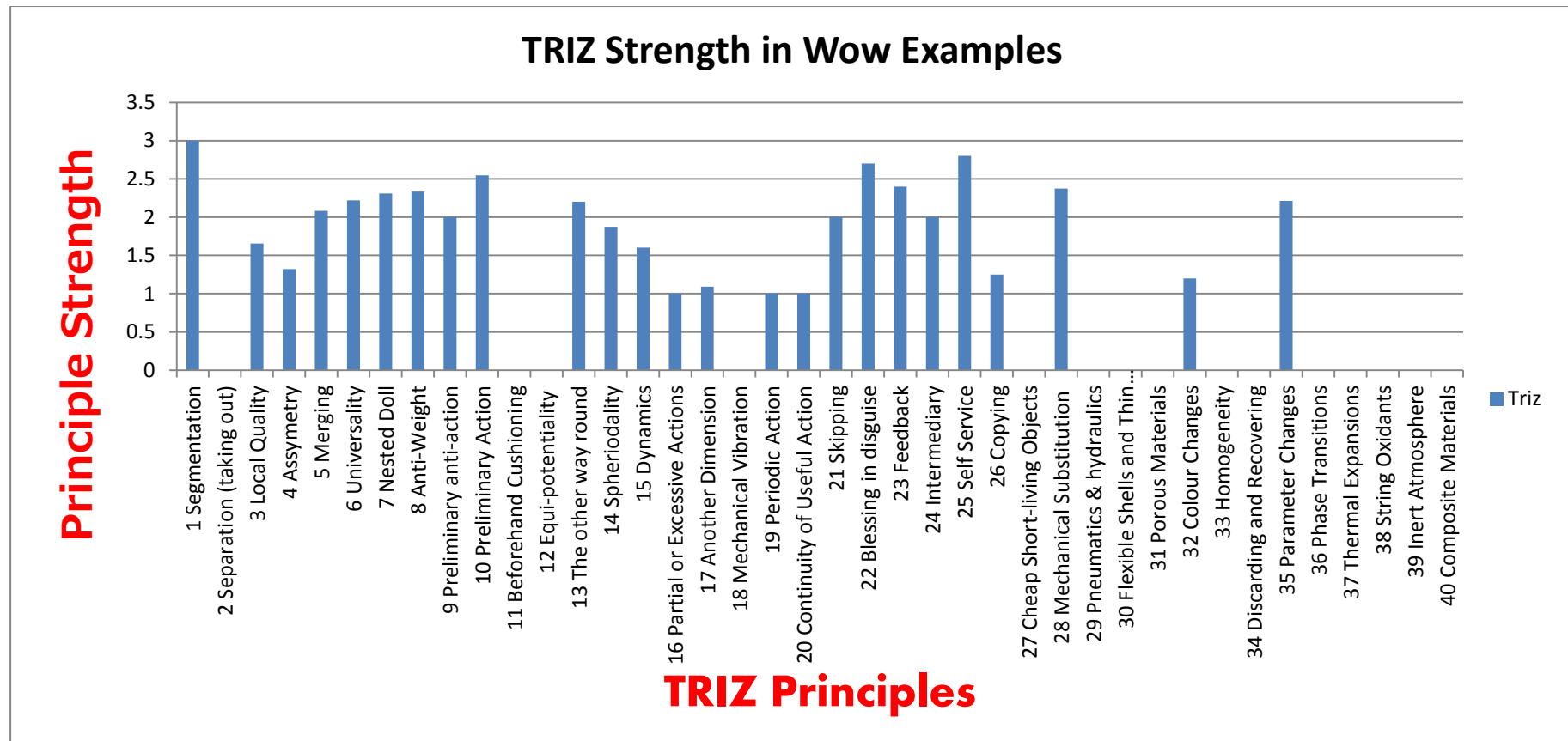


Figure 51: TRIZ Strength in the wow content.

5.6.3 Media Specific (Industry Specific) TRIZ Principles Tagging - Data by Junior TRIZ Reviewers

The strength of a portion of same data (only 3D Designs/ Images) and Graphic Design industry related data revealed a different trend in the popularity of TRIZ Principles. Figure 52 shows the data for 3D Images categories of wow content.

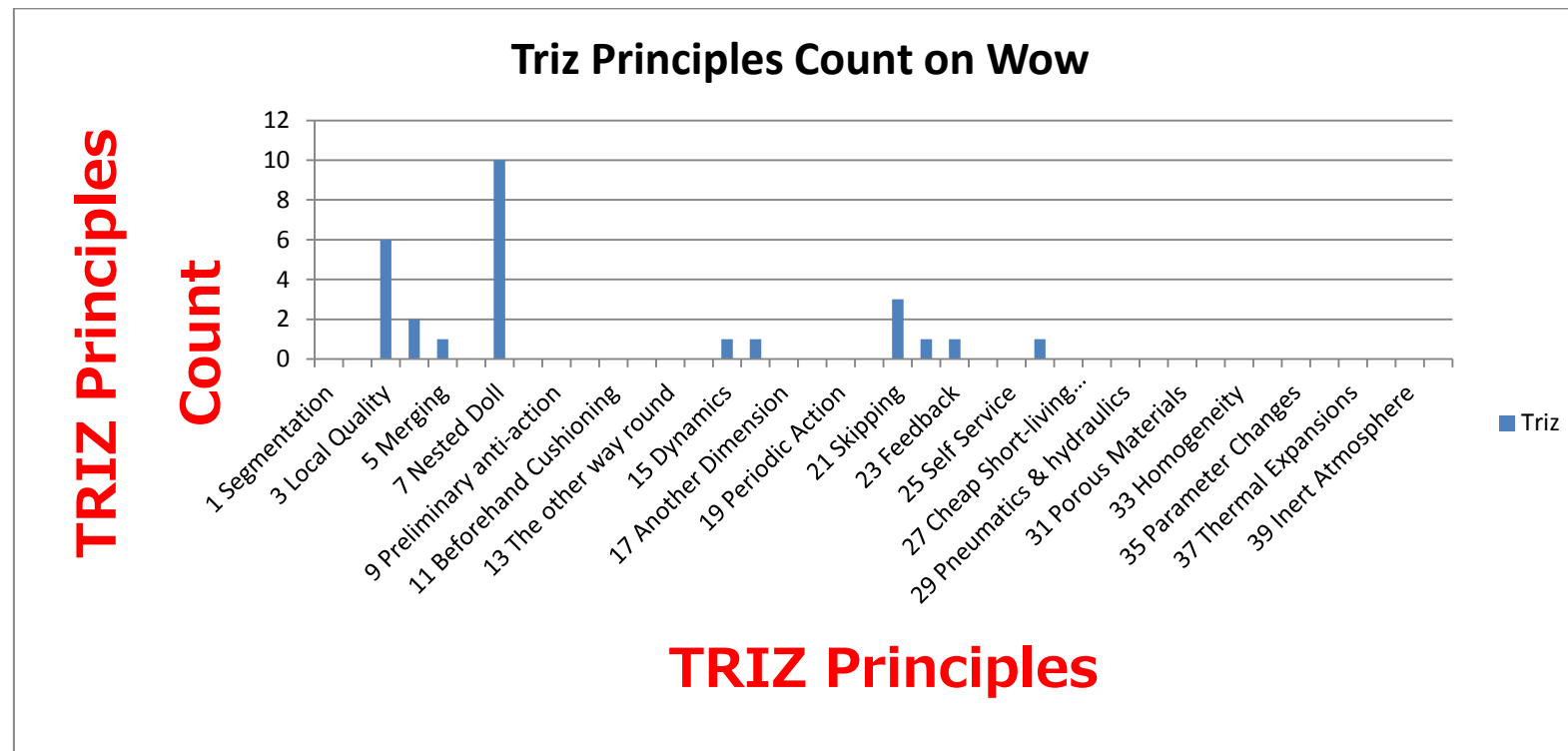


Figure 52 TRIZ Principles count on Wow (3D Graphics/ Images).

When analyzed carefully, figure 53 reveals that Nested Doll Principle is more popular in this category of wow. This is followed by local quality and skipping.

Figure 53 shows some examples of 3D Graphics wow whereby it is clear that Skipping, Nested Doll and Local Quality have been used.



Figure 53: Some examples from 3D Graphics showing how certain TRIZ Principles are more popular.

5.6.4 Strength Distribution of TRIZ Principles in Wow Content

Figure 54 shows the strength distribution of TRIZ Principles as marked by junior TRIZ experts. This shows that the junior reviewers were not much confident in applying TRIZ Principles. However, if the TRIZ strength graph is observed from figure 54, it is evident that some of the TRIZ Principles show nearly or exactly 100% strength. Hence, it is evident that some Principles are naturally easy to use and predict and apply example if Segmentation Principle.

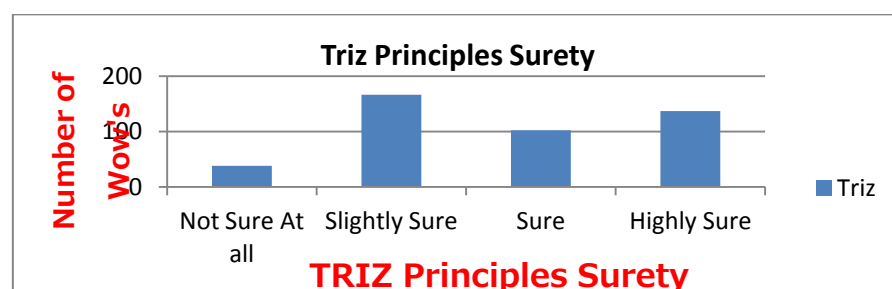


Figure 54 TRIZ Principles strength distribution in wow content.

5.6.5 Making of TRIZ Physical Contradictions by Junior Researchers in Wow Content.

It is evident from figure 54 and 55 that the reviewers have been less confident in finding the solutions through TRIZ Physical Contradiction as compared to TRIZ Principles solutions route. The junior researchers found it difficult to figure out the physical contradictions in the content (as compared to the technical contradictions and the TRIZ Principles route). However, at a later stage, after intervention by the researcher the physical contradiction data was improved but still not very strong as far as presence of physical contradictions were concerned. However, during the second round of analysis by the researcher, the physical contradiction data was improved but the presence of physical contradictions was very much weaker than the presence of technical contradictions in the content. The design for wow research mainly resolved around the TRIZ 40 Principles and technical contradictions, hence all these improvements in analysis have not been discussed in detail here and not much stress was put to research in this area due to time constraints. However, this part of study does minutely contribute to the conclusion of this research to some extent.

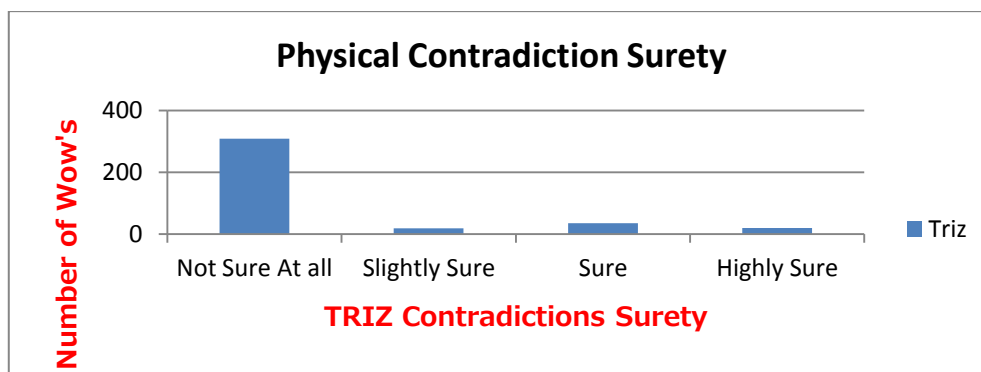


Figure 55 TRIZ Physical Contradiction strength distributions in wow content.

5.6.6 Missing of TRIZ Principles from Innovation Parameters.

It was anticipated that some of the innovative parameters found in the content analysed would not match any TRIZ Principles by the junior reviewers. It was hence planned to allow the junior researchers submit the content analysis data and also they were instructed to submit the analysis about the content where they could not find any TRIZ Principle answering the innovation in some content. After this stage, the data was planned to be passed to the researcher who would reanalyse the innovative parameters against the TRIZ Principles. The results of the researcher's analysis would be used to draw conclusion.

The reviewers have come up with some innovative parameters in the wow content for which they could not find any TRIZ Principles being applied to the problem for a solution. However, when the content is analysed fully by the researcher after this, it is revealed that each of these wow solutions also has another innovative parameter (which has equal or more potential to contribute towards the innovation of the particular content) which has a TRIZ Principle associated and in all these cases the TRIZ Principle surety is more than 50%. Hence, no innovation is without a TRIZ Principle on one of the parameter; however some parameters are where finding TRIZ is difficult.

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This part of research hence suggests that overall, all the innovative content had TRIZ principles behind them in one form or other and hence no such piece of content was found whereby TRIZ was missing at all.

Figure 56 reveals this in detail. Figure 56 shows that each of the wow solutions where TRIZ was missing to explain some sort of innovation had TRIZ present to explain some other innovation factor / parameter in the same wow solution, hence in any of the content TRIZ was not 100% missing.

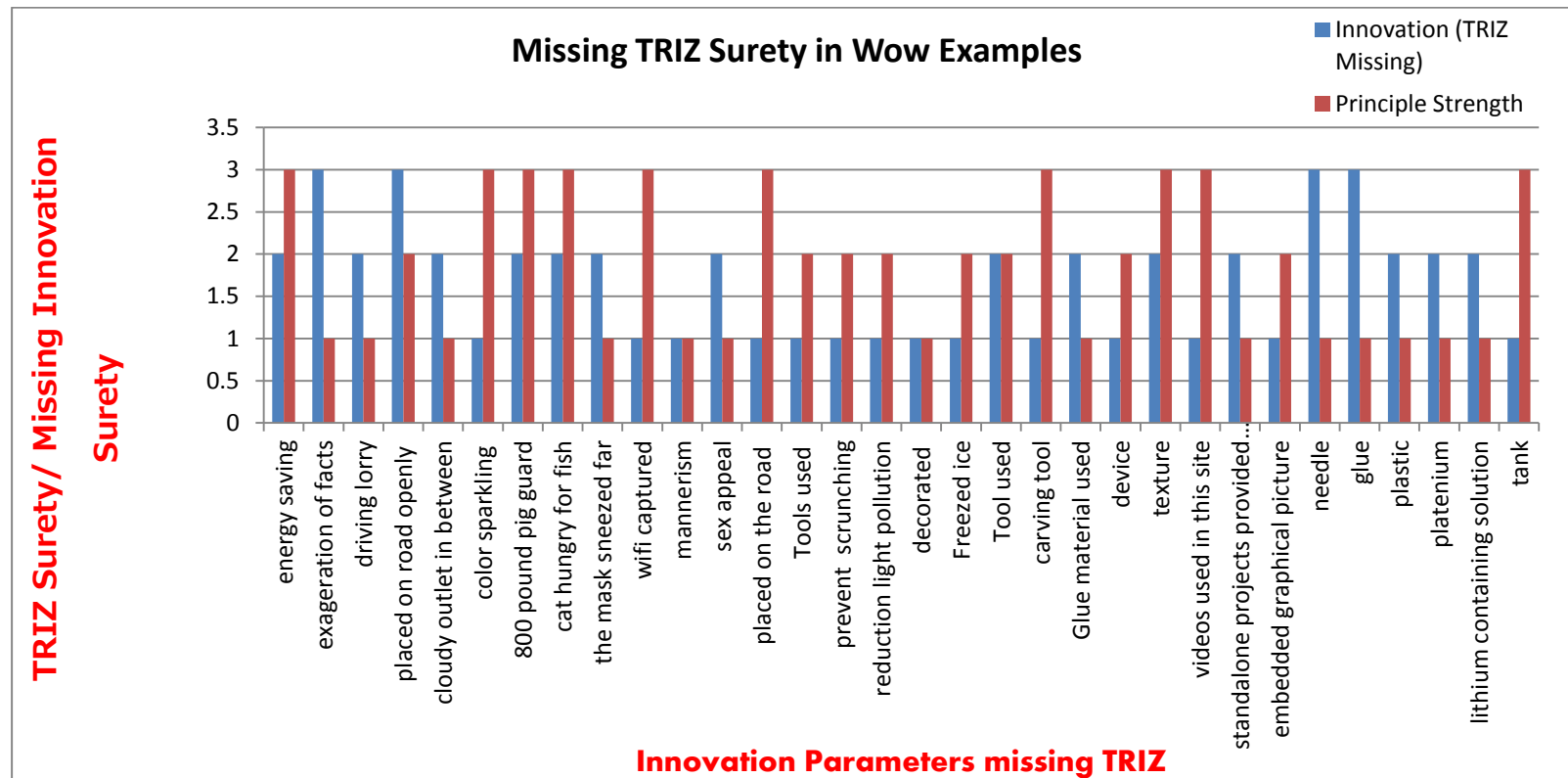


Figure 56: Innovative solutions which have an Innovation parameter with missing TRIZ Principles against TRIZ Principles present in some other parameter of the solution.

5.6.7 Overall TRIZ Presence in the Content.

The overall TRIZ presence in the Wow content is never less than 1 (never zero) in any other innovative solution on the portal, hence even the junior reviews could find TRIZ in every innovative solution on Wow. Figure 57 clearly marks this distribution in Wow content.

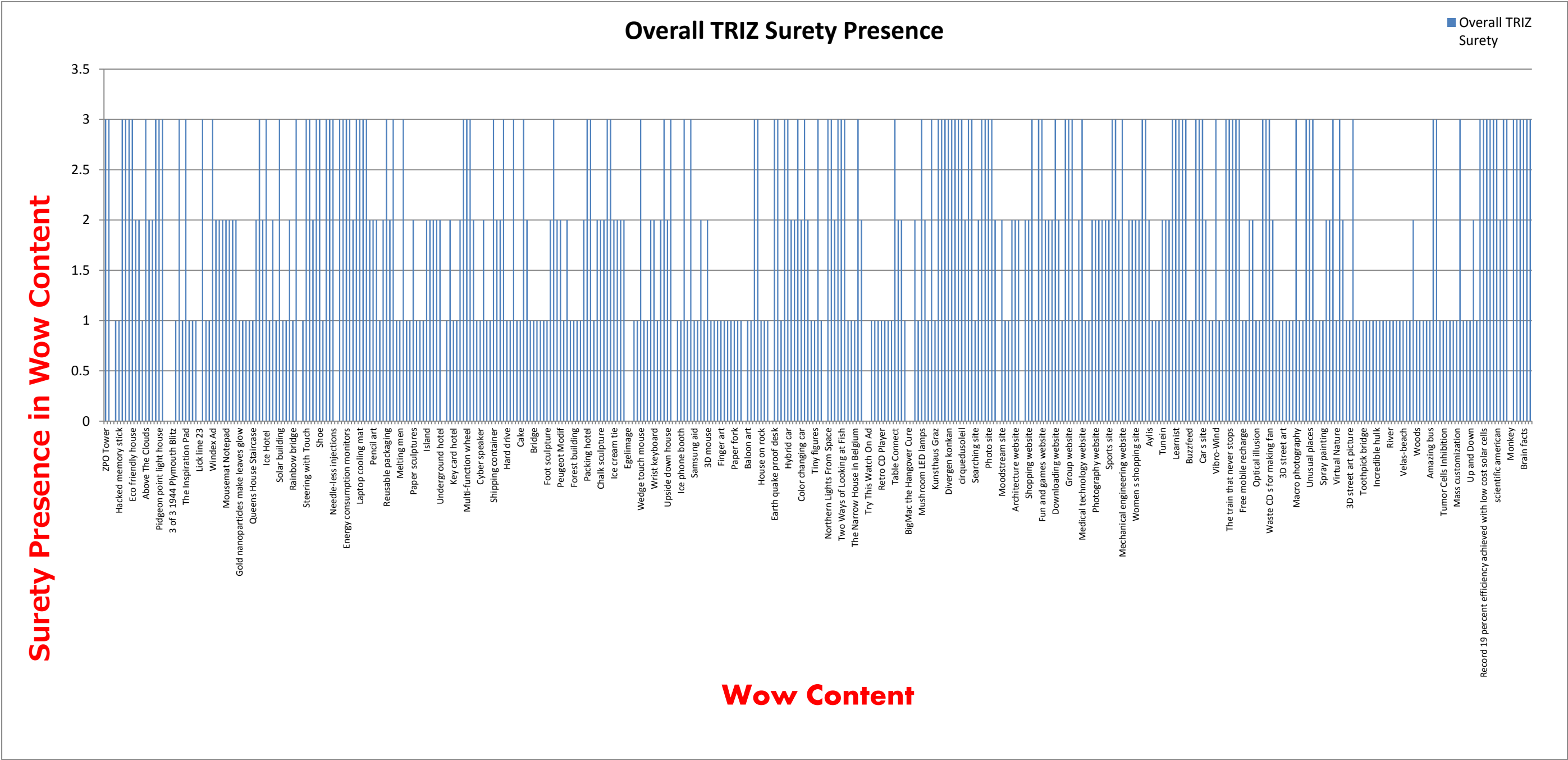


Figure 57: Overall TRIZ Surety presence in Wow content.

5.6.8 Researcher Marked TRIZ Points.

When researcher intervened and discussed the data with reviewers again, a clear improvement in TRIZ strength, surety, TRIZ count and overall distribution of TRIZ in Wow content was observed. This was then unanimously agreed by the reviewers.

Some examples of improvements are put forward in this section. For example in the Wow solution (ID:7) ,the reviewer explained that the parameter (taking out on the road for public) is not covered under TRIZ Principle but is an important innovative factor for this innovative solution. The researcher came up with Principles: Taking Out, Blessing in Disguise, etc.



Figure 58: The Security Glass Wow.

5.7 Summary

1. In many of the design for wow content, it was seen that the junior level trained TRIZ reviewers could easily come up with TRIZ Principles tagged behind the content, but they were not able to identify the TRIZ Physical Contradictions easily.
2. Some of the content was marked as having innovative parameters not covered by TRIZ but at the same time none of these content had TRIZ Principle lacking (the content had TRIZ Principle marked with some other innovative parameter).
3. When researcher looked at the data in point 2 above, researcher could identify the Principles linked to the parameters.
4. When researcher looked in to the data presented in point 1 above, it was almost equally becoming difficult for researcher to find out the TRIZ Physical Contradictions behind the content in the first revision of the data but during secondary revisions of data, TRIZ Physical Contradictions were more apparent.
5. TRIZ is overall not missing in any of the innovative solutions presented on Wow website.

It is concluded that TRIZ Principles directly applied to the problem has more potential in case of junior practitioners as compared to TRIZ Physical Contradictions.

TRIZ has potential to solve problems but at the initial level, junior practitioners need guidance to solve some problems. There may be some innovative parameters where TRIZ seems not applicable, but when looked carefully by experts TRIZ is there and need application carefully (in this case TRIZ may be applied to some other parameter while as being weak or missing in alternate parameters of same problem).

The data presented in the Appendix-VI is of paramount importance and can be used to find out specific TRIZ Principles popularity in specific industries. TRIZ 40 Principles hypothesis stands on its statement with certain recommendations as above.

Chapter 6:

Conclusion and Future Work

6.1 Overview

The theory of Inventive Problem Solving (TRIZ) is widely acclaimed by its academic experts and academic followers. This is evident from the fact that the training events, workshops and conferences related to TRIZ are on an increase and the literature on TRIZ is on a growing rise especially in this decade.

In order to find how useful TRIZ could be for graphic design, a tool AEGIS has been built in this research and tested and trained by the graphic designers. This section presents a critical overview of the feedback received and what the researcher concludes from the analysis, design and feedback phases of this research.

The second part of this research attempts to measure the strength of TRIZ Principles in one phase and potential of TRIZ Physical Contradictions in the second phase. This was undertaken in order to probe the claims by TRIZ experts that the set of TRIZ Principles can account for all innovations of the world. The TRIZ Physical contradictions probe was conducted to verify various claims in various versions of ARIZ. Some versions of ZRIZ suggest using TRIZ Principles first and if they do not succeed in delivering an ideal solution; then applying TRIZ Physical Contradictions (hence stating that TRIZ Physical Contradictions are stronger than directly applying TRIZ Principles). Some theories suggest that TRIZ Physical Contradictions are stronger than TRIZ Technical Contradictions hence should be able to deliver more robust problem analysis. Three reviewers were involved (including the main researcher) to check the potential of TRIZ Principals and TRIZ Physical Contradictions in the sample innovation database (DesignforWoW website). The conclusions are presented later in this chapter (6.1.4).

6.1.1 AEGIS- Achievements

The results in this part of research is based on feedback from more than 40 persons over several years during various sessions of questionnaire and feedback (more than 10 sessions, 20 meetings and more than 40 email communications) (See AppendixVII for details).

The feedback from designers as suggested in different questionnaires is promising.

Overall feedback is positive.

- The text section has attracted all types of users and 80% of users have come up with positive feedback about this section.

- The background and molecular transformations need refining and the images need to be cleaned after the combination of layers.
- The text (without the other layers) has been rated the most innovative part of this software by the users.
- This tool can mostly be used to generate innovative fonts for graphic labels or other purposes.
- The users are attracted to software because it generates prototypes quickly while keeping the variation speed slow to allow the users to some extent control the direction of outputs.
- As per the latest questionnaire (see appendix-VII), the colour and demeanour is the most innovative output parameter which has met the expectations of the proposed design by users. This was unanimously agreed by majority percentage of participants by marking these parameters to more than 4 on a scale of (0-5) for expectation.

A session of 30 minutes exclusive experimentation in which four persons participated (during different intervals of time), clearly suggested that the font outputs generated during each generation were on an average 250% percentage quicker generated as compared to other tools (MS Paint, Adobe Fireworks and Photoshop). This result combined with that fact presented that more than 60% percentage of designers and other users suggested that the font outputs met their expectations (and sometimes surprised them with creativity) suggests that AEGIS is a useful and an innovative tool and is the next generation CAI tool. Since this tool is based on TRIZ Principles guided GA's, hence clearly TRIZ has proven to be useful while applied to a CAI tool used for graphic designers.

6.1.2 AEGIS- Critical Analysis

100% of the participants from the beginning of this project suggested that the overall idea of this project is in itself innovative (especially the model of 9 outputs during each generation results in rapid prototyping). During 100% of sessions, the users from all backgrounds were trained on AEGIS for a duration between 5-10 minutes in groups (not individually face to face), despite this they were able to run AEGIS successfully, hence it is a user friendly tool.

Considering all the above factors, TRIZ should not be claimed as the main contributor to the success of this research. The following factors also equally contributed:

1. Timely feedback by designers
2. Careful iterative analysis
3. The idea of 9 point grid for each generation of images
4. The layering concept
5. The concept of GA took this project to entirely to a new level.

Hence TRIZ when applied with a certain level of research based planning can be a promising framework, we may argue that the 4 points above if analysed could have been a result of applying TRIZ as well (example the layering concept), but here it is necessary to mark a statement that TRIZ cannot result in innovative products or designs or processes unless applied properly. However, successfully we have answered a question: Yes the DNA of innovation can be captured using a component of TRIZ Principles and Contradictions.

6.1.3 AEGIS Future Work

The positive feedback has been discussed in the previous section. Now, it is important to discuss the future of this research. We feel that the real research has been concluded and that now we have a product which could be commercially launched. Key areas to be improved are:-

- AEGIS molecular section needs improvements
 - Images need to be cleaned
 - More manual control is needed by designers to take advantage of the outputs of AEGIS.
 - In AEGIS chapter, 8 molecular and 5 more font transformations are defined but not implemented in AEGIS 7.1, hence a future framework is defined which needs to be taken further.
 - The users of this software still need support of other tools to take the design to completion (either before using AEGIS or after using AEGIS or both). This aspect needs to be analysed further to strengthen the usefulness of AEGIS and especially need to include these aspects in the user guide (the user guide does not mention about these at present; even if the AEGIS can presently be successfully be used in conjunction with other software).

To conclude this section, we hereby present to the research and design world the first CAI tool for graphic designers based on Genetic Algorithms guided by TRIZ Principles which is available to download from <http://designforwow.com> website for free trial use and R&D under GNU Licence (please refer to AppendixV for a copy of our GNU Licence terms and conditions).

6.1.4 Design for Wow Conclusions

Three reviewers were involved (including the main researcher) to check the potential of TRIZ Principles and TRIZ Physical Contradictions in the sample innovation database (from DesignforWoW website). The conclusions are presented in this chapter.

1. In many of the design for wow content, it was seen that the junior level trained TROZ reviewers could easily come up with TRIZ Principles tagged behind the content, but they were not able to identify the TRIZ Physical Contradictions easily.
2. Some of the content was marked as having innovative parameters not covered by TRIZ but at the same time none of these content had TRIZ Principle lacking (the content had TRIZ Principle marked with some other innovative parameter).
3. When researcher looked at the data in point 2 above, researcher could identify the Principles linked to the parameters to some extent.
4. When researcher looked in to the data presented in point 1 above, it was almost equally becoming difficult for researcher to find out the TRIZ Physical Contradictions behind the content.

It is concluded that TRIZ Principles directly applied to the problem has more potential in case of junior practitioners as compared to TRIZ Physical Contradictions.

TRIZ has potential to solve problems but at the initial level, junior practitioners need guidance to solve some problems. There may be some innovative parameters where TRIZ seems not applicable, but when looked carefully by experts TRIZ is there and need application carefully (in this case TRIZ may be applied to some other parameter while as being weak or missing in alternate parameters of same problem).

6.1.5 Design for Wow Future Work

The future work of this research can be a vast topic to discuss about. It might be possible to link TRIZ Principles to the general 'Wow' database which is built in this tool (Design for Wow) at a later stage. But such work needs a very exhaustive quantity of data from all walks of life. Currently, the basic framework for this is ready on Design for Wow platform which needs to be extended and more data needs to be gathered and contribution from public is a must on a large scale to take this research to such a level.

Another level of description which can be added to the database of this tool is whether the particular principle chalked out in review process was actually used by the designer/ design team. This question has partly been answered in the review process, but the question asked in the research objectives does not directly pose this as research objective. The research question asked here is that has TRIZ Principle been used (knowingly or unknowingly is not a matter of investigation here). This question is answered when the core researcher revised the reviews put by the review team. However, in future investigation and review process can be further strengthened to investigate the literature and history affiliated to the particular product/ design as the designer intentionally used the TRIZ Principle or not. Some of this can automatically be filtered by database of this tool (by checking the date the design came to existence and comparing it with the TRIZ birth date). This can further be added by core subject area researcher's reviews by breaking down the design parameters in terms of the basic elements of the design and then analysing the application of TRIZ Principles (same way as AEGIS problem was carried on- chapter 3).

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Appendix-I (TRIZ 40 Principles)

This research is based mainly on three TRIZ tools (besides many other additional tools) (Altschuller 2009),

- TRIZ Principles
- TRIZ Contradictions
- TRIZ Trends

Previous research (Dvorak 2001) shows that application of TRIZ to problem solving not only makes possible solutions to problems which were previously considered non-solvable, but yields results far more quickly compared to other techniques. One of the most powerful methodologies of TRIZ is the use of contradiction. Contradiction enables the problem-solver to solve the root cause of problems in many industries. The TRIZ method was invented by Russian patent analyst Genrich Altshuller after studying patterns and lessons he saw in the inventions on file in thousands of patents. He saw that the same fundamental problem had been addressed by similar inventions in a number of diverse technological areas/ industries (Mann 2007). The effort led him to identify 40 Inventive Principles and around 40 (evolutionary) Trends. Three of the more frequently used Principles are called Segmentation, Inversion and Prior Action (Mann 2007).

In 1984, Altshuller described “creativity as an exact science” (Altschuller 1984). He meant by this that innovation can be achieved systematically and not as many think via a random process. He went on further to reclassify trade-offs as contradictions.

Figure 3 shows the structure of TRIZ solution approach to problem using different TRIZ methodologies and tools.

TRIZ has been widely recognized as highly relevant to innovation in the technological field. (Su 2008). The strength of TRIZ as a method for developing creative solutions to problems lies on its removal of contradictions rather than on the use of the conventional approach by means of compromises or trade-offs (Su 2008).

TRIZ 40 Principles:-

Principle 1: Segmentation

A. Divide an object into independent parts.

- Dividing a work process into separate steps.
- Segregate primary controls from secondary controls.
- Group menu options.

B. Make an object easy to disassemble.

- Modular furniture to avoid injury in transportation.

C. Increase the degree of fragmentation or segmentation.

- Phone numbers divided into perceptual chunks.
- Layering of information screens based on what is needed.
- Optimizing work processes through individual task analysis.

Principle 2: Taking Out

A. Separate an interfering part or property from an object or single out the only necessary part (or property) of an object.

Engineering Innovation (TRIZ based Computer Aided Innovation)

- Navigation systems using "turn by turn" versus complex maps.
- Removing hazardous operations to an isolated location.
- Recessed start button to minimize accidental starts.
- Progressive disclosure of information.

Principle 3: Local Quality

A. Change an object's structure from uniform to non-uniform, change an external environment (or external influence) from uniform to non-uniform.

- Oversized emergency buttons.
- Simplified cell phone panels for people with motor skills problems.

B. Make each part of an object function in conditions most suitable for its operation.

- Specialized setting on websites and software.
- Offer different ways to have software provide the same function.

C. Make each part of an object fulfill a different and useful function.

- Individual office design to reflect different ergonomic needs.
- Individual televisions on airplanes.
- Mouse performs both point and scroll functions.

Principle 4: Asymmetry

A. Change the shape of an object from symmetrical to asymmetrical.

- Left and right handed designed products.
- One way insertion for two different parts.

B. If an object is asymmetrical, increase its degree of asymmetry.

- Differ shapes to prevent improper insertion of parts.

Principle 5: Merging

A. Bring closer together (or merge) identical or similar objects, assemble identical or similar parts to perform parallel operations.

- Combine different functions in one piece of office equipment.
- Joystick changes both direction and speed.
- Electronic chips mounted on both sides of a circuit board or subassembly.
- Using touch screens for audio and climate controls at the same time.

B. Make operations contiguous or parallel; bring them together in time.

- Bring together through multi-tasking.
- Group associated controls and functions.

Principle 6: Universality

Engineering Innovation (TRIZ based Computer Aided Innovation)

A. Make a part or object perform multiple functions; eliminate the need for other parts.

- Universal design for a broad range of people.
- Common personal computer operating systems.
- Common procedure standards.
- Multiple back-up methods.
- Icon and label conventions.
- Conventions for links on websites.

Principle 7: Nested Doll

A. Place one object inside another; in turn, place each object inside the other.

- Nesting with menu hierarchies.
- Nesting within graphic displays.

B. Make one part pass through a cavity in the other.

- Radio graphical user interface (GUI). A selection (such as a radio station or MP3 file / song) that appears as one item among many on a search list that may pass through to the main screen where it is presented as the current status / selection.

Principle 8: Anti-weight

A. To compensate for the weight of an object, merge it with other objects that provide lift.

- An assembly line counterweights.

B. To compensate for the weight of an object, make it interact with the environment (use aerodynamic, hydrodynamic, buoyancy and other forces).

- Lift / carry an object. Center of gravity is close to the sagittal plane of the human body.

Principle 9: Preliminary Anti-action

A. If necessary to do an action with both harmful and useful effects, this action should be replaced with anti-actions to control harmful effects.

- Use of dead-man controls.
- Pre-flash to eliminate red eye in photography.
- Safety interlocks to prevent access to hazardous equipment.
- Insulation on local hot spots.

B. Create beforehand stresses in an object that will oppose known and undesirable working stresses later on.

- Introduce tension to avoid kickbacks.
- Stress induced training to prepare for actual conditions.
- Close eyes before entering a dark room.

Engineering Innovation (TRIZ based Computer Aided Innovation)

- Synchronous vs. asynchronous defibrillators.

Principle 10: Preliminary Action

A. Perform (before it is needed) the required change of an object (either fully or partially).

- Pre-arrange components to make assembly easier.
- Format the report before the data is available.

B. Pre-arrange objects such that they can come into action from the most convenient place and without losing time for their delivery.

- Employee pre-training for hazardous operations.
- Job planning to avoid accidents.

Principle 11: Beforehand Cushioning

A. Prepare emergency means beforehand to compensate for the relatively low reliability of an object.

- Shoe cushion inserts.
- Confirmation dialogue box.
- Navigation destiny entry to avoid need for constant attention.
- Undo button.
- A lockout.

Principle 12: Equipotentiality

A. In a potential field, limit position changes (such as a change in operating conditions to eliminate the need to raise or lower objects in a gravity field).

- Spring loaded parts.
- Spring loaded self-leveling device ("levelator").
- Workplace design for sliding objects.
- Gravity feed soda can dispenser.

Principle 13: The Other Way Around

A. Invert the action(s) used to solve the problem (instead of cooling an object, heat it).

- Start / stop buttons.

B. Make movable parts (or the external environment) fixed and fixed parts movable).

- Electric can opener.

C. Turn the object (or process) upside down.

- Parts come to the operator.
- Users help design products.

- Write the user manual before writing the computer program.

Principle 14: Spheroidality – Curvature

A. Instead of using rectilinear parts, surfaces or forms, use curvilinear ones; move from flat surfaces to spherical ones; from parts shaped as a cube (parallelepiped) to ball-shaped structures.

- Smooth work surfaces to minimize sharp points.
- Smooth work flow angles to avoid sudden turns.
- Ergonomic work stations.
- Use of curved surfaces in handles and grips.

B. Use rollers, balls, spirals, domes.

- Rotaries in gauges.

C. Go from linear to rotary motion. Use centrifugal forces.

- Produce linear motion of the cursor on the computer screen using a mouse or a trackball.
- Replace wringing clothes to remove water with spinning clothes in a washing machine.
- Spherical casters instead of cylindrical wheels to move furniture.
- Spherical casters on luggage and vacuums.

Principle 15: Dynamics

A. Allow (or design) the characteristics of an object, external environment or process to change to be optimal or to find an optimal operating condition.

- Adjustable steering wheels and seats.
- Unlearning "sounding out words" to enable speed reading.

B. Divide an object into parts capable of movement relative to each other.

- The butterfly or foldable computer keyboard.

C. If an object (or process) is rigid or inflexible, make it movable or adaptive.

- Use gooseneck connections.
- Use coiled cords / tubes / hoses to allow flexible positioning.
- Use a flexible sigmoid scope for medical examination.

Principle 16: Partial or Excessive Actions

A. If 100 percent of an object is hard to achieve by using a given solution method then, use slightly less or slightly more of the same method. The problem may be considerably easier to solve.

- Apply a safety factor over design.
- Design processes where hazardous operations are done in steps.
- Increase sampling rate of inspection.

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- Introduce irrelevant stimuli on vigilance tasks.

Principle 17: Another Dimension

A. To move an object in a two- or three-dimensional space.

- Braille for the blind.
- Finger swipe cell phone operation versus a push button.

B. Use a multi-story arrangement of objects instead of a single-story arrangement.

- Add auditory or tactile feedback to visual feedback.
- Use shelves above a work surface.

C. Tilt or re-orient the object, lay it on its side.

- Re-orient a dump truck.
- An automobile rotisserie - rotate the car body to work on the underbody.

D. Use another side of a given area.

- Use three dimensional imaging to design tasks.
- Use a shelf hanging below a work surface.

Principle 18: Mechanical Vibration

A. Cause an object to oscillate or vibrate.

- Use vibration rather than mechanical force to dislodge an object.
- Use tactile feedback.

B. Increase its frequency (even up to the ultrasonic).

- Distribute powder with vibration.

C. Use an object's resonant frequency.

- Use a rough road shoulder to alert drivers.

D. Use piezoelectric vibrators instead of mechanical ones.

- Quartz crystal oscillations drive high accuracy clocks.

E. Use combined ultrasonic and electromagnetic field oscillations.

- Use vibration and sound to alert a cell phone user of incoming calls.

Principle 19: Periodic Action

A. Instead of continuous action, use periodic or pulsating actions.

- Do hazardous tasks a little at a time.

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- Replace a continuous siren with a pulsed sound.

B. If an action is already periodic, change the periodic magnitude or frequency.

- Use auditory alerts.
- Replace a continuous siren with a sound that changes amplitude and frequency.

C. Use pauses between impulses to perform a different action.

- Press and hold down buttons.

Principle 20: Continuity of Useful Action

A. Carry on work continuously; make all parts of an object work at full load, all the time.

- Avoid lengthy machine startups.
- Employ emergency backups.

B. Eliminate all idle or intermittent actions or work.

- Eliminate repetitive motion.

Principle 21: Skipping

A. Conduct a process or a certain stage (destructible, harmful or hazardous operations) at high speed.

- Minimize duration of error consequences.
- Redesign processes to avoid hazardous operations.
- Run hazardous chemical reactions at high speed to minimize inventory.

Principle 22: "Blessing in Disguise" or "Turn Lemons into Lemonade"

A. Use harmful factors (particularly, harmful effects of the environment or surroundings) to achieve a positive effect.

- Stop system progress to prevent more errors.
- The Environmental Protection Agency regulates product changes; new product gives competitive advantage.

B. Eliminate the primary harmful action by adding it to another harmful action to resolve the problem.

- Loud noise (such as a radio) and fatigue are each bad for drivers, but combined they can cancel some negative effects for drowsy drivers.
- Make a component fragile looking to discourage abuse.

Principle 23: Feedback

A. Introduce feedback (referring back, cross-checking) to improve a process or

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action.

- Provide instant and relevant information to operators to provide safe operation.

B. If feedback is already used, change its magnitude or influence.

- Flash a warning light if steady state operation is not acknowledged in "X" seconds.
- Flash an auditory alert if steady state operation is not acknowledged within a given time frame.
- Change the color of the visual effect.

Principle 24: Intermediary

A. Use an intermediary carrier article or intermediary process.

- Use cushioning.
- Use bins to transport parts between operations.
- Use pop-up windows and a dialogue box.

B. Merge one object temporarily with another (which can be easily removed).

- Chunk numbers in a sequence.
- Track changes in document creation.

Principle 25: Self-service

A. Make an object self-serve by performing auxiliary helpful functions.

- Use optical illusions.
- Use online stress measurements, adjust equipment or positions.
- Convey depth in drawing via line convergence.

B. Use waste resources, energy or substances.

- Learn from mistakes or errors.
- Excess process heat is used to heat office area.

Principle 26: Copying

A. Instead of an unavailable, expensive, fragile object, use simpler and inexpensive copies.

- Virtual reality via the computer instead of an expensive vacation.
- Listen to an audio tape instead of attending a seminar.

B. Replace an object or process with optical copies.

- Virtual training for hazardous situations.

C. If visible optical copies are already used, move to infrared or ultraviolet copies.

- Mental models of systems.

Principle 27: Cheap Short-living Objects

A. Replace an inexpensive object with a multiple of inexpensive objects, comprising certain qualities (such as service life).

- Use lightweight temporary pieces versus heavy permanent ones.
- Use temporary blocks to restrain equipment operation.

Principle 28: Mechanics Substitution

A. Replace a mechanical means with a sensory (optical, acoustic, taste or smell) means.

- Replacement of any human force with a mechanical force reduces required human energy.
- Use a bad smelling compound in natural gas to alert users to leakage, instead of a mechanical or electrical sensor.
- Use a flashing light instead of a ringing bell to indicate an incoming telephone call.

B. Use electric, magnetic and electromagnetic fields to interact with the object.

- Use artificial intelligence.
- Interaction in a television remote.

C. Change from static to movable fields from unstructured fields to those having structure.

- Use a 3G network for wireless communication.
- Wireless communication improves work flexibility.

D. Use fields in conjunction with field-activated (ferromagnetic) particles.

- Heat a substance containing ferromagnetic material by using varying magnetic fields. When the temperature exceeds the Curie point, the material becomes paramagnetic and no longer absorbs heat.

Principle 29: Pneumatics and Hydraulics

A. Use gas and liquid parts of an object instead of solid parts (inflatable, filled with liquids, air cushion, hydrostatic, hydro-reactive).

- Use comfortable shoe sole inserts filled with gel.
- Use pneumatics and hydraulics to minimize human force requirements for heavy parts.
- Make a product use forgiving.

Principle 30: Flexible Shells and Thin Films

A. Use flexible shells and thin films instead of three dimensional structures.

- Pre-packaged materials to isolate materials from human contact.

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- Isolate un-needed features of a product.

B. Isolate the object from the external environment using flexible shells and thin films.

- Barriers to isolate operators from hazardous operations.
- Spam or information filter; personalize electronic information.
- Use shields.

Principle 31: Porous Materials

A. Make an object porous or add porous elements (inserts, coatings, etc.).

- Use porosity in a structure to reduce weight.

B. If an object is already porous, use the pores to introduce useful substances or functions.

- Use controlled information flow and direction.

Principle 32: Color Changes

A. Change the color of an object or its external environment.

- Use color to indicate danger or conditions.
- Use highway signs.
- Use color coding.

B. Change the transparency of an object or its external environment.

- Use color sensitive labeling.
- Use clear storage bins.

Principle 33: Homogeneity

A. Make objects interact with a given object of the same material (or material with identical properties).

- Use affinity mapping.
- Layer consistency in maps or displays.
- Train operators in similar tasks to minimize accidents from different tasks.

Principle 34: Discarding and Recovering

A. Make portions of an object that have fulfilled their functions go away (discard by dissolving, evaporating, etc.) or modify these directly during operation.

- Use automatic file deletion.

- Use lossy compression.

B. Conversely, restore consumable parts of an object directly in operation.

- Lighter-weight, less durable parts to minimize physical stress.
- Reconstruction of lost images.
- Pixel interpolation.

Principle 35: Parameter Changes

A. Change an object's physical state (to a gas, liquid or solid).

- Changes in data density.
- Gas explosion to deploy seat bag.

B. Change the concentration or consistency.

- Font, case, italics changes in documents.

C. Change the degree of flexibility.

- Seat belt lockup during a crash.
- Reaction time changes for different information.

D. Change the temperature.

- Raise the temperature above the Curie point to change a ferromagnetic substance to a paramagnetic substance.
- Raise the temperature of food to cook it (changes taste, aroma, texture, chemical properties, etc.).
- Lower the temperature of medical specimens to preserve them for later analysis.
- Cool a flexible component to make it stiff for assembly.

Principle 36: Phase Transitions

A. Use phenomena occurring during phase transitions (volume changes, loss or absorption of heat, etc.).

- Melting of weak point to stop current flow.
- Analog versus digital.
- Film to CCD conversion.

Principle 37: Thermal Expansion

A. Use thermal expansion (or contraction) of materials.

- Use heating and cooling to minimize force required to loosen joints.
- Use a differing stimulus.

B. If thermal expansion is used, use multiple materials with different coefficients of thermal expansion.

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- Expand granularity.
- Replace yes / no with a scale of response.

Principle 38: Strong Oxidants**A. Replace common air with oxygen-enriched air.**

- Oxidizing cleaners to reduce human effort needed.
- Use a creative outsider in an ideation session.

B. Replace enriched air with pure oxygen.

- Enrich the learning environment with visual and auditory stimulation of various sorts.
- Improved aesthetics or form.

C. Expose air or oxygen to ionizing radiation.

- Localized process radiation or ionization to avoid broad exposure or to provide enhanced local properties.

D. Use ionized oxygen.

- Focused human factor audits.

E. Replace ozonized (or ionized) oxygen with ozone.

- Enrich various hospital environments.

Principle 39: Inert Atmosphere**A. Replace a normal environment with an inert one.**

- Use gas padding to minimize impacts.
- Quiet areas in the workplace.

B. Add neutral parts or inert additives to an object.

- Use "time outs" during negotiations.

Principle 40: Composite Materials**A. Change from uniform to composite (multiple) materials.**

- Change lightweight composites to lower-weight and minimize human effort.
- Heterogeneous focus groups.
- Non-traditional work structures.
- Flow-optimum range of challenge.

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Appendix-II-C#.Net Code Samples

Structure of Gene Switches mapped to the Interface

Genetic Algorithm

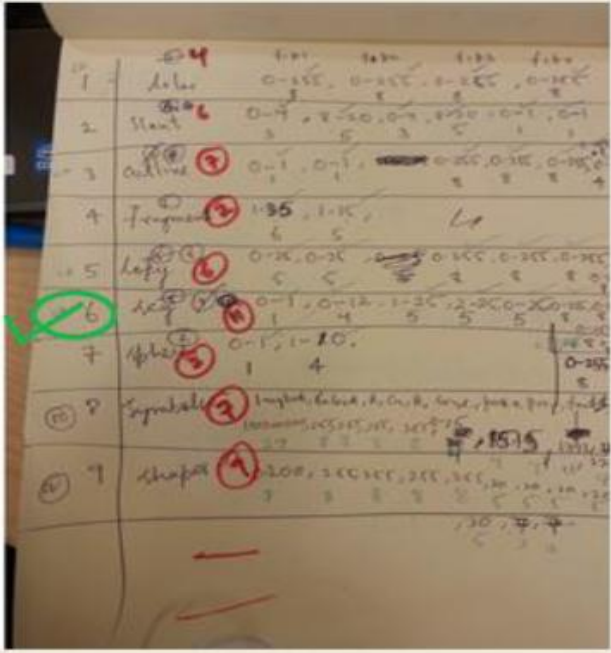
Atomic Mutations

Chromozomes Applied

- ☐ Would you like the colouring effects
- ☐ Would you like started text
- ☐ Would you like text outlining effects
- ☐ Would you like fragmented text
- ☐ Would you like duplicated text
- ☒ Would you like segmented text
- ☐ Would you like spheroidal effects
- ☐ Would you like symbol introduction
- ☐ Would you like shapes introduction

AtomicGeneSwitchesFinal:
000001000

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C#.NET Code Samples

Genome Selection Example

Genetic Algorithms: Bits and Decimals

FinalGenome9:Selected(Final):

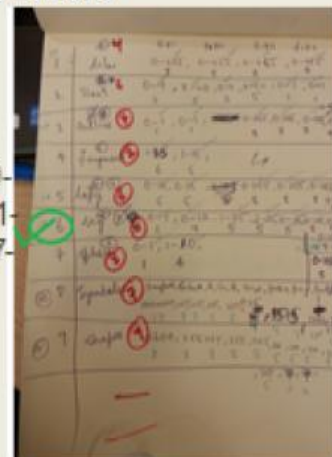
```
0111000001010001100100101000011011011011000011010001001010101101
010111101011101100001111010100110101111001001111010000110101100
1101000000001111101101001111111101101000111000010000011111111000
101000011000101110110100011110110110001011000110000001101000111
00110100011101111010111000001001000111010111000100011001001111000
011101100001000000100100011011010010000100100100100000
```

```
01010110011010000000111110110100111111110110
100011100001000001111111000101000011000101110
```

```
95-97-227-251-4-18-0-9-0-0-0-1-51-153-178-223-10-24-19-
20-14-176-76-137-0-1-10-9-5-21-216-95-253-168-96-134-1-
13-64393438-31-19-93-244-333-7-0-28-44-188-35-80-91-7-
3
```

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C# NET Code Samples



Extraction of Chromosome from Genome Example

Genetic Algorithms: Bits and Decimals

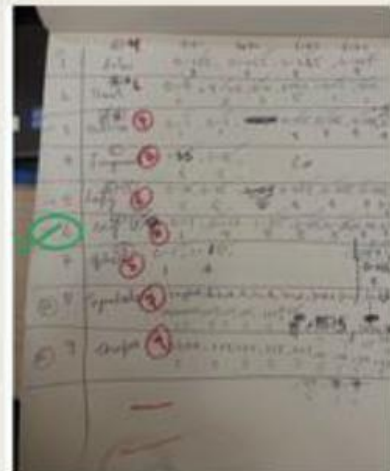
01010110011010000000111110110100111111110110100011100001000001111
1111000101000011000101110

95-97-227-251-4-18-0-9-0-0-0-1-51-153-178-223-10-24-19-20-14-176-76-137-0
10-9-5-21-216-95-253-168-96-134-1-13-64393438-31-19-93-244-333-7-0-28-44-
188-35-80-91-7-3

1-10-9-5-21-216-95-253-168-96-134

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C# NET Code Samples

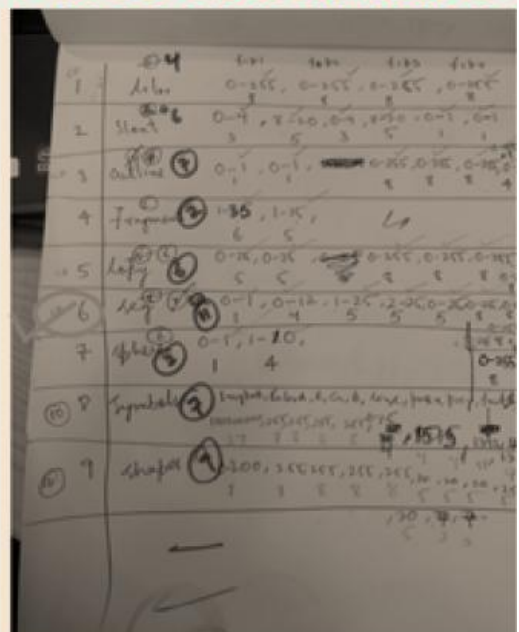


Structure of a Chromosome and mapping to Genes

Genetic Algorithms: Bits and Decimals

Gene Value	Gene
1	angle (hor/ vert)
10	min_thickness (of seg)
9	frequency (max times)
5	intervals (distance)
21	interval_gradient
216	colorA
95	colorR
253	colorG
168	colorB
96	color Gradient
134	color Grad Increment

1-10-9-5-21-216-95-253-168-96-134



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C# NET Code Samples

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Code for extraction of bits to decimals (genes)

```

///Extract the decimal values from the genome passed as an argument
/// similar way as usual
///

f1p1 = (int)GeneticAlgorithms.binarytoDecimal(GeneticAlgorithms.grayToBinary(genome_to_apply.Substring(0, 8)));
f1p2 = (int)GeneticAlgorithms.binarytoDecimal(GeneticAlgorithms.grayToBinary(genome_to_apply.Substring(8, 8)));
f1p3 = (int)GeneticAlgorithms.binarytoDecimal(GeneticAlgorithms.grayToBinary(genome_to_apply.Substring(16, 8)));
f1p4 = (int)GeneticAlgorithms.binarytoDecimal(GeneticAlgorithms.grayToBinary(genome_to_apply.Substring(24, 8)));

f2p1 = (int)GeneticAlgorithms.binarytoDecimal(GeneticAlgorithms.grayToBinary(genome_to_apply.Substring(32, 3)));
f2p2 = (int)GeneticAlgorithms.binarytoDecimal(GeneticAlgorithms.grayToBinary(genome_to_apply.Substring(35, 5)));
f2p3 = (int)GeneticAlgorithms.binarytoDecimal(GeneticAlgorithms.grayToBinary(genome_to_apply.Substring(40, 3)));
f2p4 = (int)GeneticAlgorithms.binarytoDecimal(GeneticAlgorithms.grayToBinary(genome_to_apply.Substring(43, 5)));
f2p5 = (int)GeneticAlgorithms.binarytoDecimal(GeneticAlgorithms.grayToBinary(genome_to_apply.Substring(48, 1)));
f2p6 = (int)GeneticAlgorithms.binarytoDecimal(GeneticAlgorithms.grayToBinary(genome_to_apply.Substring(49, 1)));

f3p1 = (int)GeneticAlgorithms.binarytoDecimal(GeneticAlgorithms.grayToBinary(genome_to_apply.Substring(50, 1)));
f3p2 = (int)GeneticAlgorithms.binarytoDecimal(GeneticAlgorithms.grayToBinary(genome_to_apply.Substring(51, 1)));
f3p3 = (int)GeneticAlgorithms.binarytoDecimal(GeneticAlgorithms.grayToBinary(genome_to_apply.Substring(52, 8)));
f3p4 = (int)GeneticAlgorithms.binarytoDecimal(GeneticAlgorithms.grayToBinary(genome_to_apply.Substring(60, 8)));
f3p5 = (int)GeneticAlgorithms.binarytoDecimal(GeneticAlgorithms.grayToBinary(genome_to_apply.Substring(68, 8)));
f3p6 = (int)GeneticAlgorithms.binarytoDecimal(GeneticAlgorithms.grayToBinary(genome_to_apply.Substring(76, 8)));
f3p7 = (int)GeneticAlgorithms.binarytoDecimal(GeneticAlgorithms.grayToBinary(genome_to_apply.Substring(84, 4)));

f4p1 = (int)GeneticAlgorithms.binarytoDecimal(GeneticAlgorithms.grayToBinary(genome_to_apply.Substring(88, 6)));
f4p2 = (int)GeneticAlgorithms.binarytoDecimal(GeneticAlgorithms.grayToBinary(genome_to_apply.Substring(94, 5)));

f5p1 = (int)GeneticAlgorithms.binarytoDecimal(GeneticAlgorithms.grayToBinary(genome_to_apply.Substring(99, 5)));
f5p2 = (int)GeneticAlgorithms.binarytoDecimal(GeneticAlgorithms.grayToBinary(genome_to_apply.Substring(104, 5)));
f5p3 = (int)GeneticAlgorithms.binarytoDecimal(GeneticAlgorithms.grayToBinary(genome_to_apply.Substring(109, 8)));
f5p4 = (int)GeneticAlgorithms.binarytoDecimal(GeneticAlgorithms.grayToBinary(genome_to_apply.Substring(117, 8)));

```

Mutation method in c#

```

public static string mutation(string genotype,int degree)
{
    int index;
    char temp;
    char[] temp1 = new char[share1.genome_size_font];
    temp1 = genotype.ToCharArray();
    degree=degree * genotype.Length/ 100;

    for (int i = 1; i <=degree ;i++ )
    {
        index = share1.rnd.Next(0,share1.genome_size_font);
        temp=genotype[index];
        if (temp.Equals('1'))
            temp = '0';
        else
            temp = '1';
        temp1[index]=temp;
    }

    return new string(temp1);
}

```

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Crossover method in c#

```
public static void crossover(string genotype1, string genotype2, int no_of_points)
{
    int sp;
    char[] temp1 = new char[share1.genome_size_font];
    char[] temp2 = new char[share1.genome_size_font];

    temp1 = genotype1.ToCharArray();
    temp2 = genotype2.ToCharArray();

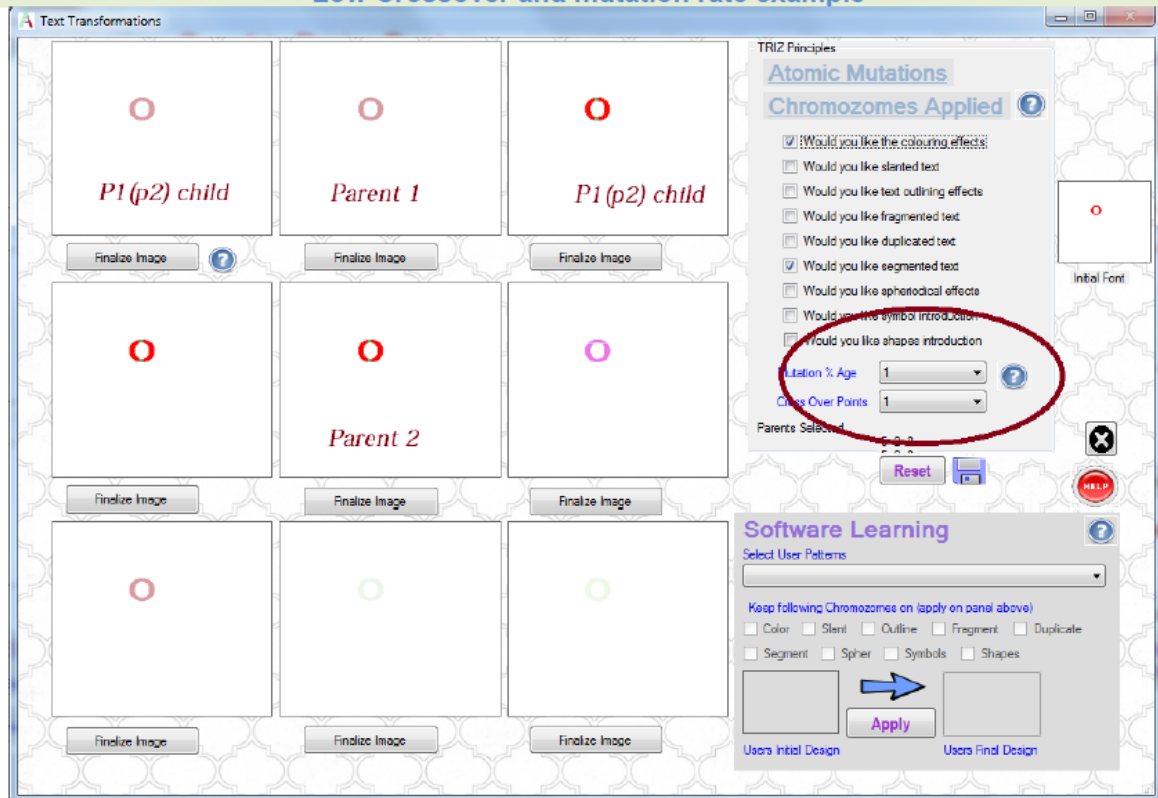
    for (int j = 0; j < no_of_points; j++)
    {
        sp = share1.rnd.Next(0, share1.no_of_genes_font);
        for (int i = 0; i < share1.crossover_points[sp, 1]; i++)
        {
            temp1[share1.crossover_points[sp, 0] + i] = genotype2[share1.crossover_points[sp, 0] + i];
            temp2[share1.crossover_points[sp, 0] + i] = genotype1[share1.crossover_points[sp, 0] + i];
        }
        share1.crossover_points_done += share1.crossover_points[sp, 0] + ",";
    }
    share1.crossover_result1 = new string(temp1);
    share1.crossover_result2 = new string(temp2);
}
```

High rate of crossover and mutation example

The screenshot displays a software interface for TRIZ Principles. The main area contains a 3x3 grid of circles. The top row is labeled 'P1 (p2) child', 'Parent 1', and 'P2(p1) child'. The middle row is labeled 'Parent2'. Each circle has a 'Finalize Image' button below it. To the right, there are two panels. The top panel, titled 'TRIZ Principles Atomic Mutations Chromosomes Applied', contains a list of checkboxes for various effects: 'Would you like the colouring effects' (checked), 'Would you like slanted text' (unchecked), 'Would you like text outlining effects' (unchecked), 'Would you like fragmented text' (unchecked), 'Would you like duplicated text' (unchecked), 'Would you like segmented text' (checked), 'Would you like periodical effects' (unchecked), 'Would you like symbol introduction' (unchecked), and 'Would you like shapes introduction' (unchecked). Below these are sliders for 'Mutation % Age' (set to 44) and 'Cross Over Points' (set to 28). The bottom panel, titled 'Software Learning', has a 'Select User Patterns' dropdown and a list of checkboxes for 'Keep following Chromosomes on (apply on panel above)': 'Color' (unchecked), 'Slant' (unchecked), 'Outline' (unchecked), 'Fragment' (unchecked), 'Duplicate' (unchecked), 'Segment' (unchecked), 'Sphere' (unchecked), 'Symbols' (unchecked), and 'Shapes' (unchecked). An 'Apply' button is at the bottom of this panel. A red circle highlights the 'Cross Over Points' slider and the 'Would you like segmented text' checkbox in the top panel.

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Low Crossover and mutation rate example



Layering Code for combining layers in c#

```
public static Bitmap CreateBitmapImage(Bitmap backLayer, string charr, Color color, int size, int position_x, int position_y, int font, int style)
{
    string FontName = font_selector(font);
    Color FontColor = new Color();
    Color BackColor = new Color();
    int FontSize = size;
    int Width = 297;
    string character = charr;
    bool loop = true;

    // Brush myBrush = new Brush(Color.Blue);

    //fontsize times 1.5 is just high enough
    //to encase the text without spacer above or below.
    int h = 318;
    int Height = h;

    //file to save as
    // string FileName = "MyImage";

    FontColor = color;

    BackColor = System.Drawing.Color.White;

    //fore color
    SolidBrush objBrushForeColor = new SolidBrush(FontColor);

    //back color
    SolidBrush objBrushBackColor = new SolidBrush(BackColor);

    //the point to start the text. I chose horizontal value of zero
    //vertical starts at 2 pixels down.
    Point objPoint = new Point(position * fontsize - fontsize, 65);
    Point objPoint;
    // if ((charr == "i" || charr == "I" || charr == "l") && share1.position_pointer != 0 && position < 5 && position > 1)
    // {
    //     share1.position_pointer -= 10;
    // }
}
```

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```

        objPoint = new Point(position_x,position_y);

        Font objFont;
        try
        {

            //font object
            objFont = new Font(FontName, FontSize + 1, style_selector(style));
        }
        catch (Exception e)
        {

        }

        finally {

            objFont = new Font(FontName, FontSize + 1,System.Drawing.FontStyle.Italic);
        }
        //bitmap object
        Bitmap objBitmap = new Bitmap(Width, Height);

        //graphics object
        Graphics objGraphics =
        System.Drawing.Graphics.FromImage(objBitmap);

        //the following line is not needed, but is shown
        //in the vb example.. dont know why.
        //Color objColor;

        //draw a white rectangle
        objGraphics.FillRectangle(objBrushBackColor, 0, 0, Width,
        Height);

        // Color(objBitmap, 255, 255, 255);
        //draw the text
        objGraphics.DrawString(character.ToString(), objFont, objBrushForeColor,
        objPoint);

    }

}

//save the bitmap.
// objBitmap.Save(fileName + ".bmp", ImageFormat.Bmp);

/* for (int k = 0; k <= objBitmap.Height - 1; k++)
{
    for (int l = objBitmap.Width - 1; l >= 0; l--)
    {
        if (objBitmap.GetPixel(l, k).R < 220 || objBitmap.GetPixel(l, k).B < 220 || objBitmap.GetPixel(l, k).G < 220)
        {
            if (share1.position_pointer < 1)
            {
                share1.position_pointer = 1;
                loop = false;
                break;
            }
        }
    }
}
if (!loop) break;
*/

// share1.position_pointer += 5;
// if ((charr == "i" || charr == "I" || charr == "l") && share1.position_pointer != 0 && position < 4)
//     share1.position_pointer -= 10;

return LayerImage(objBitmap, backLayer, backLayer, backLayer, backLayer, backLayer, backLayer);

}

```

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Appendix-III-AEGIS Logs Samples

Welcome to AEGIS log

Introduction Log

**Introduction Section

Version:AEGIS 7.1

StartTime:03/11/2013 22:01:31

Speciality:Information_Technology

Speciality1:Information Technology

UserId:AEGIS000W0001

Typography Options Log

**Typography Config Section

AtomicConfigStartTime:03/11/2013 22:01:37

AtomicConfigStartTimer:5

FontConfigText:Dove!

FontConfigType:Seagull Bold BT

FontConfigSize:51

InitialFontConfigColor:Red

InitialFontConfigColorARGB:255-255-0-0

Log for Software Auto Learn for future users

InitialTextImage1:Logs/Learning_Experience/AEGIS000W0001(Information_Technology)0_1_pictureBox16.jpg

InitialTextImage2:Logs/Learning_Experience/AEGIS000W0001(Information_Technology)0_1_pictureBox15.jpg

InitialTextImage3:Logs/Learning_Experience/AEGIS000W0001(Information_Technology)0_1_pictureBox14.jpg

InitialTextImage4:Logs/Learning_Experience/AEGIS000W0001(Information_Technology)0_1_pictureBox13.jpg

InitialTextImage5:Logs/Learning_Experience/AEGIS000W0001(Information_Technology)0_1_pictureBox12.jpg

Atomic Log for each Iteration

**Atomic Transformation Section

AtomicFormCall:1

AtomicLetterSelectedTime:03/11/2013 22:01:40

AtomicLetterSelectedTimer:8

LetterNumberSelected:14

LetterSelected:v

Atomic Genome Log

**Atomic Finalization Section

AtomicFinalGeneration:True

AtomicGeneration:1

AtomicGenerationStartTime:03/11/2013 22:01:41

AtomicGenerationStartTimer:9

Atomic Gene Switches (on/off) preferences Log

AtomicGeneSwitchesFinal:100001000

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AtomicMutationFinal:3

AtomicCrossOverFinal:2

FinalGenome1::0011100010011001100101011000100000011011011010111010100100010100010110101001001001110
1000010010101010011100010001000000110011010100101001011101010100011001101111101101110010111000001
011101101000011111100101101000000011011001001000011100110100100100110000000110001001011110110100
10110111110110000011001000011111101110100001110110011010011010011010100111011010110010FinalGenome1Decimal::47-238-230-240-0-18-2-13-1-0-1-0-225-121-206-49-9-3-12-24-23-120-11-76-99-1-9-25-2-4-169-209-
95-105-193-174-0-9-298507-9-28-479-47-458-2-3-13-86-253-224-171-167-10-17FinalGenome2:Selected(Final):001110001001100110010101100010000001101101101011101010010001010001011010100
10010100111010000100101010100111000100010000001100110101001010010111011010100011001101111101101110
0101110000010111011010000111110010110100000001101100100100001100110100100100110000000110001001
011110110100101101111011000001100100001111110111101000011101100111010011010011011010110010**Indication of Successful Final Child**FinalGenome2Decimal:Selected(Final):47-238-230-240-0-18-2-13-1-0-1-0-225-121-206-49-9-3-12-24-23-120-11-76-99-1-9-
25-2-4-169-209-95-105-193-174-0-9-298507-9-28-479-47-458-2-3-13-86-253-224-171-167-10-17FinalGenome3::001110001001100110010101100010000001101101101011101010010001010101001001001110
10000100101010100111000100010000001100110101001010010111011010100011001101111101101110010111000001
0111011010000111111001011010000000011011001001000011001101001001010011000000011000100101110110100
101101111101100000110010000111111011110100001110110011101001101001101010100111011010110010FinalGenome3Decimal::47-238-230-240-0-18-2-13-1-0-1-0-225-121-206-49-9-3-12-24-23-120-11-76-99-1-9-25-2-4-169-209-
95-105-193-174-0-9-298507-9-28-479-47-458-2-3-13-86-253-224-171-167-10-17FinalGenome4::001110001001100110010101100010000001101101101011101010010001010001011010100100101001110
10000100101010100111000100010000001100110101001010010111011010100011001101111101101110010111000001
0111011010000111111001011010000000011011001001000011001101001001010011000000011000100101110110100
101101111101100000110010000111111011110100001110110011101001101001101010100111011010110010FinalGenome4Decimal::47-238-230-240-0-18-2-13-1-0-1-0-225-121-206-49-9-3-12-24-23-120-11-76-99-1-9-25-2-4-169-209-
95-105-193-174-0-9-298507-9-28-479-47-458-2-3-13-86-253-224-171-167-10-17

95-105-193-174-0-9-298507-9-28-479-47-458-2-3-13-86-253-224-171-167-10-17FinalGenome5::00111000100110011001010110001000000110110110101110101001000101010100100101001110
10000100101010100111000100010000001100110101001010010111011010100011001101111101101110010111000001
0111011010000111111001011010000000011011001001000011100110100100100110000000110001001011110110100
101101111101100000110010000111111011110100001110110011101001101001101010100111011010110010FinalGenome5Decimal::47-238-230-240-0-18-2-13-1-0-1-0-225-121-206-49-9-3-12-24-23-120-11-76-99-1-9-25-2-4-169-209-
95-105-193-174-0-9-298507-9-28-479-47-458-2-3-13-86-253-224-171-167-10-17FinalGenome6::00111000100110011001010110001000000110110110101110101001000101010100100101001110
10000100101010100111000100010000001100110101001010010111011010100011001101111101101110010111000001
0111011010000111111001011010000000011011001001000011001101001001010011000000011000100101110110100
101101111101100000110010000111111011110100001110110011101001101001101010100111011010110010FinalGenome6Decimal::47-238-230-240-0-18-2-13-1-0-1-0-225-121-206-49-9-3-12-24-23-120-11-76-99-1-9-25-2-4-169-209-
95-105-193-174-0-9-298507-9-28-479-47-458-2-3-13-86-253-224-171-167-10-17FinalGenome7::00111000100110011001010110001000000110110110101110101001000101010100100101001110
10000100101010100111000100010000001100110101001010010111011010100011001101111101101110010111000001
0111011010000111111001011010000000011011001001000011001101001001010011000000011000100101110110100
101101111101100000110010000111111011110100001110110011101001101001101010100111011010110010FinalGenome7Decimal::47-238-230-240-0-18-2-13-1-0-1-0-225-121-206-49-9-3-12-24-23-120-11-76-99-1-9-25-2-4-169-209-
95-105-193-174-0-9-298507-9-28-479-47-458-2-3-13-86-253-224-171-167-10-17FinalGenome8::00111000100110011001010110001000000110110110101110101001000101010100100101001110
10000100101010100111000100010000001100110101001010010111011010100011001101111101101110010111000001
0111011010000111111001011010000000011011001001000011100110100100100110000000110001001011110110100
101101111101100000110010000111111011110100001110110011101001101001101010100111011010110010FinalGenome8Decimal::47-238-230-240-0-18-2-13-1-0-1-0-225-121-206-49-9-3-12-24-23-120-11-76-99-1-9-25-2-4-169-209-
95-105-193-174-0-9-298507-9-28-479-47-458-2-3-13-86-253-224-171-167-10-17FinalGenome9::00111000100110011001010110001000000110110110101110101001000101010100100101001110
10000100101010100111000100010000001100110101001010010111011010100011001101111101101110010111000001
0111011010000111111001011010000000011011001001000011001101001001010011000000011000100101110110100

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1011011111011000001110010000111111011110100001110110011101001101010011101101010110010
 FinalGenome9Decimal::47-238-230-240-0-18-2-13-1-0-1-0-225-121-206-49-9-3-12-24-23-120-11-76-99-1-9-25-2-4-169-209-
 95-105-193-174-0-9-298507-9-28-479-47-458-2-3-13-86-253-224-171-167-10-17
 AtomicFinalizedText3:Logs/Learning_Experience/AEGIS000W0001(Information_Technology)0_1_3.jpg
 AtomicFinalizedBox:2
 AtomicFinalizedText5:Logs/Learning_Experience/AEGIS000W0001(Information_Technology)0_1_5.jpg
 AtomicFinalizedText4:Logs/Learning_Experience/AEGIS000W0001(Information_Technology)0_1_4.jpg
 AtomicFinalizedText2:Logs/Learning_Experience/AEGIS000W0001(Information_Technology)0_1_2.jpg
 AtomicFinalizedText1:Logs/Learning_Experience/AEGIS000W0001(Information_Technology)0_1_1.jpg

****Molecular Transformation Section**

MolecularFormCall:1

MolecularFormCallTime:03/11/2013 22:01:48

MolecularFormCallTimer:16

InitialBackGround1:Logs/Learning_Experience/AEGIS000W0001(Information_Technology)0_1initialback.jpg

InitialLogo:1:Logs/Learning_Experience/AEGIS000W0001(Information_Technology)0_1initiallogo.jpg

InitialExtraLogo:1:Logs/Learning_Experience/AEGIS000W0001(Information_Technology)0_1extralogo.jpg

Molecular Genome Log****Molecular Finalization Section**

MolecularFinalGeneration:True

MolecularGeneration:1

MolecularGenerationStartTime:03/11/2013 22:01:41

MolecularGenerationStartTimer:9

Molecular Gene Switches (on/off) preferences Log

MolecularGeneSwitchesFinal:10001

MolecularFinalMutation:2

MolecularFinalCrossOver:1

MolecularFinalGenome1::0100110101110100011110000001110101011111110011000110000010110101001100001001
 11100000001101100100011001001100101000110001001110111010000001011100100000110000010111001001100110
 0101000000100001110010111111010000111001

MolecularGenomeFinal1Decimal::118-88-87-11-1-405-1-1-239-129-76-65-80-18-0-123-59-48-16-235-176-26-63-129-81-68-
 192-125-229-167-46

MolecularBack1:Logs/Transitions/AEGIS000W0001(Information_Technology)0_2backBox1.jpg

MolecularExtra1:Logs/Transitions/AEGIS000W0001(Information_Technology)0_2extraBox1.jpg

MolecularFinalGenome2:Selected(Final):00000111000000100000001100011110111001011110110010111010010011101
 010100110001000110100111100011100100100110100011111100001010010000010010111101010011010110001010
 01111100111100010010000000001000000010000000100000001

Indication of Successful Final Child

MolecularGenomeFinal2Decimal:Selected(Final):5-3-2-21-0-741-1-1-70-156-89-119-246-80-1-142-19-21-16-99-14-86-118-
 111-197-276-112-1-1-1-1

MolecularBack2:Selected(Final):Logs/Transitions/AEGIS000W0001(Information_Technology)0_2backBox2.jpg

MolecularExtra2:Selected(Final):Logs/Transitions/AEGIS000W0001(Information_Technology)0_2extraBox2.jpg

MolecularFinalGenome3:0110111101110011000101011011110110100010111011100101011000111101110000010011
 011101011001001011101000000000101100110011010100100111111010110010010100101000000100100010010101101
 11000111011001001001101000101100000100100

MolecularGenomeFinal3Decimal::74-93-25-214-1-485-1-0-185-72-82-252-150-142-0-176-1-34-4-199-171-220-99-254-60-
 201-267-142-39-111-56

Final Generation Image Components Log

MolecularBack3::Logs/Transitions/AEGIS000W0001(Information_Technology)0_2backBox3.jpg
MolecularExtra3::Logs/Transitions/AEGIS000W0001(Information_Technology)0_2extraBox3.jpg
MolecularFinalGenome4::01011100010100010101001111001100000111010111110000110000010111011100000010111001
0000101101101100001010011001010100001110010011101000001111010111001111001111100001011011110110011
00011000111010101000010101111011000100001
MolecularGenomeFinal4Decimal::104-97-98-136-0-178-1-1-251-13-208-26-124-293-0-24-70-48-11-116-253-154-40-175-109-
290-33-153-12-164-62
MolecularBack4::Logs/Transitions/AEGIS000W0001(Information_Technology)0_2backBox4.jpg
MolecularExtra4::Logs/Transitions/AEGIS000W0001(Information_Technology)0_2extraBox4.jpg
MolecularFinalGenome5::01101100011011010000100010011101100110000101011101110001001101011101100101000010
1110111100010111111000000000111110010001001100101011001111011101110100001100010011010101000001100010
01011000100010110011010100001101100111010
MolecularGenomeFinal5Decimal::72-73-15-233-1-131-1-0-180-59-210-48-210-269-1-191-5-71-14-230-235-180-251-59-207-
67-222-27-76-18-44
MolecularBack5::Logs/Transitions/AEGIS000W0001(Information_Technology)0_2backBox5.jpg
MolecularExtra5::Logs/Transitions/AEGIS000W0001(Information_Technology)0_2extraBox5.jpg
MolecularFinalGenome6::11011011011110010100111000100101110110000110000011000001010100000011100001001
1000010001011110011111101000010101100000000011111110110010000111100001011101011011110001110111
11000110000010111010100000101101110101000
MolecularGenomeFinal6Decimal::146-87-206-135-1-367-0-1-253-6-127-190-65-53-0-85-62-50-0-10-164-125-190-83-148-90-
264-26-96-109-207
MolecularBack6::Logs/Transitions/AEGIS000W0001(Information_Technology)0_2backBox6.jpg
MolecularExtra6::Logs/Transitions/AEGIS000W0001(Information_Technology)0_2extraBox6.jpg
MolecularFinalGenome7::10111100111100010000100101100000110010111110111011100000011100110010011011000010
000001011000111110111000000111001000011101010000010110000110110000001101110011000001111011101001
01101011110001010110000111100110110011111
01101011110001010110000111100110110011111

Decimal Equivalent of Genome Log

MolecularGenomeFinal7Decimal::215-161-14-64-1-917-0-1-151-11-71-144-254-133-1-151-5-31-20-223-111-72-9-136-21-177-154-243-130-137-234
MolecularBack7::Logs/Transitions/AEGIS000W0001(Information_Technology)0_2backBox7.jpg
MolecularExtra7::Logs/Transitions/AEGIS000W0001(Information_Technology)0_2extraBox7.jpg
MolecularFinalGenome8::0110101111001000010110111101000011111011111000010110000001110011101011010110
0100000010010101100010011100001001100001011011011110110010000101000011001000011101001
011110101001111101100000101100101010000
MolecularGenomeFinal8Decimal::77-143-54-167-0-169-1-1-131-128-186-108-287-115-1-172-67-47-14-195-180-148-143-96-143-177-166-42-64-110-96
MolecularBack8::Logs/Transitions/AEGIS000W0001(Information_Technology)0_2backBox8.jpg
MolecularExtra8::Logs/Transitions/AEGIS000W0001(Information_Technology)0_2extraBox8.jpg
MolecularFinalGenomeFinal9::010110010000100100110001100001101111011101111101110100110101101111010110110
1001011110010110001100001100000101100010111101011011110111111000110110100111001011011110010000000
000111000111000010100110001101111011111100000
MolecularGenomeFinal9Decimal::110-14-33-250-0-662-1-1-150-38-214-73-107-222-1-8-13-13-19-149-85-246-197-54-184-1-267-24-132-165-191
MolecularBack9::Logs/Transitions/AEGIS000W0001(Information_Technology)0_2backBox9.jpg
MolecularExtra9::Logs/Transitions/AEGIS000W0001(Information_Technology)0_2extraBox9.jpg
MolecularFinalizedComplex:Logs/Learning_Experience/AEGIS000W0001(Information_Technology)0_molecularfinal_1.jpg
OutputsUsefulFor:Packaging Design

User Exiting Log

**User closed the application on Form1- Main form
ApplicationClosingTime:03/11/2013 22:02:35
ApplicationClosingTimer:62

Appendix IV (Design and Development of Design for Wow)

IV.1 Technology Platform

The site is implemented using PHP, flash, My SQL, Fedora8, Web-min, AJAX, XHTML, XML. PHP: Hypertext Pre-processor is a widely used, general-purpose scripting language that was originally designed for web development to produce dynamic web pages. For this purpose, PHP code is embedded into the HTML source document and interpreted by a web server with a PHP processor module, which generates the web page document (PHP wiki 2010). As a general-purpose programming language, PHP code is processed by an interpreter application in command-line mode performing desired operating system operations and producing program output on its standard output channel. It may also function as a graphical application. PHP is available as a processor for most modern web servers and as standalone interpreter on most operating systems and computing platforms (W3Schools, 2011).

PHP was originally created by Rasmus Lerdorf (Severance, 2012) in 1995 and has been in continuous development ever since. The main implementation of PHP is now produced by The PHP Group and serves as the *de facto* standard for PHP as there is no formal specification (W3Schools, 2011). PHP is free software released under the PHP License (W3Schools, 2011).

IV.2 Server Specifications

Initial Server

Initially Webmin admin interface based server was used. A typical Webmin control panel is shown in figure IV.1. Webmin is a web-based system configuration tool for Unix-like systems. With it, it is possible to configure operating system control specifications like users, disk quotas, services or configuration files, as well as modify and control open source apps, such as the Apache HTTP Server, PHP or MySQL.

Webmin is largely based on Perl, running as its own process and web server. It defaults to TCP port 10000 for communicating, and can be configured to use SSL if OpenSSL is installed with additional required Perl Modules. It is built around modules, which have an interface to the configuration files and the Webmin server. This makes it easy to add new functionality. Due to Webmin's modular design, it is possible for anyone who is interested to write plugins for desktop configuration. Webmin also allows for controlling many machines through a single interface, or seamless login on other webmin hosts on the same subnet or LAN. Webmin is primarily coded by Australian Jamie Cameron (Cameron, 1997) and released under the BSD license (Opensource, 2012).

The server was based on Fedora Linux (Wei et al., 2011), and LAMP Technologies (Kay, 2006).

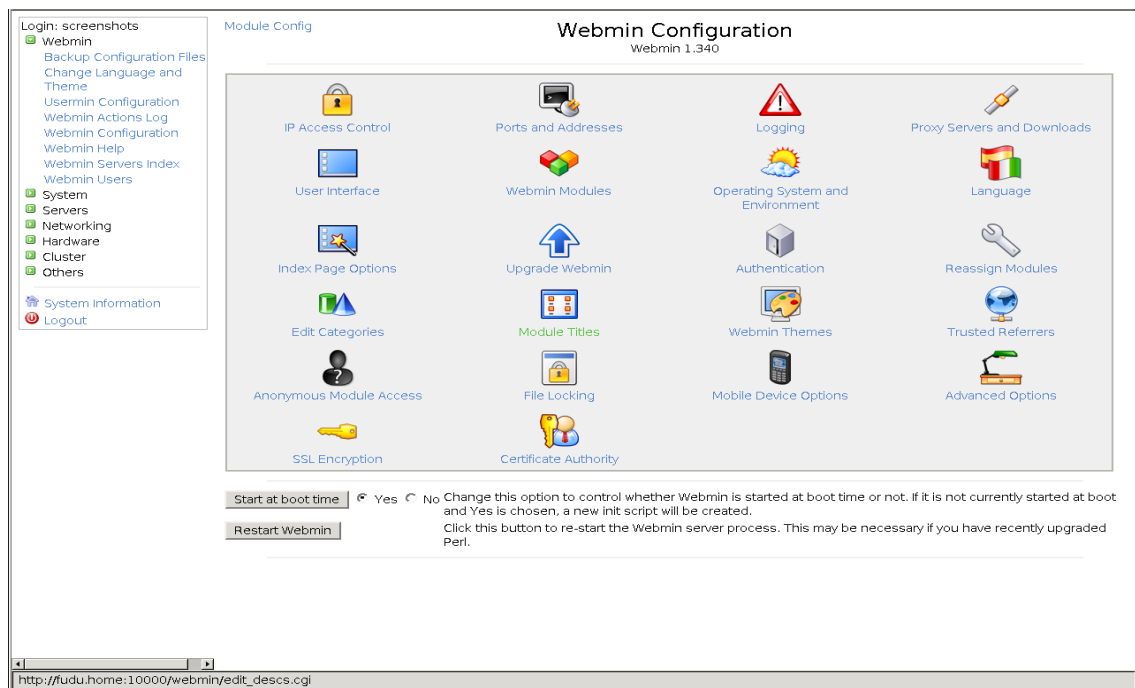


Figure IV.1 A Typical Webmin 1.340 Interface (Webmin, 1997).

Current Server

The website was then shifted to Plesk control panel based WAMP Server (Plesk, 2011). The server employs WAMP (WAMP, 2010). The Parallels Plesk Panel (ex: Parallels Plesk Control Panel, Plesk Server Administrator, PSA, or just Plesk) software package is a commercial web hosting automation program. Originally released under the U.S. company Plesk Inc. and designed in Novosibirsk, Russia, Plesk was acquired by SWSoft in July 2003. SWSoft renamed themselves under the Parallels name (a brand which had been acquired by SWSoft) in 2008 (SWsoft, 2011).

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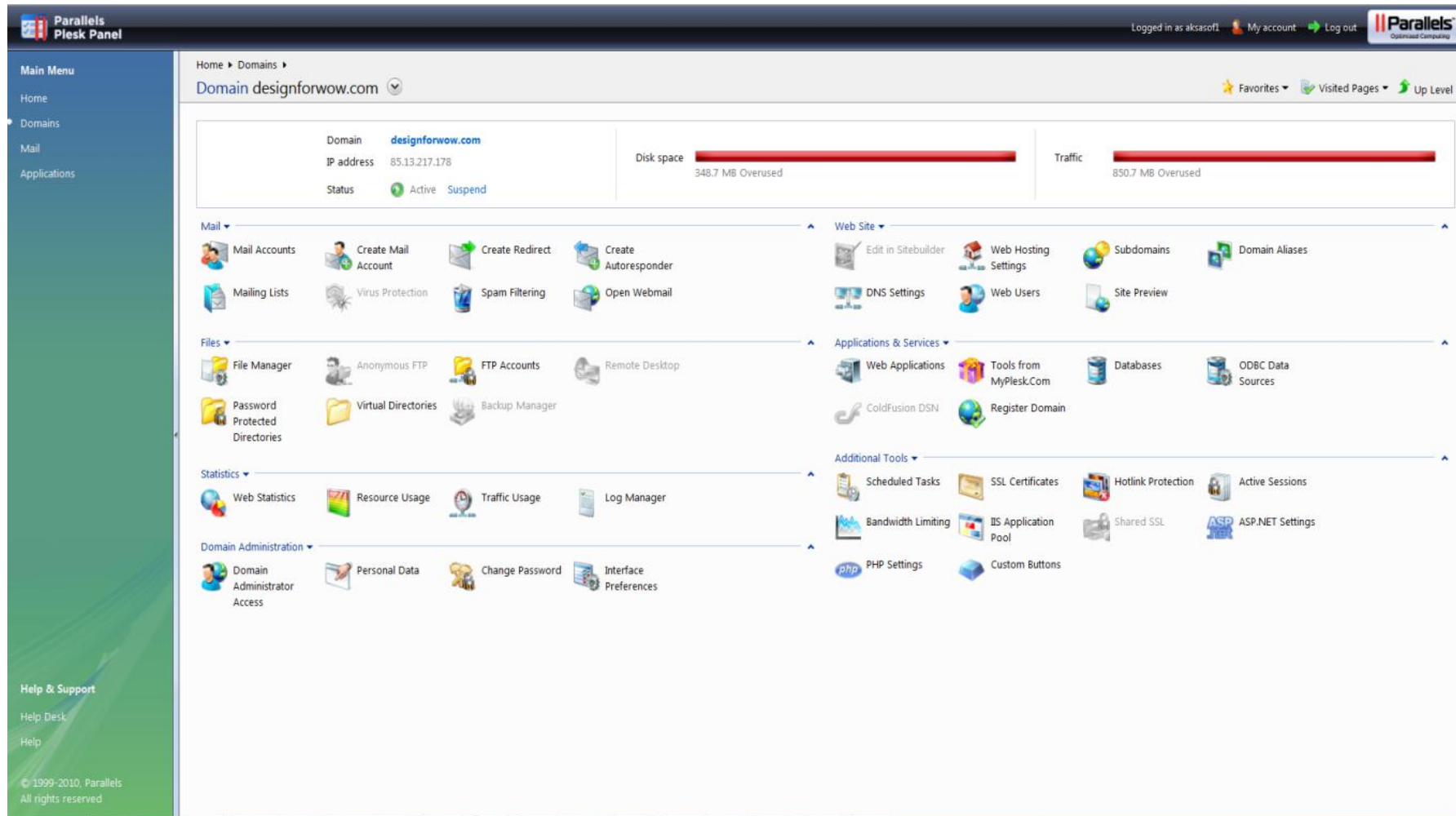


Figure IV.2: A Typical Parallels Plesk 9.5.5 Interface (Webmin, 1997)

IV.3 Sections (previous version of portal)

Home Page: This page (See Figure IV.3) gives an introduction to users. Every user views this first. Since, it is difficult to tell what a 'wow' actually is, we have mentioned some tips about how to feel a 'wow' and declare 'wow' about something. Also, we have tried to define (research) questions in this page: **Can we really capture and reproduce the mechanism of 'wow'?**

Why is it then that we rarely get a 'wow' feeling?

This site will hopefully identify whether it is by random mechanism that we get a 'wow' generated or by some systematic innovation approach.

Apart from the home page, this site also has many other pages of information and reviews. For example, the theory page introduces the 40 Inventive Principles (Mann, 2007a). As suggested by many TRIZ experts, almost all the problems in the world can be tracked down to have contradictions, and those contradictions can be solved by the use of TRIZ Principles (Altshuller, 1984).



Figure IV.3: Home page of DesignforWow.com

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Reviewers (R&D) Page: This page is the key to the analysis and report generation for the site. It has been assembled with some useful search coding mechanisms. The key search mechanism uses a query to locate uploaded content which has been tagged by reviewers to specific Inventive Principles. Having performed this search, a reviewer can see all the content which has been uploaded and whether it had been tagged differently by any other reviewer. Also any text comment from the general public and other reviews comments, including ratings, are displayed. Hence, in this page, a reviewer gets an overall view of the research data collected for each 'wow' example. In addition to its search capabilities, the web site was designed for high visitor traffic and large database capacity. Figure IV.4 shows a typical display for the end reviewer or site data administrator.

Hi Abubakr | Sign out

Design for Wow

Home Wow Examples Other Kind Of Wow Theory Bibliography Who Are We Educator Resources

Upload >> Upload Image Upload Document Upload Music Upload Video Upload Graphics Link Videos Submit Sites Research Review

Research Review

Method :

Principle :

Media Type :

Reviewer Statistics

Total review on Image	1
Total review on Document	0
Total review on Video	0
Total review on Audio	0
Total review on 2D Graphics	0
Total review on 3D Graphics	0
Total review received	1

Title	Industry	Average Rating	Number Of Review	What has been done to achieve wow
ZPO Tower	Engineering	★★★★★	0	From the land of opulence Dubai comes another amazing feat of architecture and engineering to add to the emirates extravagant skyline. The spiraling tubular design for the Zaabeel Park Observation (ZPO) Tower incorporates roof gardens, extensive solar paneling and geothermal cooling and ventilation in an organically inspired structure topped by three observation deck petals
Spiderman Urinal	NA	★★★★★	0	NA
Virtual Nature	Graphic Design	★★★★★	0	Nature has been mixed with virtual effects
Woods	GD	★★★★★	0	Woods are visible from the picture
Thirty Minutes From Andromeda	Patents	★★★★★	0	Some aspects of patent filing have been exposed in this document
Pepsi Truck	advertising	★★★★★	0	make sodas appear to float to emphasise low calorie message
Security Glass	Glass	★★★★★	0	Put something very valuable behind the glass
Human voices as music	Entertainment	★★★★★	0	Human voice acts as music

Figure IV.4: Design for Wow Reviewers (R&D) Analysis Page.

Contents Upload Page: To allow registered users to upload the content they think is 'wow', a content upload page has been designed for this website. The site at present allows uploading 'wow' examples which can be of the following types:

- A piece of music
- A film
- A book
- A product
- A building

Hence, to capture these 'wow' examples, at present four types of media content have been implemented:

- Audio (music or speech)
- Video (audio visual)
- Document (literature or a book)
- Image (e.g., screen shots of 'wow' effects)
- Website
- Youtube and other online videos

Design for Wow

Home | Wow Examples | Other Kind of Wow | Theory | Bibliography | Who Are We | Educator Resources

My Wow | Upload Image | Upload Document | Upload Words | Upload Video

Upload Image

Upload Wow Image (Good designs and innovations)

Select an image to upload:

Title of image:

Source / author:


What the viewer expects from this image?:

What is done in this theme to achieve wow?:

Any innovation triggered or achievable from this?:

Industry Related:

Last Wow Image Uploaded

 Spring supported bed...
0 Comments posted till now

 Lamp acting upon stimulus...
0 Comments posted till now

Upload Other kind of Wow Image (Reverse innovations and bad designs)

Select an image to upload:

Title of image:

Source / author:

What the viewer expects from this image?:

What is bad in this theme?:

Any reverse innovation effect triggered by this theme?:

Industry Related:

Last Other kind of Wow Image Uploaded

Figure IV.5: Design for Wow; Wow's content Upload Page

Wow examples view page: To ensure that any viewer (i.e. non registered users) also have access to content uploaded by other users, we have kept the content open to be viewed

by everyone. Hence, one of the efficient and elegant tools is the free source 'Tilt Viewer' (Interactive, 2009) for images. This page is shown in Figure IV.6.



Figure IV.6: Design for Wow; Wow Examples View Page (2009 version)

The site was slow launched in April 2009 and the contents started to be uploaded by users in June 2009. July saw maximum number of contents being uploaded by users. See Figure IV.7.

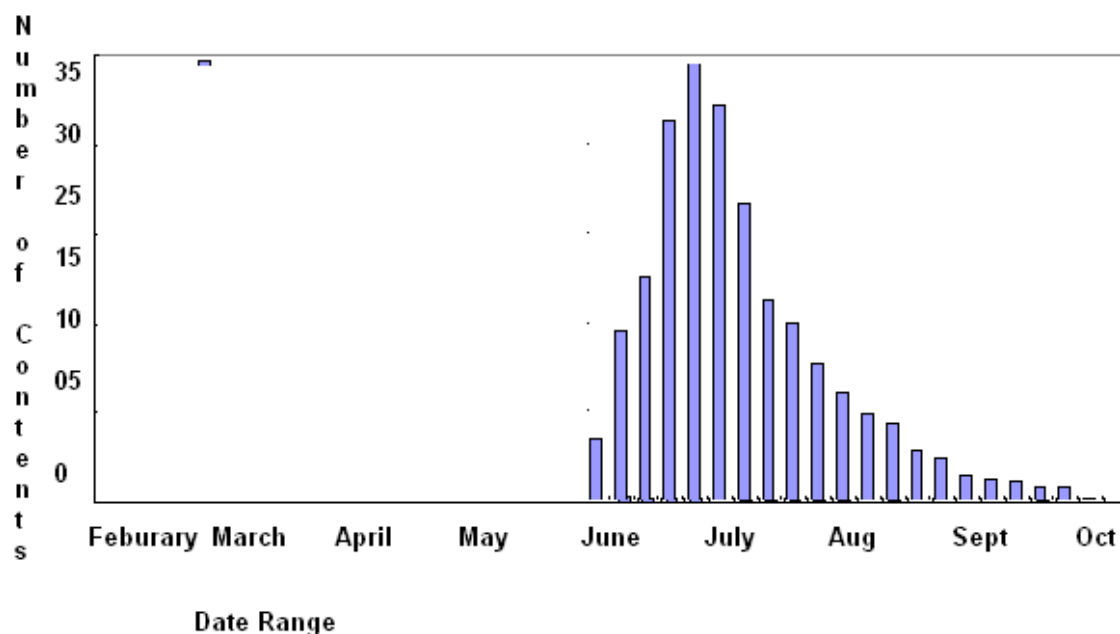
IV.4 Previous Data (before April 2010)

Figure IV.7: The uploading of contents by users (2009)

Figure IV.8 shows the categorization of contents after the reviewers linked the contents to TRIZ Principles. Principles 2 and 5 were the most frequent Principles in the designs. But, at this stage a comprehensive conclusion cannot be made until more data will be available at a later stage. The preliminary study of existing content on design for wow has been done. The pilot study of contents in context of TRIZ will be done when the number of uploads will be at least 200 and at least 500 ratings will be done by the users of the site. After this study, the next phase is conclusive phase of study of content on site, which will be carried on when the site will have at least 1000 contents and 3000 ratings.

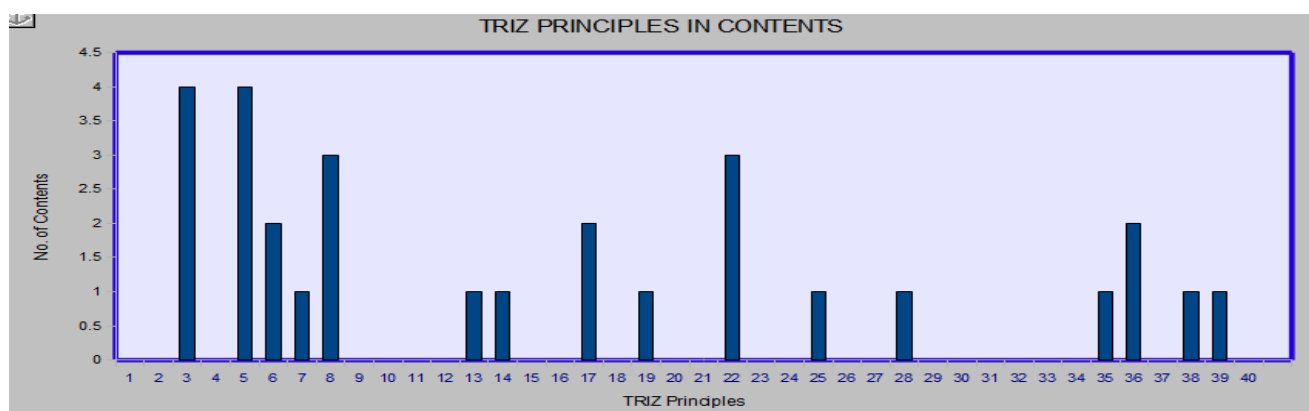


Figure IV.8: Results after linking TRIZ Principles with the contents (2009 version).

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Total number of hits (cumulative hits) is increasing at a greater speed on the site (with present number of hits reaching 21,000 hits). This is because of promoting the site within TRIZ groups and other online communities. Furthermore, the optimization work has contributed to the search engine listings of the site.

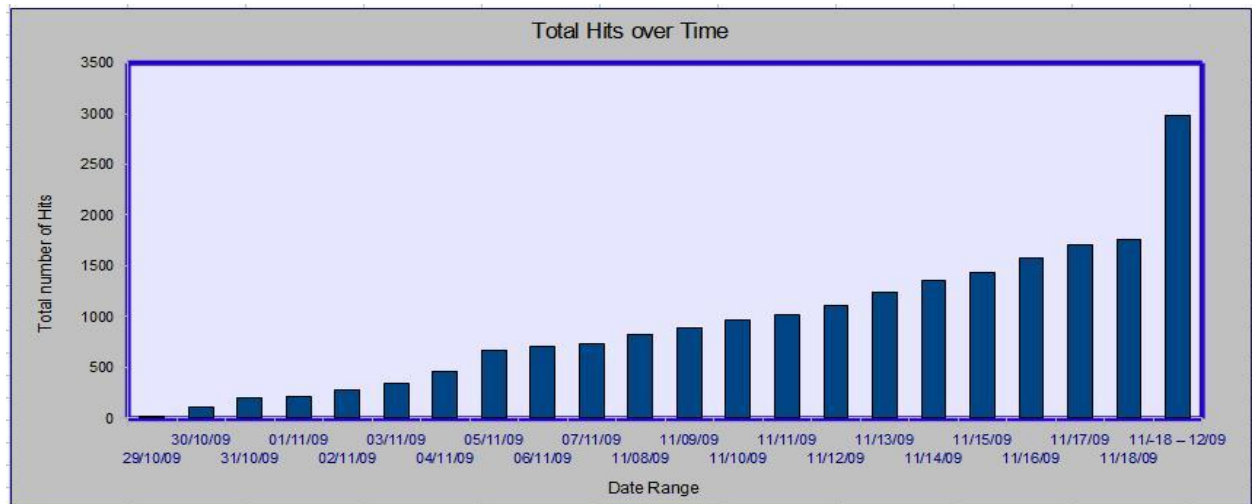


Figure IV.9: Total hits over time (number of hits are 21,000 till 12/09)

Appendix V (AEGIS GNU Licence Note)

Only the trial version of this software is distributed under GNU Licence for academic and research purposes strictly and any other use should be taken permission from the research team.

For any queries or defects, contact admin@designforwow.com

Appendix-VI (D4W Review Data)

Physical Contradiction Data

Title		Contradiction value2		Value1
1	ZPO Tower	NA		
59	Hacked memory stick	NA		
72	Typewriter octopus	NA		
72	Typewriter octopus	NA		
91	Motor cycle hat stand	NA		
7	Security Glass	strength	weak	strong
7	Security Glass	strength	weak	strong
16	Above The Clouds	reality	real	unreal
16	Above The Clouds	reality	real	unreal
16	Above The Clouds	reality	real	unreal
16	Above The Clouds	reality	real	unreal
17	Northern Lights From Space	direction	north	south
18	Pidgeon point light house	na	na	na
19	Two Ways of Looking at Fish	facial expression	cat:hungry	baby:astonished
35	bottle design	shape	preserved	unpreserved
39	Safety Trump Card	purpose	entertaining	educating
48	Panadol Sneeze Ad	na	na	na
52	The Inspiration Pad	portability	portable	static
54	Mr Kaktus	condition	playful	useful
54	Mr Kaktus	condition	playful	useful
54	Mr Kaktus	condition	playful	useful
59	HACKED Memory Stick	na	na	na
60	Aquila Handart	purpose	entertaining	educating

Title		Contradiction	value2	Value1
60	Aquila Handart	purpose	entertaining	educating
61	Windex Ad	cleaning	concentrated	dilute(environment)
62	Paper draggon sculpture	texture	real	fake
67	Mousemat Notepad	function	writing	sliding
67	Mousemat Notepad	function	writing	sliding
67	Mousemat Notepad	function	writing	sliding
71	Gold nanoparticles make leaves glow	expense	costly	cheap
71	Gold nanoparticles make leaves glow	expense	costly	cheap
71	Gold nanoparticles make leaves glow	expense	costly	cheap
71	Gold nanoparticles make leaves glow	expense	costly	cheap
73	Lego Ad	reality	real	unreal
73	Lego Ad	reality	real	unreal
74	Queens House Staircase	architecture	comfortable	decorative
74	Queens House Staircase	architecture	comfortable	decorative
75	Square Melons	characteristic	small	large
75	Square Melons	characteristic	small	large
76	Ice Hotel	temperature	cold	hot
76	Ice Hotel	temperature	cold	hot
76	Ice Hotel	temperature	cold	hot
83	Transparent B Iron 715	characteristic	opaque	transparent
83	Transparent B Iron 715	characteristic	opaque	transparent
111	Solar building	energy	production	conservation
112	Sculptures	texture	real	unreal
113	Food packaging	condition	edible	educative
114	Pirate ship wedding cake	characteristic	edible	decorative
118	Rainbow bridge	characteristic	beautiful	safe

Title		Contradiction	value2	Value1
120	Toaster	characteristic	small	big
122	Mirror tie	na	na	na
123	Steering with Touch	na	na	na
123	Steering with Touch	na	na	na
124	Smart car	characteristic	fast	slow
125	Shoe	size	big	small
125	Shoe	size	big	small
126	Eye glasses	characteristic	transparent	opaque
127	Umbrella charger	size	cheap	expensive
128	Green phones	characteristic	safe	dangerous
129	Needle-less injections	safety	safe	dangerous
137	2D gel image scanner	NA		
135	Energy consumption monitors	NA		
134	Big dog robot	NA		
133	Laptop cooling mat	NA		
132	Laundry POD	NA		
144	Barcelona rock	NA		
143	Pencil art	NA		
142	Sand art	NA		
139	Reusable packaging	Cost	cheap	expensive
138	Food Package product	Cost	cheap	expensive
149	Fruit	NA		
148	Rainbow fountain	NA		
147	Melting men	NA		
146	Paper art	NA		
145	Paper sculptures	NA		

Title		Contradiction	value2	Value1
141	Peacock wedding dress	Cost	cheap	expensive
145	Paper sculptures	NA		
151	Cubic house	NA		
150	Island	NA		
152	Sleep profiler	NA		
153	Cycle	NA		
155	Underground hotel	NA		
157	Toothpicks boat	NA		
157	Toothpicks boat	NA		
158	Key card hotel	NA		
159	Solar car	NA		
160	Multi-function wheel	NA		
161	Finger-nose stylus	NA		
162	warcraft-mouse	NA		
163	Cyber speaker	NA		
164	Shipping container	NA		
165	Egg mouse	NA		
166	Blue tooth webcam	NA		
167	laptop desk	NA		
168	Hard drive	NA		
169	eye ring	NA		
171	Sinking airport	NA		
172	Car house	NA		
173	Cake	NA		
174	Motor cycle man	NA		
175	LED umbrella	NA		

Title		Contradiction	value2	Value1
176	Rock road	NA		
177	Bridge	NA		
183	Dog shaped hotel	NA		
185	Car charger	NA		
186	Butter sculptures	NA		
187	Foot sculpture	NA		
188	Sculpture garden	NA		
190	Furniture	NA		
192	Peugeot Modif	space	Tight	flexible
193	Basket building	NA		
194	Piano house	NA		
195	Replay building	NA		
198	Forest building	NA		
199	Mind house	NA		
203	Tianzi Hotel	NA		
204	Salt hotel	NA		
205	Packing hotel	NA		
209	Lipstick sculpture	NA		
213	Replica of empire building	NA		
215	Chalk sculpture	NA		
216	Little milk people	NA		
229	watch part motorcycle	NA		
230	Rock garden	NA		
231	Ice cream tie	NA		
232	Parrot tie	NA		
233	Keyboard tie	NA		

Title		Contradiction	value2	Value1
285	Tea men	NA		
286	Egelimage	NA		
287	Wedding dress	NA		
288	Tree restaurant	NA		
289	Dish hat	NA		
290	Wedge touch mouse	NA		
291	Rolling keyboard	NA		
292	Wrist keyboard	NA		
293	Spider mouse	NA		
294	Spiral staircase	NA		
298	Paper phone	NA		
299	Upside down house	NA		
301	Telephone booth	NA		
302	Ice phone booth	Strength	Melt	freeze
303	Pencil fence	NA		
304	Samsung aid	NA		
305	Wow ads	NA		
306	Creative shoes	NA		
307	Jet shapped mouse	NA		
308	3D mouse	NA		
309	Amazing cake	NA		
310	Banana man	NA		
312	Finger art	NA		
313	Grass car	NA		
314	Water drops photography	NA		
320	Coin balance	NA		

Title		Contradiction	value2	Value1
321	Paper fork	NA		
322	Sand men	NA		
323	Sandle chair	NA		
325	Baloon art	NA		
326	Book art	NA		
327	Computer inside keyboard	space	Less	More
330	House on rock	NA		
331	Tree house	NA		
332	Lake house	NA		
335	Earth quake proof desk	Safety	safe	unsafe
336	Double chair	NA		
337	Hybrid car	Flexibility	comfort	discomfort
338	Air car	Safety	safe	unsafe
339	Sim card reader	Benificial	Recover	Lost
340	Color changing car	Look	Static	Dynamic
341	Toy friend	NA		
342	Backlit keyboard	Use	Useful	useless
343	Bridging home	NA		
344	Tiny figures	NA		
345	Spiral tower	NA		
2	Spiderman Urinal	NA		
6	Pepsi Truck	NA		
66	Spread Your Love bicycle	NA		
80	The British Library	NA		
82	let them wear wedding cakes	NA		
84	Retro CD Player	NA		

Title		Contradiction	value2	Value1
85	Glove Shoes	NA		
86	Andre Perugia	NA		
87	Mighty Strange Bread	Look	Dangerous	Safe
88	Table Connect	NA		
78	Melting Staircase	NA		
79	Desert Chair	NA		
89	Bodegas Ysios in Spain	NA		
93	BigMac the Hangover Cure	NA		
96	Artist Jack Featherstone	NA		
97	ReadDot	NA		
98	uk_bookshelf	NA		
100	Mushroom LED lamps	NA		
101	LED origami cards	NA		
102	latte art	NA		
104	Solar bridge	NA		
106	Kunsthau Graz	NA		
107	High House	NA		
109	Real time data system	NA		
217	Divergen konkan	NA		
218	Cloudy sunset	NA		
219	Bullcart.	NA		
235	Angel falls	NA		
24	cirquedusoleil	NA		
58	The Daily Smell Blog	NA		
117	Cool website	NA		
178	Space site	NA		

Title		Contradiction	value2	Value1
179	Searching site	NA		
180	Maps	Behaviour	Old	New
181	Email	Space	Less	more
196	Searching website	Searching	Quick	slow
197	Photo site	NA		
318	Amazing website	NA		
346	Music website	NA		
347	Brain facts	Informative	Less	More
407	Moodstream site	NA		
408	Stone laboratory website	NA		
409	Photo editing website	NA		
410	College website	NA		
411	Architecture website	NA		
412	Beginners website	NA		
413	Book review website	NA		
414	Business website	NA		
415	Shopping website	Time	Satisfactory	Unsatisfactory
416	Music website	Searching	Less	More
417	News and information website	Informative	Less	More
418	Productivity website	NA		
419	Fun and games website	NA		
420	Meta search engine	NA		
421	Video website	NA		
422	Books searc engine website	NA		
423	Downloading website	NA		
424	Kids website	NA		

Title		Contradiction value2	Value1
425	Learning website	NA	
426	Teaching website	NA	
427	Group website	NA	
428	Learning website	NA	
429	Footwear website	NA	
430	Tech news website	NA	
431	Medical technology website	NA	
432	E news website	NA	
433	Art website	NA	
434	Photography website	NA	
435	Photography website	NA	
436	Health website	NA	
437	Health website	NA	
438	Food packaging site	NA	
439	Sports site	NA	
440	Car s website	NA	
441	Mechanical engineering website	NA	
444	Electrical engineering site	NA	
445	Civil engineering site	NA	
446	Men s shopping site	NA	
447	Women s shopping site	NA	
448	children s site	NA	
449	Gift rocket	NA	
450	Opresume	NA	
451	Aylis	NA	
452	Evoluxion site	NA	

Engineering Innovation (Computer Aided Innovation)

Title		Contradiction	value2	Value1
453	Funny website	NA		
454	Lastpass	NA		
455	Tunein	Cost	Cheap	Expensive
456	Songza	NA		
457	Devour	NA		
458	Quartetothree	NA		
459	Gamasutra	Output	Professional	un-professional
460	Learnist	NA		
461	Coursera	Informative	Less	More
462	Codecademy	NA		
463	Vocabulary	NA		
464	Buzzfeed	NA		
465	Theverge	NA		
466	Shopittome	NA		
467	Wantful	Usability	simple	complex
468	Car s site	NA		
469	File sharing site	NA		
47	Audio slideshow - Britain from the Air	NA		
57	Interactive CD Cover	NA		
63	The T-Mobile Welcome Back	NA		
92	Vibro-Wind	NA		
95	War Horse puppets	NA		
8	Lives Leak	NA		
23	BMW South Africa Defining innovation	NA		
28	U3-X Personal Mobility Prototype	NA		
30	The train that never stops	NA		

Title		Contradiction value2	Value1
90	Sloan Digital Sky Survey Data Release 8	NA	
348	How to turn water into ice in 5 secs	NA	
349	Egg in bottle	NA	
350	Free mobile recharge	NA	
351	3D pictures	NA	
352	Breaking bridge	NA	
353	Hand advertisement	NA	
354	Optical illusion	NA	
382	Color illusion	NA	
383	Shocking facts	NA	
384	Concrete sink	NA	
385	Coin balance	NA	
386	Waste CD s for making fan	NA	
387	Charge iPOD with fruits	NA	
388	Working of brain	NA	
389	Underwater drive	NA	
390	Underwater restaurant	NA	
391	3D street art	NA	
392	Fruit art	NA	
393	Apple swan	NA	
394	Sugar art	NA	
395	Macro photography	NA	
396	Invisible computer mouse	NA	
397	Water fountain	NA	
398	Photos	NA	
399	Unusual places	NA	

Title		Contradiction value2	Value1
400	Snow sculpture	NA	
401	Clay sculpture	NA	
402	3D projection	NA	
403	Spray painting	NA	
404	Kinetic architecture	NA	
405	Needle art	NA	
406	Microscopic art	NA	
3	Virtual Nature	NA	
12	ship underwater	NA	
81	Skull Sunglasses	NA	
103	Graffiti Desktop Wallpapers	NA	
115	Photo	NA	
136	3D street art picture	NA	
140	Macro photography	NA	
206	Little people	NA	
207	Sweing needle	NA	
208	Toothpick bridge	NA	
210	Camel inside needle	NA	
211	Bull sculpture	NA	
212	Replica of lloyd	NA	
214	Incredible hulk	NA	
220	Resort	NA	
221	Train	NA	
222	Tunnel	NA	
223	River	NA	
224	Mountain	NA	

Title		Contradiction	value2	Value1
225	Sea	NA		
226	Waterfall	NA		
227	Velas-beach	NA	na	na
228	Konkan-monsoon	NA	na	na
284	Tiny photograph	size	small	big
295	4D painting	reality	real	unreal
296	Amazing sculpture	NA	na	na
297	Tree branches	NA	na	na
319	Amazing painting	NA	na	na
333	Mountain house	NA	na	na
4	Woods	strength	strong	weak
33	Worlds best 12 packaging designs	design	clear	flashy(unclear)
36	Book packaging design	design	clear	flashy(unclear)
77	Stop n Grow	growth	slow	fast
316	Amazing bus	speed	fast	slow
5	Thirty Minutes From Andromeda	Time	slow	fast
13	Vista - The Wow Starts Now	NA	na	na
14	wall-e	NA	na	na
15	ORQUIDEORAMA- Stunning Sustainable Botanical Garden	characteristic	beautiful	useful
20	Tumor Cells Inhibition	Safety	safe	unsafe
21	Battery made of paper charges up	time	longlasting	shortlasting
22	Switchable Glass Shower Screens	switch	on	off
29	Training the Immune System to Fight Cancer	safety	safe	unsafe
31	Mass customization	time	fast	slow
32	Inkjet Cell Fabricator Prints Healing Flesh Directly Onto Wounds	sideeffects	safe	unsafe
37	Innovation at the Verge by Joel A Barker	NA	na	na

Engineering Innovation (Computer Aided Innovation)

Title		Contradiction	value2	Value1
38	U2 Stage	size	large	small
40	Up and Down	quality	up	down
41	Bluetooth over wi-fi brings huge speed boosts	switch	on	off
	SunPower claims new solar cell efficiency record of 24.2			
42	percent	size	large	small
43	Terrafugia Transition flying car cleared by the FAA	speed	fast	slow
44	Record 19 percent efficiency achieved with low cost solar cells	cost	cheap	expensive
	French team smashes five year efficiency record in eco			
45	marathon	NA	na	na
46	Self repairing photovoltaics not damaged by the Sun	NA	na	na
49	The Smart Fridge	size	small	big
50	Leafy Sea Dragon Phycodurus Eques	reality	real	unreal
51	Dazzle Laser Sailboat	speed	fast	slow
56	Natura Morta	NA	na	na
94	scientific american	size	big	small
99	Teuco Bathtub Sorgente	NA	na	na
154	Unbelievable facts	information	useful	useless
182	Unknown facts about mobile phones	quality	good	bad
184	Monkey	NA	na	na
189	Taj mahal	age	old	new
200	Windows unknown magic	information	Useful	useless
201	Science facts	information	Useful	useless
202	Brain facts	information	Useful	useless
315	Amazing science facts	information	Useful	useless
317	Amazing facts	information	useful	useless

Engineering Innovation (Computer Aided Innovation)

TRIZ Principles Data

NAME	PARAMETER	PRIN	SP	SURETY	TRIZ MISSING	MISSING STRENGT H
ZPO Tower	Principle 22(a) is applied on roof	22	a	3	energy saving	2
ZPO Tower	principle 25(b) is applied for waste used on the site	25	b	3		
Spiderman Urinal				0	exagera tion of facts driving	3
Pepsi Truck	Principle 4(a) is applied on truck	4	a	1	lorry	2
Hacked memory stick	Principle 21(a) is applied on it	21	a	1		
Typewriter octopus	Principle 1(b) is applied on whole sculpture	1	b	3		
Typewriter octopus	Principle 25(b) is applied on whole sculpture	25	b	3		
Motor cycle hat stand	Principle 25(b)is applied on whole product	25	b	3		
Eco friendly house	This principle 25(b)is applied on the roof of the house	25	b	3		
Security Glass	Principle 17(b) is applied on the cash which is put in stack form	17	b	2	placed on road openly	3
Security Glass	principle 22(c) is applied on the glass	22	c	2		

Engineering Innovation (Computer Aided Innovation)

NAME	PARAMETER	PRIN	SP	SURETY	TRIZ MISSING	MISSING STRENGTH
Above The Clouds	principle 3(c) is applied on parts of camera used in this photograph	3	c	1	cloudy outlet in between	2
Above The Clouds	7(b) is applied on lens	7	b	3	n	
Above The Clouds	,principle 13 (b) is applied on camera	13	b	2		
Above The Clouds	Principle 26(b) is applied on photograph	26	b	2		
Northern Lights From Space	Principle 28(b) is applied on earth	28	b	3	color sparklin g 800 pound pig guard cat hungry for fish	1
Pidgeon point light house	Principle 7(b) is applied on camera	7	b	3		2
Two Ways of Looking at Fish	Principle 7(b) is applied on camera	7	b	3		2
1 of 3 1940 Plymouth Blitz begins				0		
2 of 3 1941 Plymouth Blitz continues				0		
3 of 3 1944 Plymouth Blitz bottle design	Principle 4(a) is applied on bottle	4	a	1		
Safety Trump Card	Principle 6(a) is applied on trump cards	6	a	3		
Panadol Sneeze Ad	Principle 6(a) is applied on ad	6	a	1	the	2

Engineering Innovation (Computer Aided Innovation)

NAME	PARAMETER	PRIN	SP	SURETY	TRIZ MISSING	MISSING STRENGT H
					mask sneezed far wifi capture	
The Inspiration Pad	This principle is applied on the whole product	6	a	3	d	1
Mr Kaktus	principle 4(a) is applied on chilli portion	4	a	1	manneri sm	1
Mr Kaktus	Principle 15(a) is applied on the red chilli portion as it can be also changed	15	a	1	sex appeal	2
Mr Kaktus Lick line 23	principle 15(b) is applied on the object as it can be divided into parts	15	b	1 0		
HACKED Memory Stick	Principle 21(a) is applied on its speed	21	a	3		
Aquila Handart	Principle 3(c) is applied on fingers	3	c	1		
Aquila Handart	principle 4(a) is applied on fingers	4	a	1		
Windex Ad	Principle 6(a) is applied on windex	6	a	3	placed on the road	1
Paper draggon sclupture	Principle 4(a) is applied on paper	4	a	2	Tools used prevent scrunchi	
Mousemat Notepad	Principle 3(c) is applied on its parts like mouse and mat	3	c	2	ng	1

Engineering Innovation (Computer Aided Innovation)

NAME	PARAMETER	PRIN	SP	SURETY	TRIZ MISSING	MISSING STRENGTH
Mousemat Notepad	principle 6(a) is applied on the whole object as it can be used both as mouse and as notepad	6	a	2		
Mousemat Notepad	principle 15 (c) is applied on whole product	15	c	2		
Gold nanoparticles make leaves glow	Principle 9(a) is applied on leaves,	9	a	2	reductio n light pollutio n	1
Gold nanoparticles make leaves glow	principle 9(b) is applied on which which will produce light	9	b	2		
Gold nanoparticles make leaves glow	principle 22(a) is applied on tree and principle	22	a	2		
Gold nanoparticles make leaves glow	32(a) is applied on leaves which changes color.	32	a	1		
Lego Ad	Principle 13(c) is applied on equipment used to capture this photograph	13	c	1	decorat ed	1
Lego Ad	principle 26(b) is applied on photograph captured by device	26	b	1		
Queens House Staircase	Principle 14(a) is applied on structure of stairs	14	a	1		
Queens House Staircase	25(a) is applied on base of staircases	25	a	1		

Engineering Innovation (Computer Aided Innovation)

NAME	PARAMETER	PRIN	SP	SURETY	TRIZ MISSING	MISSING STRENGT H
Square Melons	Principle 4(a) is applied on whole object as shape of whole object changes	4	a	2		
Square Melons	Principle 6(a) is applied on whole object as object can perform multiple functions	6	a	3		
Ice Hotel	Principle 3(c) is applied on different rooms in hotel which serve different functions	3	c	2	Freezed ice	1
Ice Hotel	,principle 35 (a) is applied on hotel material	35	a	3		
Ice Hotel	principle 35(d) is applied on whole hotel.	35	d	1		
Transparent B Iron 715	principle 3(b) is applied on floor of iron	3	b	2		
Transparent B Iron 715	Principle 4(a) is applied on structure of object	4	a	1		
Solar building	Principle 25(b) is applied on roof of building	25	b	3		
Sculptures	Principle 4(a) is applied on sculptures	4	a	1		
Food packaging	principle 7(a) is applied on straw which is inserted inside candy	7	a	1		
Pirate ship wedding cake	Principle 4(a) is applied on shape of object	4	a	2		

Engineering Innovation (Computer Aided Innovation)

NAME	PARAMETER	PRIN	SP	SURETY	TRIZ MISSING	MISSING STRENGT H
Rainbow bridge	Principle 20(a) is applied on bridge	20	a	1		
Toaster	principle 6(a) is applied on toaster	6	a	3		
Vial				0		
Mirror tie	Principle 4(a) is applied on tie	4	a	1		
Steering with Touch	Priciple 10(a) is applied on steering	10	a	3		
Steering with Touch	principle 23(a) is applied on steering wheel	23	a	3		
Smart car	Principle 10(a) is applied on camera laser rangefinder	10	a	2		
Shoe	Principle 7(a) is applied on sensors sewn into the sole	7	a	3		
Shoe	,principle 10(a) is applied on smartphone connected through Bluetooth and principle	10	a	3		
Eye glasses	Principle 21(a) is applied on filters	21	a	1		
Umbrella charger	Principle 25(b) is applied on device which is rec yclcd	25	b	3		
Green phones	Principle 22(a) is applied on material used in phone	22	a	3		
Needle-less injections	Principle 28(b) is applied on device as it is electromagnetically powered device	28	b	3		
Mobile based locks				0		
2D gel image scanner	Principle 6(a) is applied on device	6	a	3		
Energy consumption monitors	principle 6(a) is applied on all parts	6	a	3		

Engineering Innovation (Computer Aided Innovation)

NAME	PARAMETER	PRIN	SP	SURETY	TRIZ MISSING	MISSING STRENGT H
Energy consumption monitors	Principle 23(a) is applied on monitor	23	a	3		
Big dog robot	principle 6(a) is applied on whole device	6	a	3		
Big dog robot	Principle 8(a) is applied on engine	8	a	2		
Laptop cooling mat	Principle 6(a) is applied on device	6	a	3		
Laptop cooling mat	principle 10(a) is applied on fan	10	a	3		
Laundry POD	Principle 6(a) is applied on whole device	6	a	3		
Barcelona rock	Principle 6(a) is applied on whole building	6	a	3		
Pencil art	Principle 4(a) is applied on pencils	4	a	2	Tool used	2
Pencil art	5(a) is applied on pencils	5	a	2		
Sand art	Principle 3(a) is applied on sand	3	a	2		
Sand art	principle 15(a) is applied on sand	15	a	1		
Reusable packaging	Principle 6(a) is applied on product	6	a	2		
Reusable packaging	principle 22(a) is applied on material used in product	22	a	3		
Food Package product	Principle 6(a) is applied on product	6	a	2		
Fruit	Principle 4(a) is applied on fruit or vegetable	4	a	3	Carving tool	1
Rainbow fountain	Principle 32 (a) is applied on LED nozzles	32	a	1		
Melting men	Principle 3(a) is applied on object	3	a	1		

Engineering Innovation (Computer Aided Innovation)

NAME	PARAMETER	PRIN	SP	SURETY	TRIZ MISSING	MISSING STRENGT H
Melting men	principle 35(a) is applied on water which is converted into ice cubes	35	a	3		
Paper art	Principle 4(a) is applied on shape of object	4	a	1		
Paper sculptures	Principle 4(a) is applied on paper	4	a	1		
Paper sculptures	,principle 5(a) is applied on paper pieces	5	a	2		
Peacock wedding dress	Principle 4(a) is applied on dress	4	a	1		
Paper sculptures	principle 32(a) is applied on paper	32	a	1		
Cubic house	Principle 4(a) is applied on structure of building	4	a	1		
Island	Principle 4(a) on shape of island	4	a	2		
Cubic house	Principle 4(a) is applied on shape of house	4	a	2		
Sleep profiler	Principle 23(a) is applied on 3 channel frontal EEG	23	a	2		
Cycle	Principle 4(a) is applied on shape of cycle	4	a	2		
Underground hotel	Principle 14(b) is applied on hotel	14	b	2		
Park				0		
Toothpicks boat	Principle 3(a) is applied on structure of boat	3	a	1	Glue material used	2
Toothpicks boat	principle 5(a) is applied on toothpicks	5	a	2		

Engineering Innovation (Computer Aided Innovation)

NAME	PARAMETER	PRIN	SP	SURETY	TRIZ MISSING	MISSING STRENGT H
Key card hotel	Principle 5(a) is applied on plastic key cards	5	a	1		
Key card hotel	principle 17(b) is applied on key cards	17	b	1		
Solar car	Principle 3(a) is applied on structure of car	3	a	2		
Solar car	principle 25(b) is applied on its energy	25	b	3		
Multi-function wheel	principle 5(a) is applied on revolving modules	5	a	3		
Multi-function wheel	Principle 6(a) is applied on spinning wall	6	a	3		
Finger-nose stylus	Principle 6(a) is applied on nose	6	a	2	device	1
warcraft-mouse	Principle 4(a) is applied on shape of mouse	4	a	1		
Cyber speaker	principle 21(a) is applied on its wireless connection	21	a	1		
Cyber speaker	Principle 3(c) is applied on parts of speaker	3	c	2		
Shipping container	Principle 17(a) is applied on container	17	a	1		
Shipping container	principle 35(c) is applied on its flexibility	35	c	1		
Shipping container	d principle 22(a) is applied on its recycled material	22	a	3		

Engineering Innovation (Computer Aided Innovation)

NAME	PARAMETER	PRIN	SP	SURETY	TRIZ MISSING	MISSING STRENGTH
Egg mouse	Principle 26(b) is applied on its technique	26	b	2		
Blue tooth webcam	Principle 35(c) is applied on its flexibility	35	c	2		
laptop desk	Principle 1(b) is applied on device	1	b	3	Texture	2
Hard drive	Principle 3(a) is applied on hard drive	3	a	1		
eye ring	Principle 35(c) is applied on its flexibility	35	c	1		
Sinking airport	Principle 10(a) is applied on harmful conditions which exists like earth quake	10	a	3		
Car house	Principle 4(a) is applied on car	4	a	1		
Cake	Principle 4(a) is applied on shape of cake	4	a	1		
Motor cycle man	Principle 22(a) is applied on material used for sculpture	22	a	3		
LED umbrella	Principle 6(a) is applied on object	6	a	2		
Rock road	Principle 14(a) is applied on shape of road surface	14	a	1		
Bridge	Principle 14(a) is applied on structure of bridge	14	a	1		
Dog shaped hotel	Principle 4(a) is applied on shape of hotel	4	a	1		
Car charger	Principle 6(a) is applied on charger	6	a	1		

Engineering Innovation (Computer Aided Innovation)

NAME	PARAMETER	PRIN	SP	SURETY	TRIZ MISSING	MISSING STRENGTH
Butter sculptures	Principle 4(a) is applied on shape of butter	4	a	1		
Foot sculpture	Principle 4(a) is applied on foot	4	a	1		
Sculpture garden	Principle 10(a) is applied on garden plants	10	a	2		
Furniture	Principle 1(b) is applied on furniture	1	b	3		
Peugeot Modif	Principle 10(a) is applied on size of car	10	a	2		
Peugeot Modif	Principle 35(c) is applied on center shaft	35	c	2		
Basket building	Principle 3(a) is applied on structure of building	3	a	1		
Piano house	Principle 8(b) is applied on escalator	8	b	2		
Replay building	Principle 4(a) is applied on house	4	a	1		
Forest building	Principle 4(a) is applied on building	4	a	1		
Mind house	Principle 4(a) is applied on building	4	a	1		
Tianzi Hotel	Principle 4(a) is applied on hotel	4	a	1		
Salt hotel	Principle 5(a) is applied on salt blocks	5	a	2		
Packing hotel	Principle 1(b) is applied on whole hotel	1	b	3		

Engineering Innovation (Computer Aided Innovation)

NAME	PARAMETER	PRIN	SP	SURETY	TRIZ MISSING	MISSING STRENGT H
Packing hotel	Principle 3(c) is applie on various parts of hotel like romte control and different rooms in hotel	3	c	3		
Lipstick sculpture	Principle 3(a) is applied on lipstick	3	a	1		
Replica of empire building	Principle 3(a) is applied on structure of object	3	a	2		
Chalk sculpture	Principle 4(a) is applied on shape of object	4	a	2		
Little milk people	Principle 3(a) is applied on boat and man	3	a	2		
watch part motorcycle	Principle 22(a) is applied on parts of motorcycle	22	a	3		
Rock garden	Principle 22(a) is applied on plugs, switches, tubelights, bangles, crockery, wash basins, marbles	22	a	3		
Ice cream tie	Principle 4(a) is applied on shape of tie	4	a	2		
Parrot tie	Principle 4(a) is applied on shape of tie	4	a	2		
Keyboard tie	Principle 4(a) is applied on shape of tie	4	a	2		
Tea men	Principle 3(a) is applied on tea men	3	a	2		
Egelimage				0		
Wedding dress				0		

Engineering Innovation (Computer Aided Innovation)

NAME	PARAMETER	PRIN	SP	SURETY	TRIZ MISSING	MISSING STRENGT H
Tree restaurant	Principle 14(a) is applied on wood used in restaurent	14	a	1		
Dish hat	Principle 4(a) is applied on shape of hat	4	a	1		
Wedge touch mouse	Principle 4(a) is applied on shape of mouse	4	a	3		
Wedge touch mouse	Principle 35(c) is applied on its compatibility with any operationg system	35	c	1		
Rolling keyboard	Principle 3(a) is applied on keyboard	3	a	1		
Wrist keyboard	Principle 3(a) is applied on structure of keyboard	3	a	2		
Wrist keyboard	Principle 10(a) is applied on its compatibility with environmental conditions	10	a	2		
Spider mouse	Principle 3(a) is applied on sturcture of mouse	3	a	1		
Spiral staircase	Principle 3(a) is applied on sturcture of staircase	3	a	2		
Paper phone	Principle 22(a) is applied on paper	22	a	3		
Upside down house	Principle 3(a) is applied on structure of house	3	a	2		
Upside down house	Principle 13(c) is applied on house	13	c	3		
Woolen art				0		

Engineering Innovation (Computer Aided Innovation)

NAME	PARAMETER	PRIN	SP	SURETY	TRIZ MISSING	MISSING STRENGT H
Telephone booth	Principle 4(a) is applied on shape of telephone booth	4	a	1		
Ice phone booth	Principle 4(a) is applied on shape of telephone booth	4	a	1		
Ice phone booth	Principle 35(a) is applied on snow used for telephone booth	35	a	3		
Pencil fence	Principle 4(a) is applied on shape of fence	4	a	1		
Pencil fence	Principle 13(c) is applied on pencils	13	c	3		
Samsung aid	Principle 4(a) is applied on samsung phone's shape	4	a	1		
Wow ads	Principle 4(a) is applied on words used in this ad	4	a	1		
Creative shoes	Principle 4(a) is applied on shape of sandle	4	a	2		
Jet shapped mouse	Principle 4(a)is applied on shape of mouse	4	a	1		
3D mouse	Principle 4(a) is applied on shape of mouse	4	a	2		
3D mouse	Principle 17(a) is applied on mouse	17	a	1		
Amazing cake	Principle 4(a) is applied on shape of cake	4	a	1		
Banana man	Principle 4(a) is applied on shape of banana	4	a	1		

Engineering Innovation (Computer Aided Innovation)

NAME	PARAMETER	PRIN	SP	SURETY	TRIZ MISSING	MISSING STRENGTH
Finger art	Principle 4(a) is applied on shape of finger	4	a	1		
Grass car	Principle 4(a) is applied on shape of car	4	a	1		
Water drops photography	Principle 26(b) is applied on photograph	26	b	1		
Coin balance	Principle 3(a) is applied on coins	3	a	1		
Paper fork	Principle 4(a) is applied on the shape of frok	4	a	1		
Sand men	Principle 4(a) is applied on sand	4	a	1		
Sandle chair	Principle 3(a) is applied on sturcture of chair	3	a	1		
Micro art				0		
Baloon art	Principle 4(a) is applied on baloons	4	a	1		
Book art	Principle 4(a) is applied on paper	4	a	1		
Computer inside keyboard	Principle 6(a) is applied on whole object	6	a	3		
Computer inside keyboard	Principle 3(c) is applied on parts of product	3	c	3		
House on rock	Principle 4(a) is applied on structure of rock	4	a	1		
Tree house	Principle 3(a) is applied on shape of house	4	a	1		
Lake house	Principle 4(a) is applied on shape of house	4	a	1		

Engineering Innovation (Computer Aided Innovation)

NAME	PARAMETER	PRIN	SP	SURETY	TRIZ MISSING	MISSING STRENGT H
Glass house				0		
Earth quake proof desk	Principle 10(a) is applied on desk	10	a	3		
Double chair	Principle 35(c) is applied on arms of chair	35	c	3		
Hybrid car	Principle 4(a) is applied on shape of car	4	a	1		
Hybrid car	Principle 10(a) is applied on wheels of car	10	a	3		
Hybrid car	Principle 28(b) is applied on car	28	b	3		
Air car	Principle 35(a) is applied on fuel of car	35	a	2		
Air car	Principle 10(a) is applied on micro transmitters	10	a	2		
Sim card reader	Principle 6(a) is applied on whole product	6	a	3		
Color changing car	Principle 28(b) is applied on polymer	28	b	2		
Toy friend	Principle 28(a) is applied on sensors used in toy	28	a	3		
Backlit keyboard	Principle 6(a) is applied on product	6	a	2		
Bridging home	Principle 3(a) is applied on structure of house	3	a	1		
Tiny figures	Principle 3(a) is applied on structure of watch	3	a	1		
Spiral tower	Principle 5(a) is applied on books	5	a	3		

Engineering Innovation (Computer Aided Innovation)

NAME	PARAMETER	PRIN	SP	SURETY	TRIZ MISSING	MISSING STRENGT H
Spiderman Urinal						0
Pepsi Truck	Principle 3(a) is applied on structure of truck	3	a		1	
Security Glass						0
Northern Lights From Space	Principle 28(b) is applied on earth	28	b		3	
Northern Lights From Space	Principle 7(b) is applied on camera	7	b		3	
Pidgeon point light house	Principle 32(a) is applied on light house	32	a		2	
Pidgeon point light house	Principle 7(b) is applied on camera	7	b		3	
Two Ways of Looking at Fish	Principle 7(b) is applied on camera	7	b		3	
1 of 3 1940 Plymouth Blitz begins						0
2 of 3 1941 Plymouth Blitz continues						0
3 of 3 1944 Plymouth Blitz						0
bottle design	Principle 4(a) is applied on shape of bottle	4	a		3	
Safety Trump Card	Principle 6(a) is applied on trump cards	6	a		1	
Panadol Sneeze Ad	Principle 6(a) is applied on ad	6	a		1	
The Narrow House in Belgium	Principle 6(a) is applied on house	6	a		1	
Windex Ad	Principle 6(a) is applied on product	6	a		3	
Paper dragon sculpture	Principle 4(a) is applied on shape of paper	4	a		2	
Multi-color Splash Sink						0
Try This Watch On Ad						0

Engineering Innovation (Computer Aided Innovation)

NAME	PARAMETER	PRIN	SP	SURETY	TRIZ MISSING	MISSING STRENGT H
Spread Your Love bicycle	Principle 3(a) is applied on structure of tyre	3	a	1		
The British Library	Principle 6(a) is applied on library	6	a	1		
let them wear wedding cakes	Principle 4(a) is applied on dress	4	a	1		
Retro CD Player	Principle 3(a) is applied on product	3	a	1		
Glove Shoes	Principle 4(a) is applied on shape of product	4	a	1		
Andre Perugia	Principle 4(a) is applied on shape of product	4	a	1		
Mighty Strange Bread	Principle 4(a) is applied on shape of bread	4	a	1		
Table Connect	Principle 6(a) is applied on product	6	a	3		
Melting Staircase	Principle 4(a) is applied on staircase	4	a	2		
Desert Chair	Principle 4(a) is applied on chair	4	a	2		
Bodegas Ysios in Spain	Principle 4(a) is applied on building	4	a	1		
BigMac the Hangover Cure				0		
Artist Jack Featherstone				0		
ReadDot	Principle 6(a) is applied on product	6	a	2		
uk_bookshelf	Principle 4(a) is applied on shape of books	4	a	1		
Mushroom LED lamps	Principle 6(a) is applied on product	6	a	3		
LED origami cards	Principle 17(b) is applied on cards	17	b	2		
latte art	Principle 4(a) is applied on shape of cofee	4	a	1		
Solar bridge	Principle 25(b) is applied on rooftop	25	b	3		

Engineering Innovation (Computer Aided Innovation)

NAME	PARAMETER	PRIN	SP	SURETY	TRIZ MISSING	MISSING STRENGT H
Kunsthaus Graz	Principle 3(c) is applied on building parts	3	c	1		
High House	Principle 25(b) is applied on thermal mass	25	b	3		
EP 09 Tower	Principle 25(b) is applied on building	25	b	3		
Real time data system	Principle 23(a) is applied on real time system	23	a	3		
Divergen konkan	Principle 7(b) is applied on lens of camera	7	b	3		
Cloudy sunset	Principle 7(b) is applied on lens of camera	7	b	3		
Bullcart.	Principle 7(b) is applied on lens of camera	7	b	3		
Angel falls	Principle 7(b) is applied on lens of camera	7	b	3		
cirquedusoleil	Principle 6(a) is applied on shows performed in this theatre	6	a	3		
The Daily Smell Blog	Principle 6(a) is applied on the website	6	a	2		
Cool website	Principle 6(a) is applied on the website	6	a	3		
Space site	Principle 7(b) is applied on photographs which are in this website	7	b	3	Videos used in this site	1
Searching site	Principle 6(a) is applied on search option of this site	6	a	1		
Maps	Principle 21(a) is applied on features provided by the site	21	a	2		
Email	Principle 6(a) is applied on features of bluebottle	6	a	3		

Engineering Innovation (Computer Aided Innovation)

NAME	PARAMETER	PRIN	SP	SURETY	TRIZ MISSING	MISSING STRENGTH
Searching website	Principle 21(a) is applied on features provided by the site	21	a	3		
Photo site	Principle 6(a) is applied on its tools	6	a	3		
Amazing website	Principle 21(a) is applied on google earth used by this site	21	a	3		
Music website	Principle 6(a) is applied on features of website	6	a	2		
Brain facts				0		
Moodstream site	Principle 6(a) is applied on features provided by this site	6	a	2		
Stone laboratory website	Principle 6(a) is applied on features provided by this site	6	a	1		
					Standal one projects provide d in this website	2
Photo editing website	Principle 6(a) is applied on flauntR software	6	a	1		
College website	Principle 6(a) is applied on features provided by this site	6	a	2		
Architecture website	Principle 6(a) is applied on features provided by this site	6	a	2		
Beginers website	Principle 6(a) is applied on features provided by this site	6	a	2		
Book review website				0		
Business website	Principle 6(a) is applied on the features which is provided by this site	6	a	2		
Shopping website	Principle 21 (a) is applied on time which is saved by using this site	21	a	2		
Music website	Principle 25(a) is applied on Gnod system	25	a	3		
News and information website	Principle 6(a) is applied on features provided by this site	6	a	1		
Productivity website	Principle 21(a) is applied on its conversion technique	21	a	3		
Fun and games website	Principle 4(a) is applied on paper used for making toys	4	a	3		
Meta search engine	Principle 6(a) is applied on search engine	6	a	2		
Video website	Principle 6(a) is applied on features provied by this video site	6	a	2		
Books searc engine website	Principle 21(a) is applied on its search options	21	a	2		

Engineering Innovation (Computer Aided Innovation)

NAME	PARAMETER	PRIN	SP	SURETY	TRIZ MISSING	MISSING STRENGT H
Downloading website	Principle 3(c) is applied on each e book which this website provides	3	c	3		
Kids website	Principle 6(a) is applied on features provided by this website	6	a	2		
Learning website	Principle 6(a) is applied on features provided by this website	6	a	1		
Teaching website	Principle 6(a) is applied on features provided by this website	6	a	3		
Group website	Principle 5(a) is applied on groups	5	a	3		
Learning website	Principle 21(a) is applied on learning methodology of this website	21	a	3		
Footwear website	Principle 21(a) is applied on saving time by using this site	21	a	1		
Tech news website	Principle 6(a) is applied on information,insight and support provided by this site	6	a	2		
Medical technology website	Principle 3(c) is applied on menu items provided in this website	3	c	3		
E news website	Principle 3(c) is applied on news portions provided by this website	3	c	1		
Art website	Principle 4(a) is applied on shape of art work provided in this site	4	a	1		
Photography website	Principle 3(c) is applied on features provided by this website	3	c	2		
Photography website	Principle 3(c) is applied on features provided by this website	3	c	2		
Health website	Principle 3(c) is applied on features provided by this website	3	c	2		
Health website	Principle 3(c) is applied on features provided by this website	3	c	2		
Food packaging site	Principle 21(a) is applied on its processing time	21	a	2		
Sports site	Principle 3(c) is applied on features provided by this website	3	c	2		
Car s website	Principle 21(a) is applied on the features which this website provides and saves time	21	a	3		
Mechanical engineering website	Principle 3(c) is applied on features provided by this website	3	c	3		
Mechanical engineering website	Principle 3(c) is applied on features provided by this website	3	c	2		
Mechanical engineering website	Principle 21(a) is applied on the features which this website provides and saves time	21	a	3		
Electrical engineering site	Principle 6(a) is applied on functions provided by this website	6	a	1		
Civil engineering site	Principle 21(a) is applied on learning technique provided by this site	21	a	2		

Engineering Innovation (Computer Aided Innovation)

NAME	PARAMETER	PRIN	SP	SURETY	TRIZ MISSING	MISSING STRENGT H
Men s shopping site	Principle 21(a) is applied on time which is saved using this site	21	a	2		
Women s shopping site	Principle 21(a) is applied on time which is saved using this site	21	a	2		
children s site	Principle 3(c) is applied on features provided by this website	3	c	2		
Gift rocket	Principle 21(a) is applied on time which is saved using this site	21	a	3		
Opresume	Principle 21(a) is applied on time which is saved using this site	21	a	3		
Aylis	Principle 3(c) is applied on features provided by this website	3	c	2		
Evoluxion site	Principle 21(a) is applied on time which is saved using this site	21	a	1		
Funny website	Principle 21(a) is applied on time which is saved using this site	21	a	1		
Lastpass	Principle 21(a) is applied on time which is saved using this site	21	a	1		
Tunein	Principle 3(c) is applied on features provided by this website	3	c	2		
Songza	Principle 3(c) is applied on features provided by this website	3	c	2		
Devour	Principle 21(a) is applied on time which is saved using this site	21	a	2		
Quartetothree				0		
Gamasutra	Principle 21(a) is applied on time which is saved using this site	21	a	3		
Learnist	Principle 21(a) is applied on time which is saved using this site	21	a	3		
Coursera	Principle 21(a) is applied on time which is saved using this site	21	a	3		
Codecademy	Principle 3(c) is applied on courses provided by this site	3	c	3		
Vocabulary	Principle 21(a) is applied on time which is saved using this site	21	a	3		
Buzzfeed	Principle 21(a) is applied on time which is saved using this site	21	a	1		
Theverge	Principle 21(a) is applied on time which is saved using this site	21	a	1		
Shopittome	Principle 21(a) is applied on time which is saved using this site	21	a	3		
Wantful	Principle 21(a) is applied on time which is saved using this site	21	a	3		
Car s site	Principle 21(a) is applied on time which is saved using this site	21	a	3		
File sharing site	Principle 21(a) is applied on time which is saved using this site	21	a	2		
Audio slideshow - Britain from the	Principle 21(a) is applied on time which is saved using this site	21	a	1		

Engineering Innovation (Computer Aided Innovation)

NAME	PARAMETER	PRIN	SP	SURETY	TRIZ MISSING	MISSING STRENGT H
Air						
Interactive CD Cover	Principle 4(a) is applied on CD cover	4	a	1		
The T-Mobile Welcome Back				0		
Vibro-Wind	Principle 18(a) is applied on generator	14	a	3		
War Horse puppets	Principle 4(a) is applied on horse	4	a	1		
Lives Leak				0		
BMW South Africa Defining innovation	Principle 4(a) is applied on sculpture	4	a	1		
U3-X Personal Mobility Prototype	Principle 28(b) is applied on vehicle	28	b	3		
The train that never stops	Principle 5(a) is applied on compartments	5	a	3		
Sloan Digital Sky Survey Data						
Release 8	Principle 7(b) is applied on telescope	7	b	3		
How to turn water into ice in 5 secs	Principle 35 (a) is applied on water	35	a	3		
Egg in bottle	Principle 35(d) is applied on air	35	d	3		
Free mobile recharge	Principle 21(a) is applied on recharge process	21	a	1		
3D pictures	Principle 17(a) is applied on drawings	17	a	1		
Breaking bridge	Principle 3(a) is applied on bridge	3	a	2		
Hand advertisement	Principle 4(a) is applied on hands	4	a	2		
Optical illusion	Principle 28(a) is applied on illusions	28	a	1		
Color illusion	Principle 28(a) is applied on illusions	28	a	1		
Shocking facts				0		
Concrete sink	Principle 14(a) is applied on channels	14	a	3		
Coin balance	Principle 8(a) is applied on coins	8	a	3		
Waste CD s for making fan	Principle 22(a) is applied on CD's	22	a	3		
Charge iPOD with fruits	Principle 24(a) is applied on fruits	24	a	2		
Working of brain	Principle 21(a) is applied on animation	21	a	1		

Engineering Innovation (Computer Aided Innovation)

NAME	PARAMETER	PRIN	SP	SURETY	TRIZ MISSING	MISSING STRENGT H
Underwater drive						0
Underwater restaurant	Principle 3(a) is applied on structure of hotel	3	a	1		
3D street art	Principle 17(a) is applied on artwork	17	a	1		
Fruit art	Principle 4(a) is applied on frit	4	a	1		
Apple swan	Principle 4(a) is applied on apple	4	a	1		
Sugar art	Principle 4(a) is applied on sugar	4	a	1		
Macro photography	Principle 7(b) is applied on camera	7	b	3		
Invisible computer mouse	Principle 21(a) is applied on mouse	21	a	1		
Water fountain	Principle 19(a) is applied on music	19	a	1		
Photos	Principle 7(b) is applied on camera	7	b	3		
Unusual places	Principle 7(b) is applied on camera	7	b	3		
Snow sculpture	Principle 35(a) is applied on snow	35	a	3		
Clay sculpture	Principle 4(a) is applied on clay	4	a	1		
3D projection	Principle 17(a) is applied on projection	17	a	1		
Spray painting	Principle 32(a) is applied on painting	32	a	1		
Kinetic architecture	Principle 13(b) is applied on uni system	13	b	2		
Needle art	Principle 4(a) is applied on sculpture	4	a	2		
Microscopic art	Principle 7(b) is applied on microscope	7	b	3		
Virtual Nature	Principle 17(a) is applied on image	17	a	1		
ship underwater	Principle 7(b) is applied on camera	7	b	3		
					Embedd ed graphica l picture	1
Skull Sunglasses	Principle 6(a) is applied on sun glasses	6	a	2		
Graffiti Desktop Wallpapers				0		
Photo	Principle 17(a) is applied on photograph	17	a	1		

Engineering Innovation (Computer Aided Innovation)

NAME	PARAMETER	PRIN	SP	SURETY	TRIZ MISSING	MISSING STRENGT H
3D street art picture	Principle 17(a) is applied on art	17	a	1		
Macro photography	Principle 7(b) is applied on camera	7	b	3		
Little people	Principle 3(a) is applied on structure of sculpture	3	a	1		
Sweing needle	Principle 3(a) is applied on sculpture	3	a	1	Needle	3
Toothpick bridge	Principle 3(a) is applied on bridge	3	a	1	Glue	5
Camel inside needle	Principle 3(a) is applied on camel	3	a	1		
Bull sculpture	Principle 17(a) is applied on sculpture	17	a	1	Plastic Plateniu m	2
Replica of lloyd	Principle 3(a) is applied on structure	3	a	1		2
Incredible hulk	Principle 3(a) is applied on structure	3	a	1		
Resort	Principle 7(b) is applied on camera	7	b	1		
Train	Principle 7(b) is applied on camera	7	b	1		
Tunnel	Principle 7(b) is applied on camera	7	b	1		
River	Principle 7(b) is applied on camera	7	b	1		
Mountain	Principle 7(b) is applied on camera	7	b	1		
Sea	Principle 7(b) is applied on camera	7	b	1		
Waterfall	Principle 7(b) is applied on camera	7	b	1		
Velas-beach	Principle 7(b) is applied on camera	7	b	1		
Konkan-monsoon	Principle 7(b) is applied on camera	7	b	1		
Tiny photograph	Principle 4(a) is applied on tiny people	4	a	1		
4D painting				0		
Amazing sculpture	Principle 5(a) is applied on natural materials	5	a	2		
Tree branches				0		
Amazing painting				0		
Mountain house				0		

Engineering Innovation (Computer Aided Innovation)

NAME	PARAMETER	PRIN	SP	SURETY	TRIZ MISSING	MISSING STRENGT H
Woods	Principle 16(a) is applied on painting	16	a	1		
Worlds best 12 packaging designs	Principle 21(a) is applied on packaging	21	a	1		
Book packaging design	Principle 4(a) is applied on packaging	4	a	1		
Stop n Grow	Principle 4(a) is applied on shape of bag	4	a	1		
Amazing bus	Principle 4(a) is applied on bus	4	a	1		
Oil painting				0		
Thirty Minutes From Andromeda				0		
Vista - The Wow Starts Now	Principle 6(a) is applied on vista	6	a	3		
wall-e	Principle 15(c) is applied on robot	15	c	3		
ORQUIDEORAMA- Stunning						
Sustainable Botanical Garden	Principle 22(a) is applied on petals	22	a	1		
Tumor Cells Inhibition	Principle 5(b) is applied on therapy	5	b	1		
					Lithium containi ng solution	2
Battery made of paper charges up	Principle 26(a) is applied on copier paper	26	a	1		
Switchable Glass Shower Screens	Principle 6(a) is applied on screens	6	a	1		
Training the Immune System to Fight Cancer	Principle 5(b) is applied on therapy	5	b	1		
Mass customization	Principle 21(a) is applied on its processing time	21	a	1		
Inkjet Cell Fabricator Prints Healing Flesh Directly Onto Wounds	Principle 6(a) is applied on device	6	a	3	Tank	1
Innovation at the Verge by Joel A Barker	Principle 6(a) is applied on program	6	a	1		
U2 Stage	Principle 6(a) is applied on stage	6	a	1		
Up and Down	Principle 21(a) is applied on report	21	a	1		

Engineering Innovation (Computer Aided Innovation)

NAME	PARAMETER	PRIN	SP	SURETY	TRIZ MISSING	MISSING STRENGTH
Bluetooth over wi-fi brings huge speed boosts	Principle 6(a) is applied on device	6	a	2		
SunPower claims new solar cell efficiency record of 24.2 percent	Principle 23(a) is applied on solar cell efficiency	23	a	1		
Terrafugia Transition flying car cleared by the FAA	Principle 6(a) is applied on car	6	a	3		
Record 19 percent efficiency achieved with low cost solar cells	Principle 6(a) is applied on device	6	a	3		
French team smashes five year efficiency record in eco marathon	Principle 6(a) is applied on car	6	a	3		
Self repairing photovoltaics not damaged by the Sun	Principle 25(a) is applied on photovoltaic cell	25	a	3		
The Smart Fridge	Principle 6(a) is applied on fridge	6	a	3		
Leafy Sea Dragon Phycodurus Eques						
Dazzle Laser Sailboat	Principle 21(a) is applied on sailing speed	21	a	1		
Natura Morta				0		
scientific american	Principle 25(a) is applied on sheets	25	a	3		
Teuco Bathtub Sorgente	Principle 3(c) is applied on bath tub	3	c	2		
Unbelievable facts	Principle 1(a) is applied on contents of this article	1	a	3		
Unknown facts about mobile phones	Principle 1(a) is applied on contents of this article	1	a	3		
Monkey				0		
Taj mahal	Principle 14(b) is applied on building	14	b	3		
Windows unknown magic	Principle 6(a) is applied on windows operating system	6	a	3		
Science facts	Principle 1(a) is applied on contents of this article	1	a	3		
Brain facts	Principle 1(a) is applied on contents of this article	1	a	3		

Engineering Innovation (Computer Aided Innovation)

NAME	PARAMETER	PRIN	SP	SURETY	TRIZ MISSING	MISSING STRENGT H
Amazing science facts	Principle 1(a) is applied on contents of this article	1	a	3		
Amazing facts	Principle 1(a) is applied on contents of this article	1	a	3		

Appendix-VII (Meetings and Questionnaires)

<i>Meeting/ Questionnaire ID</i>	<i>Type</i>	<i>With</i>	<i>Date</i>	<i>Meeting Location</i>	<i>Extra Information</i>
AEGISP1. 1 person	Meeting/ Questionnaire (Personal interview) AEGIS Analysis/ Conceptual Phase.	Peter Jones (Graphic Designer/ head of TC) Highly experienced designer and researcher.	11-June 2009	Typographic Communication Design Group RLB Plymouth University, Level 7	Attachment AEGISP1/01.
AEGISP2. 1 person	Meeting/ Questionnaire (Personal interview) AEGIS Analysis/ Conceptual Phase.	Simon Standing (Graphic Designer for DPC Plymouth University) Highly experienced print designer.	16-July 2009	Department of Design and Printing, Plymouth University	Personal interview
AEGISP3 1 person.	Meeting/ Questionnaire (Personal Interview) AEGIS Analysis/ Conceptual Phase.	Lee Mattock (Graphic Designer for DPC Plymouth University) Highly experienced print designer.	30-June-2009	Department of Design and Printing, Plymouth University	Personal interview

<i>Meeting/ Questionnaire ID</i>	<i>Type</i>	<i>With</i>	<i>Date</i>	<i>Meeting Location</i>	<i>Extra Information</i>
AEGISQ4 3 persons.	Group Questionnaire. AEGIS Analysis/ Conceptual Phase. AEGIS Version 6.0 demonstrated and discussed	Jake Jennings, Richard Gray, Mario Picariello. (Graphic Designers) Junior level experienced.	21-June 2010	PSQ- C4 Lecture Theatre, Plymouth University	Group questionnaire, focus group and group interviews. AEGIS demo shown.
AEGIST5 1 person	Personal Interview. AEGIS Demo.	Thomas Weekeners (Computational Neuroscience)	22-June 2010	PSQ, Plymouth University	Attachment-AEGIST5/01.
AEGISQ6 5 persons	Group Questionnaire.	Graphic Designers At TC Plymouth University	23-Nov-2010	PSQ Plymouth University	Group Questionnaire
AEGISP7 1 person	Personal Meeting	Dr. Phil Culverhouse Center for Robotics	July 2011	PSQ Plymouth University	Attachment-AEGISP7/01.
AEGIST8	User Testing and Data Logging for Analysis.	Graphic Designers	27-Oct-2013	RLB Plymouth University	Attachment-AEGIST9/01

<i>Meeting/ Questionnaire ID</i>	<i>Type</i>	<i>With</i>	<i>Date</i>	<i>Meeting Location</i>	<i>Extra Information</i>
					AEGIST9/02
AEGISQ9	Group Questionnaire AEGIS v 6.6 demo	Graphic Designers	May 2012	RLB Plymouth	Group Questionnaire
AEGISP10 1 person	Personal meeting To discuss possibility of GA's	Angelo Cangelosi Artificial Intelligence and Cognition	June 2012	PSQ Plymouth	Attachment AEGISP10/01
AEGISQ11 12 persons	Different sessions plus individual sessions of questionnaire along with demo of version AEGIS v 7.0/7.1	7 Graphic Designers 1 Fashion Designer 2 IT Engineers 1 Business Manager	Oct 2013 Nov 2013	PSQ Plymouth Riyadh Saudi Arabia Srinagar India	

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AEGISP1, AEGISP2, AEGISP3. Questionnaire Data for AEGIS Project.

	How has CAI been Used in GD in the past	How would the outputs (referred) be rated	What approaches would a GD use for this type of project	Recommendation of Specific tools	Evaluation Criteria	General Comments	Attachments / Future meetings
Simon Standing	<ul style="list-style-type: none"> Manipulation Advertising Pdesign Packaging and S Design Book design Publishing digital press 	<ul style="list-style-type: none"> Potentially seen as very systematic A non-expressive system Mathematically driven 	<ul style="list-style-type: none"> Using prior knowledge and exp. Using people to test and generate new ideas Research and questionnaires 	No	<ul style="list-style-type: none"> Customer focus groups Pilot product on retail locations 	It will be interesting to see how designers view the idea of mathematical sys	Happy to meet again
Lee Mattock	<ul style="list-style-type: none"> Cowgum fumes were used before computers Now they use Photoshop etc Before computers, it was harder (Example, 1/2 a day for b cards) 	<ul style="list-style-type: none"> Changing colours may not be noticed by users Black and Red ones are good Company brands are tricky 	<ul style="list-style-type: none"> First customer gives an idea Then iteratively taking feedback Shape sketch is tricky 	<ul style="list-style-type: none"> GD is ideas centred design Some questions need formulated certain automation used in Photoshop 	<ul style="list-style-type: none"> Questions attached 	It could just be a basic trigger for ideas Even computer automation is not fully automatic	Enclosed Would like to see the further dev of CAI tool
Peter Jones	<ul style="list-style-type: none"> Experimentation Interactive media 	Useful for discussion	<ul style="list-style-type: none"> Mood Boards Radically diff solutions that raise a variety of issues 	Adobe packages	<ul style="list-style-type: none"> Yes , but these would be fuzzy eg cheap 		Enclosed below Future joint venture possible

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AEGISQ4-Part A Questionnaire Data.

Name	From your experience of specific design tools like Photoshop and Illustrator, please identify any advantages (and disadvantages) that AEGIS would give graphic designers.		How could the layering system help graphic designers; specifically packaging designers?	From your experience of previous methods used by Graphic Designers, how innovative do you think AEGIS is?	What features would you like to see developed further and why?	Seeing the TRIZ Principles overview today, which Principles you suggest can be applied to Graphic Design?
	Advantages	Disadvantages				
Jake Jennings	Quickly provides a range of alternate ideas/ variations. Works with a variety of elements to see how text/shapes/photos- (all 3 creative suite programs) working together in a variety of situations.	Too easy to rely on. (what will happen to the human talent)	Ability to see the designs in a variety of situations very quickly changing.	There are filter galleries available in each CS program, however do not go to the same extent as what has been shown today. Alternate methods is own creative mind. It is innovative. Currently I know nothing in the market like this or at least where it is trying to achieve- needs to push to be different.	Interface should look friendlier (but then windows never were friendly). There are a million choices to be considered to be made when designing something yet to use this over existing programs it needs to cover all bases:- Size/colour/ position/type. Range of options for variations, gradients, specific shades of colour particular type styles etc.	1,2,3,4,5,6,8,13,15,17, 19,23,25,26,32,33,40

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Richard Gray	It would help to create a finalized outcome and help the designer in considering a broader range of options to create exactly what the designer wants.	AEGIS is not able to create ideas for the designer it can only assist in creating what the designer wants.	I think the layering system would help in design as it can offer a range of different combinations which the designer may not have thought of using, so that the best combination of layers is used.	I definitely think this will be the future of how graphic design will be, but I still think that a program cannot create design ideas.	<p>I really like the feature which gives you a range of options which you can choose, and then move on to the next layer and choose what will work with that.</p> <p>I would like it more if it was more flexible with how you can arrange layers in different sizes, positions.</p> <p>The layers feature could be fine-tuned so that the layers went in to more detail.</p>	<ul style="list-style-type: none"> • 1-Segmentation • 2-Extraction • 8-Counterweight • 9- Prior counteraction • Prior action • Moving to a new dimension • Convert harm in to benefits • Changing the colour.
Mario Picariello	For fast responses to a problem, it is ideal but may lack personality. Good for a non-designer to design something aesthetically pleasing.	Giving the designer options, takes away their creative thinking and knowledge and puts it in the computer system.	This will help by be able to isolate certain graphic e.g. the text from the background colour, instead of the whole image/ graphic changing- this is very important.	<p>It is very innovative when it comes to the thinking and technical side of the design.</p> <p>But the way program looks; its navigation system could be improved.</p>	<p>The idea of selecting the best out of 9 images works so keep the separate layers as this is key to making each design individual.</p> <p>The option to change just the colour of the</p>	<ul style="list-style-type: none"> • 13-Inversion • 23-Feedback • 32-Change the colour • 33-Homogeneity • 34-Rejecting & regenerating • 40-Composite materials

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					<p>whole image doesn't work and look very immature, instead each layers colour needs to be carefully considered.</p> <p>The feature to be able to move layers freely where you wish to make adjustments will give the designer more freedom. Also, may be a use of a grid to design to (like InDesign).</p> <p>The menu that gets loft on the right needs to be much more vocal.</p>	
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AEGISQ4-Part B Questionnaire Data.

Name	Have you any other comments/ ideas etc which may help in this development?	Ho would you rate the sample outputs shown to you will you rate as 'useful' for Graphic Designers?			Using the scale of 1-5 what will you rate this tool as in terms of helping the Graphic Designers to make better packaging designs? (1= best/innovative, 5= worst),	How much will you rate the layering concept as a contribution to the innovative capability of this tool on a scale of 1 to 5 (1=most, 5= least)	Would you recommend this tool to Graphic Designers (with or without slight modifications and fine tuning)	
		<10%	10-50 %	50-60%			Yes	No.
		60-90%		>90%			Yes but in combination with other tools	Needs further improvement
							Cannot Say	
Jake Jennings	<p>Present thoughts are that it is similar to variant galleries on CS programs. I feel it is almost edging in a design for everyday consumer, taking creativity out of the equation of design.</p> <p>However, it will speed the whole design process up which when time=money and everyone demanding on faster production, it does have a use.</p> <p>However, it needs to encompass all areas of design choices.</p> <p>It would be hard to shake peoples' confidence + user loyalty in programs such as Photoshop. Could this be developed as a plugin application as an extension to existing workflow, I</p>	50-60 %			3 (50%)	2 (75%)	<p>Yes but in combination with other tools.</p> <p>Yes but needs further improvement.</p>	

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	see more if a use through this.				
Richard Gray		50-60%	2 (75%)	2 (75%)	Yes but needs further improvement.
Mario Picariello	You have to be careful you are not taking the graphic designers job and replacing it with a computer. This tool would be best used to enhance the designer skillset by making the process easier and quicker but not less creative.	10-50%	3 (50%)	2 (75%)	Yes but needs further improvement.

AEGISQ4-Part C Questionnaire Data.

Name	On a scale of 0-100%, has TRIZ potential to develop this tool??			Using the scale of 1-5, is AEGIS coming up with images which you might not expect and are exciting. (1= mostly, 5= none)	Is AEGIS coming up with images which you would not have easily achieved using already existing tools. If yes, then what percentage? (1=mostly, 5= none)	Amongst the TRIZ Principles shown to you, how many TRIZ Principles would you recommend as useful;/ applicable to this tool at some point of implementation and design?
	<10%	10-50 %	50-60% 60-90%			
Jake Jennings				3 (50%)	3 (50%)	20-30 %
Richard Gray			>90%	4 (25%)	4 (25%)	10-20 %
Mario Picariello			60-90%	5 (0%)	4 (25%)	10-20%

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AEGIST5/01 Attachment – Meeting with Thomas Weekenders.

Possibility of Intelligent Learner/ Experimental Mode of working in AEGIS

Meeting with Thomas Wennekers.

Brief description:-

AEGIS is designed to be a CAI based tool to help graphic designers innovate. It takes images as input layers and combines them with a typographic font. All the layers (font layers, background image layer and logo layer) can be mutated. The mutation algorithms are guided by TRIZ Principles. The output is a set of user preferred images.

Problem Specification:-

Following issues will need to be addressed in the upcoming version of AEGIS.

If the user likes certain sets of images while operating the AEGIS and the user wants the software to “remember” the preferences and trends of operations for the subsequent use.

For implementing this, AEGIS will need to have two modes of operations (experimental/learner and advanced mode). The data/ information collected by AEGIS in “learner” mode should be used by AEGIS as a “guide” to mutations in “advanced” mode.

Background reading/ work done by other researchers:-

1. Learning Algorithms for Human-Machine Interfaces [6].
2. Applying digital evolution to the design of self-adaptive software [2].
3. A controller synthesis algorithm for building self-adaptive software. Information and Software Technology [3].
4. A computer language that supports general formal expression with evolving data structures [4].

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5. A genetic algorithm as the learning procedure for neural networks [1].
6. Retrieval of movie scenes by semantic matrix and automatic feature weight update [5]

Note for discussion:

Key here (for the meeting) is how can we get AEGIS to learn which images the user likes (i.e., train AEGIS) and secondly how do we implement an 'expert' mode where AEGIS mutates the images automatically under e.g., the control of a GA?

In reference to this we have seen papers e.g., ref 1 where a genetic algorithm has been used as learning procedure for neural networks. In this case, reverse engineering approach has been followed. The genetic algorithms have been used as a learning algorithm for neural networks. The neural networks are iteratively improvised using genetic algorithms. (Normally, the neural networks are genetically cross fertilized in an attempt to improve the neural networks, but this has been an attempt to implement the scenario in opposite direction).

In example 6 (ref6), the HMI mapping is iteratively improved where the software learns during each iteration of user action. The meantime error is constantly reduced by constantly screening the user actions during each session of user input. In this case, the end point errors were removed by implementing four data sets. The data manipulation has been implemented using matrixes in this case study.

In yet another example (ref 4), a computer language has been developed to support better presentation of objects and data for evolving data structures (evolutionary computation). This language is called as GENETICA. In this language, the regularly used criterion in genetic algorithms can be easily implemented (such as selection, breeding, termination, etc).

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Some other case studies are also considered as important for this research e.g., “A controller synthesis algorithm for building self-adaptive software” and “Retrieval of movie scenes by semantic matrix and automatic feature weight update”.

Considering the data manipulation and binding requirements of the proposed feature and to facilitate this learning feature, the following has been implemented: an XML data logger which captures user key strokes and images. This module catches the clicks, images, user actions, key inputs and other aspects of Human Machine Interfaces.

There are two approaches to tracking the image offspring generated during the learner mode of AEGIS. One approach is to store the images produced during each iteration. Second approach is to store the image data or mutation algorithm parameters in a database/ XML.

Today's discussion mainly focuses on the possible approach and suitable algorithm groups which will be suitable for the new feature in AEGIS.

References:-

1. Gonzalez-Seco, J. (1992, 7-11 Jun 1992). *A genetic algorithm as the learning procedure for neural networks*. Paper presented at the Neural Networks, 1992. IJCNN., International Joint Conference on.
2. Beckmann, B. E., Grabowski, L. M., McKinley, P. K., & Ofria, C. (2009, March 3 2009-April 2 2009). *Applying digital evolution to the design of self-adaptive software*. Paper presented at the Artificial Life, 2009. ALife '09. IEEE Symposium on.
3. Tzialis, G., & Theodoulidis, B. (2004). A controller synthesis algorithm for building self-adaptive software. *Information and Software Technology*, 46(11), 719-727.
4. Virirakis, L. (2003). GENETICA: A computer language that supports general formal expression with evolving data structures. *Evolutionary Computation, IEEE Transactions on*, 7(5), 456-481.
5. Yoo, H.-W. (2008). Retrieval of movie scenes by semantic matrix and automatic feature weight update. *Expert Systems with Applications*, 34(4), 2382-2395.
6. Danziger, Z., Fishbach, A., & Mussa-Ivaldi, F. A. (2009). Learning Algorithms for Human-Machine Interfaces. *Biomedical Engineering, IEEE Transactions on*, 56(5), 1502-1511.

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Notes in meeting:

A. Discussions

1. A long and detailed discussion was initiated by the participants of this meeting. The project was described by researcher and TRIZ awareness was created in the meeting.
2. The inputs, outputs and processing units of current AEGIS version were discussed in detail and the iterations were considered as an important factor for determining the method of data mining, data collection and data reproduction during the proposed two modes of AEGIS.
3. The bitmaps in AEGIS are more or less already represented by objects at the current stage. Each object has its attributes. The objects and attributes in each iteration (state of each iteration) need to be stored in the data store during “learning phase” and retrieved in the “advanced phase”.

B. Possibility of implementation of some algorithms/ methods

Two types of implementations have been

1. Trees and Statistical Analysis

- a. To represent all iterations in a tree structure. The iterations will be stored in subsequent level nodes along with the attributes (each object can act as a node with particular attributes).
- b. To traverse the iterations in advanced mode, particular traversal algorithm will be followed.
- c. The nodes can either represent the object data directly or point towards the image data and other data or it can represent the object and algorithms used (example Gaussian) parameters.
- d. For advanced mode operation of AEGIS, the parameters from nodes can be retrieved and special algorithms (which we can call as replay algorithms) can be used to replay the scenario and reproduce the sets of images using the parameters retrieved from nodes.
- e. Before finalizing the above method and before deciding whether to opt for this or not, a mini experiment has to be followed.
- f. The mini experiment consists of steps a through c. After step c, a series of statistical analysis has to be followed. If the statistical analysis yields predictable results then it is recommended to continue with this methodology, otherwise methodology 2 has to be followed.
- g. The method 1 can be supported by the existing XML framework being implemented in AEGIS.

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2. Neural Networks

- a. If method 1 fails, then a neural network has to be implemented to cover the unpredictable statistical behaviour of users and software.
- b. “Support vector machines” or “back propagation” neural network types are being recommended suitable for this project.
- c. Training patterns and other functions have to be implemented through neural networks.

Conclusion

The conclusion of this meeting has been categorized in to different actions to be taken as below.

1. Modify the XML schema and XML implementation to cover the objects and attributes along with the mutation algorithm information taking place in each iteration.
2. Using full support of XML framework, the tree structure has to be implemented. The statistical analysis has to be carried out after this step. After these steps are followed, as decision can be taken whether to switch over to original neural networks or not.
3. Neural networks, HMI, and genetic algorithm literature review should be considered in simultaneously.

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AEGISQ6-Part A/B Questionnaire Data.

Participant	Please compare AEGIS with the tools currently being used by you group (e.g. Photoshop). What do you like and what do you dislike?	Please comment on the layering system used by AEGIS. Does this software need more layering functionalities, if so what and why?	Considering layering, typography, mutations and algorithms, which of the area do you think needs further work and why (suggestions and comments appreciated).	Compared to the tools you use presently, would you consider AEGIS gives useful outputs faster? (yes/no /not sure) Why do you think this is?	What percent of the sample outputs shown to you would rate as ‘useful’ for Graphic Designers?		Which of the sub-tools in AEGIS do you consider innovative as compared to other tools you use, on a scale of 1 to 5 (1=most innovative, 5= least innovative) <table><tr><td colspan="2">Typography</td></tr><tr><td colspan="2">Merging of layers</td></tr><tr><td colspan="2">Iterations</td></tr><tr><td colspan="2">Layering</td></tr><tr><td colspan="2">Mutations/Algorithms</td></tr></table>	Typography		Merging of layers		Iterations		Layering		Mutations/Algorithms		
					Typography													
					Merging of layers													
					Iterations													
					Layering													
Mutations/Algorithms																		
Less than 10%	Less than quarter																	
Between quarter and a half	Between half and three quarters																	
Over three quarters but less than 90%	Greater than 90%																	
AEGISQ6#1	Like: could be quite useful as a starter tool for initial designs. Dislike: it doesn’t seem usually innovative. Lose personal touch as you are using existing typefaces. May be better used for 3D prototype.	You need to design the layers elsewhere you can only edit them using the software, so you don’t really need more layers.	Because there isn’t much choice for where each layer is placed this could be developed more. More choice of mutation.	It gives examples quicker but doesn’t give as successful final output as the tools used presently.	50-75% <table><tr><td colspan="2">% age</td></tr><tr><td>Typography</td><td>0</td></tr><tr><td>Merging of layers</td><td>25</td></tr><tr><td>Iterations</td><td>100</td></tr><tr><td>Layering</td><td>75</td></tr><tr><td>Mutations/Algorithms</td><td>50</td></tr></table>		% age		Typography	0	Merging of layers	25	Iterations	100	Layering	75	Mutations/Algorithms	50
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Merging of layers	25																	
Iterations	100																	
Layering	75																	
Mutations/Algorithms	50																	
AEGISQ6#2	Like: would be used as a starter tool to younger designers who have not used Photoshop. Able to see multiple outcomes on one screen. Dislike: no personal	More layering options would be good, in Photoshop you are able to change layer effects, e.g. multiplier and lighting.	Areas which make typography stand out need work.	Yes, for initial stages of design. It gives examples of combinations quicker. However when it comes to more developed design it could become more	25-50% <table><tr><td>Typography</td><td></td></tr><tr><td>Merging of layers</td><td></td></tr><tr><td>Iterations</td><td></td></tr><tr><td>Layering</td><td></td></tr><tr><td>Mutations/Algorithms</td><td></td></tr></table>		Typography		Merging of layers		Iterations		Layering		Mutations/Algorithms			
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Iterations																		
Layering																		
Mutations/Algorithms																		

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	touches to work as they are computer generated.			time consuming.												
AEGISQ6#3	<p>It is very east to create visuals without having any knowledge of creativity in terms of design. However, I would argue this is not necessarily a good thing. In my mind this tool would actively downgrade people’s perception of graphic design as an occupation that requires vast amounts of creativity. Not everyone can do graphic design.</p> <p>Typography tool is severely basic as is the layout of the program.</p>	<p>I did not fully understand how the layering system worked as it was so far removed from the current layering system used by Adobe.</p> <p>I am therefor unable to give an informed answer to this question.</p>	<p>Typography first and foremost- there is far much more to designing and arranging type on a document than this program provides.</p>	<p>No.</p> <p>This program effectively negates the needs for a human being to design something as the designs are produced on a mechanical basis and are selected purely due to preference.</p> <p>I am not obliged to answer this.</p>	50-75%	<table><tr><td>Typography</td><td>0</td></tr><tr><td>Merging of layers</td><td>0</td></tr><tr><td>Iterations</td><td>0</td></tr><tr><td>Layering</td><td>0</td></tr><tr><td>Mutations/Algorithms</td><td>0</td></tr></table>	Typography	0	Merging of layers	0	Iterations	0	Layering	0	Mutations/Algorithms	0
Typography	0															
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Iterations	0															
Layering	0															
Mutations/Algorithms	0															
AEGISQ6#4	<p>AEGIS has a very different approach to graphic design in my opinion- it is clever in a sense by the way it almost replaces the need for an actual designer using it- anyone could create an interesting visual without having a design background. Photoshop for</p>	<p>To be used by designers successfully I think the layering system would have to be more versatile- meaning you could change small aspects of the final ourcome e.g. position, size.</p>	<p>Typography- Size, positioning</p>	<p>Yes.</p> <p>Has the potential to produce a fast outcome but may not be used as a first option if designers have the time to produce the outcome using original programmers.</p>	25-50%	<table><tr><td>Typography</td><td>0</td></tr><tr><td>Merging of layers</td><td>25</td></tr><tr><td>Iterations</td><td>100</td></tr><tr><td>Layering</td><td>50</td></tr><tr><td>Mutations/Algorithms</td><td>75</td></tr></table>	Typography	0	Merging of layers	25	Iterations	100	Layering	50	Mutations/Algorithms	75
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Merging of layers	25															
Iterations	100															
Layering	50															
Mutations/Algorithms	75															

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	example gives more scope for the designer and AEGIS would be something that could work very well alongside a program like Photoshop.															
AEGISQ6#5	This software seems useful as a tool for graphic designers starting out, but the current available software is a lot more developed. However, the simplicity of AEGIS might be useful.	It is important to have the option infinite layers, and not be constricted to only a few layers. So this may need to be developed.	The typography section might benefit from work, as line spacing etc. options are important. Unless this program would just act as a pre software to Photoshop & other programs where you could finish editing text.	<p>Not sure.</p> <p>It might show a variety of options simultaneously faster than current programs.</p> <p>With Photoshop you don't get given options to choose from you have to know what you are aiming for.</p>	25-50%	<table><tr><td>Typography</td><td>0</td></tr><tr><td>Merging of layers</td><td>25</td></tr><tr><td>Iterations</td><td>75</td></tr><tr><td>Layering</td><td>4</td></tr><tr><td>Mutations/Algorithms</td><td>75</td></tr></table>	Typography	0	Merging of layers	25	Iterations	75	Layering	4	Mutations/Algorithms	75
Typography	0															
Merging of layers	25															
Iterations	75															
Layering	4															
Mutations/Algorithms	75															

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AEGISQ7-Part C1 Questionnaire Data.

Partici-pant	Considering the TRIZ Principles, please select the ones which you think are relevant to this project																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	Segmentation	Taking out	Local quality	Asymmetry	Merging	Universality	Nested doll	Anti-weight	Preliminary anti-action	Preliminary action	Beforehand cushioning	Equipotentiality	The other way round	Curvature	Dynamics	Partial or excessive actions	Another dimension	Mechanical vibration	Periodic action	Continuity of useful action
AEGISQ6#1	1	1	0	0	1	0	0	0	0	1	0	0	0	1	0	0	1	0	0	0
AEGISQ6#2	1	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
AEGISQ6#3	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AEGISQ6#4	1	1	0	0	1	0	0	1	0	1	1	0	0	0	1	0	1	0	0	0
AEGISQ6#5	1	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0

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AEGISQ7-Part C2 Questionnaire Data.

Partici-pant	Considering the TRIZ Principles, please select the ones which you think are relevant to this project																			
	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
	Skipping	Blessing in disguise	Feedback	Intermediary	Self-service	Copying	Cheap short living objects	Substitution	Hydraulics	Flexible shells	Porous materials	Colour changes	Homogeneity	Discarding and recovering	Parameter changes	Phase transitions	Thermal expansion	Strong oxidants	Inert atmosphere	Composite materials
AEGISQ7#1	0	0	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
AEGISQ6#2	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
AEGISQ6#3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AEGISQ6#4	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AEGISQ6#5	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0

AEGISP7/01 Attachment.**Possibility of Intelligent Learner/ Experimental Mode of working in AEGIS****Meeting with Dr. Phil Culverhouse.****Brief description:-**

AEGIS is being designed to be a CAI based tool to help graphic designers innovate. It takes images as input layers and combines them with a typographic font which is mutated. The mutations in the layers and font are guided by TRIZ Principles. Output is a set of user preferred images.

Problem Specification:-

Following issues will need to be addressed in the upcoming version of AEGIS.

1. If the user likes certain sets of images while operating the AEGIS and does want the AEGIS to remember those. For this, the AEGIS has image save feature.
2. If the user wants to work on AEGIS in an “experimental/learner” mode and likes certain sets of images, and wants the AEGIS to run in “advanced” mode next time, where the AEGIS is guided and seeded by the data collected in the experimental mode.

Background reading/ work done by other researchers:-

Case Study1: A genetic algorithm (GA) is a search heuristic that mimics the process of natural evolution. This heuristic is routinely used to generate useful solutions to optimization and search problems. Genetic algorithms belong to the larger class of evolutionary algorithms (EA), which generate solutions to optimization problems using techniques inspired by natural evolution, such as inheritance, mutation, selection, and crossover.

The essential steps involved are:

- Initialization
- Selection

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- Reproduction
- Termination

The termination stage is reached, if one of the following is achieved :

- A solution is found that satisfies minimum criteria
- Fixed number of generations reached
- Allocated budget (computation time/money) reached
- The highest ranking solution's fitness is reaching or has reached a plateau such that successive iterations no longer produce better results
- Manual inspection
- Combinations of the above

Case Study 2: RAPID Research on Automated Plankton Identification

The important aspect of this case study is the imaging systems used to identify the zooplanktons. Some of the key factors studied under this case study, which may be related to AEGIS in future are:-

1. Direct digitization
2. Advanced scanner technology
3. Solving resolution problems
4. Classification and other functions performed by the software.

Note for discussion:

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As far as AEGIS is concerned, two types of coding can be done to achieve the learning feature:-

1. Data oriented
2. Image oriented

References:-

7. Fraser, Alex (1957). "Simulation of genetic systems by automatic digital computers. I. Introduction". *Aust. J. Biol. Sci.* **10**: 484–491.
8. **RAPID Research on Automated Plankton Identification**- Dr Phil Culverhouse.

Notes in meeting:

Following points were discussed with Dr Phil Culverhouse during the meeting.

- A. Actions to be taken
 1. Need to put more comments in the code.
 2. Structured diagram/ UML/UML2 to be made for the AEGIS.
 3. To make a system to collect statistical information while the users are using the software
 - a. Interactions
 - b. History trace of their interactions
 - c. Frequency of usage
 - d. Different techniques followed
 - e. Trends over time followed

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- f. User of the software information
 - g. Automatically save interactions as a log file (at the end of the week).
4. This will be a mini experiment with a few users with the following steps
 - a. Log the interactions (3 above)
 - b. Analyse interactions (data analysis)
 - c. Report “a” and “b”.
5. After this experiment subsequent steps can be taken.
6. Before proceeding to step 3 through 6, the TRIZ implementation in AEGIS should be strengthened with more TRIZ Principles or to be defined clearly the application of TRIZ Principles to the AEGIS.

Technical discussions held about the AEGIS design and moderation.

Two types of iterative designs for a software can be followed

1. Breadth first search
2. Depth first search

The approach 1 is more practical for research projects.

User perspective

AEGIS	EU	NU
ED	EUI	Guided UI
ND	Guided Design Space	Guided UI with guided DS

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US= User interface DS= Design space

AEGISQ9-Part A Questionnaire Data.

Participant	Q1. Please list the basic graphic design forms (elements, building blocks) you are aware of (e.g., what are the basic building blocks/ components of graphic communication design).	Q2. Referring to the question 1 above, please mention any software package (and other non-digital tools) and the relevant tools in that software or tool which help you implement these graphic design forms (building blocks/elements).	Q3. Considering the AEGIS software, where (in which sub-tool and in which process) do you recommend implementing these graphic design elements (as mentioned in your answer for Q1 and Q2)? In your comments, please indicate if you think these are already implemented in AEGIS.
AEGISQ9#1	<ul style="list-style-type: none"> • Colour • Form • Context • Type/letters-text • Image-graphic/ drawn photographic • Static moving/ interactive 	<ul style="list-style-type: none"> • Photoshop • Illustrator • InDesign • Pencil • Paper • Pencil <p>Photoshop (size, position, colour, shape, distortion, interface, format, layer tools).</p>	<p>Typography- Type tool selection Font Atomic section-Layers- distortion Background/ Extra layers Mutation Process-distortion pallette</p>
AEGISQ9#2	<ul style="list-style-type: none"> • Colour • Size • Typography • Positioning • Image and text relationships • Shapes • Is it interesting • Finished format print • Web/animation • File-types • Styled effects • Message 	<p>Adobe-colour picker- lets you hover above anything Adobe Typo window-choice of point size, bold/light, tracking etc</p> <p>Adobe illustrator- positioning any object or segment of an object can be dragged around and moved</p>	<p>Typography- should have its own window for point size and editing etc Font layers- useful to be able to see the different mutations/ shapes side by side. Background- layers- needs to be able to add more than one logo and extras Mutation process- not sure if every letter needs it own layer but sometimes yes Shapes- a separate window/ process is needed for a shape tool Colours- this needs ot have its own section where you can choose your colour etc.</p>

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	<ul style="list-style-type: none"> Aesthetics 		
AEGISQ9#3	<ul style="list-style-type: none"> Typeface Colour Size Shape Information needed to be included Positioning Printing documents Layout Saving types of file e.g.pdf 	<ul style="list-style-type: none"> Adobe Package Pen Pencil Colour picker Shape-tool Selection tool Eraser Typeface selection Ruler Grids Paper sized documents Saving document section Typeface-font choice (b/I U) 	<p>Typography- should sit on its own, it is used regularly</p> <p>Font- should have bold italic etc options</p> <p>Background etc layers- should be linked to colour choice</p> <p>Mutation process- should be linked to type face etc and should have >5 layers</p> <p>Colour- being able to change the tones of colour.</p> <p>Shapes- shape tool needed.</p>

AEGISQ9-Part B Questionnaire Data.

Considering the non-digital tools and software you are using at present, please compare the present application of these elements (as per your answer for Q1 and Q2) in AEGIS? (Comparison can be on the basis of speed of implementation, presence and absence of these elements, method of application of these forms, convenience and user friendliness of implementation of these forms, etc.					Please list the graphic design characteristics which you implement and define in graphic design practices (e.g. tone, colour, shape).	Among the list of characteristics which you listed above in your answer for Q4, please shortlist the characteristics which you recommend in being implemented though a computer aided innovation tool. Please list the characteristics which according to your observation are already implemented in AEGIS.
Application Tool	GD Element	List of Criteria	Comments	Rating (1-5) 5=best	<ul style="list-style-type: none"> • Colour • Shape • position • context • sequence • tone 	Shape/distortion- well implemented in AEGIS Colour combinations- implemented by AEGIS to a satisfactory level.
AEGIS	Text	Size/position/ layout	Poor/ slow to operate	1		
AEGIS	Text	Shape/colour distortion speed	Unforeseen possibilities , rapid generation	4		
AEGIS	Image	Shape / distortion	Variable of shape distortion is rather limited	2		
	Image	Color	Good range of variants	4		
	Image	Speed	Good	4		
Photoshop	Text	Shape/colour distortion	Good	2		

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		Speed and complexity of variables		2		
AEGIS	Size, measurement	No way of measuring as object that has been placed.			<ul style="list-style-type: none">• Applying colour• Ability to move objects around• Typography detailing• Measuring system- rules	AEGIS has: <ul style="list-style-type: none">• Font choice• Font colour• Font size• Easy to import files
Adobe	Colour	User friendly speed	Easy to pick a colour			AEGIS needs: <ul style="list-style-type: none">• Font detailing• Colour picker with codes for itermis• Rulers for measuring
AEGIS	Typography	Almost presence	Need editing			
AEGIS	Shapes tool	Not present	Would be necessary			
AEGIS	File saving	Export as	Need to be able to export as different file type			
Adobe	Typography	Present	Full editing options			
AEGIS		Speed	Fast and quick		<ul style="list-style-type: none">• Designing onto different shapes• Creating different shapes in a design document• Using more than one typeface in a design• Using layers	
		Appearance	Grey colours are used more			
Adobe		Speed	Sometimes slow			
AEGIS	Mutation		Seems to adapt quickly and responses well to user.			
AEGIS		Presence	Not a complicated interface, simple layout and design.			
AEGIS	Typography		Wide selection of type good for graphic designer			
AEGIS	Colour	Present	Choices of colour if only a few to choose from.			
Adobe/AEGIS	Shapes		Can create shapes in Adobe not in AEGIS			

AEGISQ9-Part C Questionnaire Data.

S.No	Name	Relevant / Not Relevant (tick/ cross) Y/N	Corresponding Graphic Design Elements (please make a sketch or point to relevant tool in your industry to help us with relevant examples).
1.	Segmentation	<ul style="list-style-type: none"> • 1 • 1 • 1 	<ul style="list-style-type: none"> • Project Stages, • Different Skills, responsibilities • Ungrouping an object • Ungrouping
2.	Taking out	<ul style="list-style-type: none"> • 1 • 1 • 1 	<ul style="list-style-type: none"> • Edit / crop image • Lines of shapes removed from an object • Cut out a shape • Reverse out
3.	Local quality	<ul style="list-style-type: none"> • 1 • 0 	<ul style="list-style-type: none"> • Lateral thinking
4.	Asymmetry	<ul style="list-style-type: none"> • 1 • 1 	<ul style="list-style-type: none"> • Composition or layout • The ability to rotate
5.	Merging	<ul style="list-style-type: none"> • 1 • 1 • 1 	<ul style="list-style-type: none"> • Merging • Groups of items and objects can be merged • Reflecting / 3D effects
6.	Universality	<ul style="list-style-type: none"> • 1 	<ul style="list-style-type: none"> • Lateral thinking • Universal file type save
7.	Nested Doll	<ul style="list-style-type: none"> • 1 • 1 	<ul style="list-style-type: none"> • Placing an object • Insert/ invert / merge

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S.No	Name	Relevant / Not Relevant (tick/ cross) Y/N	Corresponding Graphic Design Elements (please make a sketch or point to relevant tool in your industry to help us with relevant examples).
8.	Anti-Weight	<ul style="list-style-type: none"> • 1 • 1 	<ul style="list-style-type: none"> • Emboss or level to appear 3D. • 3D effect
9.	Preliminary Anti-Action	<ul style="list-style-type: none"> • 0 	<ul style="list-style-type: none"> • Masked
10.	Preliminary Action	<ul style="list-style-type: none"> • 	<ul style="list-style-type: none"> • Initial layout
11.	Before hand cushioning	<ul style="list-style-type: none"> • 	<ul style="list-style-type: none"> •
12.	Equipotentiality	<ul style="list-style-type: none"> • 1 	<ul style="list-style-type: none"> • Lateral thinking
13.	The other way round	<ul style="list-style-type: none"> • 1 • 1 	<ul style="list-style-type: none"> • Flip objects opposite way • Inverting a shape into colour for example white logo out of black screen
14.	Curvature	<ul style="list-style-type: none"> • 1 • 1 	<ul style="list-style-type: none"> • Experimentation • Warp shapes and text to apply curves. • Using the white arrow in Adobe to change the shape something curved etc
15.	Dynamics	<ul style="list-style-type: none"> • 1 	<ul style="list-style-type: none"> • User characteristics to be remembers for future use.
16.	Partial or excessive Actions	<ul style="list-style-type: none"> • 	<ul style="list-style-type: none"> •
17.	Another dimension	<ul style="list-style-type: none"> • 1 • 1 • 1 	<ul style="list-style-type: none"> • Lateral thinking • Make an object/ shape 3D. • Changing or rotating something
18.	Mechanical vibration	<ul style="list-style-type: none"> • 	<ul style="list-style-type: none"> •
19.	Periodic action	<ul style="list-style-type: none"> • 1 	<ul style="list-style-type: none"> • Sequence layout
20.	Continuity of useful action	<ul style="list-style-type: none"> • 1 • 1 	<ul style="list-style-type: none"> • Have multiple windows open at the same time • Choosing typeface/ colour/ saving / printing

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S.No	Name	Relevant / Not Relevant (tick/ cross) Y/N	Corresponding Graphic Design Elements (please make a sketch or point to relevant tool in your industry to help us with relevant examples).
21.	Skipping	•	•
22.	Blessing in disguise	• 1 • 1 • 1	• Experimentation • Put noise or distortion filter on an image • Image noise
23.	Feedback	•	• Discussion
24.	Intermediary	•	•
25.	Self-service	•	•
26.	Copying	• 1 • 1	• Duplicate objects • Duplicate text shape etc
27.	Cheap shortliving objects	• 0	•
28.	Substitution	•	•
29.	Hydraulics	•	•
30.	Flexible shells	•	•
31.	Porous materials	• 1 • 1	• Change the opacity of an item. • Opacity making something solid or see through
32.	Colour changes	• 1 • 1 • 1	• Change colour mode (RGB, CMKY etc) • Tonal colours • Making image black/white etc (RGB, CMRY etc)
33.	Homogeneity		•
34.	Discarding and recovering	•	•

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S.No	Name	Relevant / Not Relevant (tick/ cross) Y/N	Corresponding Graphic Design Elements (please make a sketch or point to relevant tool in your industry to help us with relevant examples).
35.	Parameter changes	<ul style="list-style-type: none"> • 1 • 1 	<ul style="list-style-type: none"> • Alter the shape of an object- drag edges in an out. • Shape of object (curves/ straight/ edges/ both etc)
36.	Phase transitions	<ul style="list-style-type: none"> • 	<ul style="list-style-type: none"> •
37.	Thermal expansion		<ul style="list-style-type: none"> •
38.	Strong oxidants	<ul style="list-style-type: none"> • 	<ul style="list-style-type: none"> •
39.	Inert atmosphere	<ul style="list-style-type: none"> • 	<ul style="list-style-type: none"> •
40.	Composite materials	<ul style="list-style-type: none"> • 1 	<ul style="list-style-type: none"> • Different textures.

AEGISP10/01 Questionnaire Data.

In the meeting with Angelo, TRIZ application to GD was discussed in which expert advice was taken for applying TRIZ through GA's to GD.

It was recommended that TRIZ effects be applied to images in the form of functions/ methods as chromosomes and each gene in a chromosome represented as parameter for each function. Decisions were taken considering the existing framework and supporting functionality of AEGIS plus the requirements of whole project.

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AEGISQ11-Part A Questionnaire Data (Participants).

Qualification	Gender	Qualification Level	Expertise in	Expertise Level (0-5)	Research Experience (0-5)	GD Experience (0-5)
AEGIS000W0003	Female	UG	Graphic Design	3	2	3
AEGIS000W0004	Male	UG	Graphic Design	3	2	4
AEGIS000W0005	Female	UG	Graphic Design	3	3	3
AEGIS000W0006	Female	UG	Graphic Design	3	3	3
AEGIS000W0007	Male	UG	Graphic Design	2	1	2
AEGIS000W0008	Male	UG	Graphic Design	2	0	2
AEGIS000W0009	Male	UG	Graphic Design	3	3	3
AEGIS000W0010	Male	Doctorate	Business Administration	5	4	1
AEGIS003W0001	Male	PG	Computer Science	0	0	1
AEGIS003W0002	Male	PG	Computer Science	1	1	1
AEGIS003W0003	Male	PG	Computer Science	0	0	1
AEGIS003W0004	Female	PG	Computer Science	0	0	0
AEGIS003W0005	Male	PG	Computer Science	0	0	1
AEGIS003W0006	Male	PG	Computer Science	3	0	1
AEGIS003W0007	Female	PG	Computer Science	0	0	0
AEGIS003W0008	Male	PG	Computer Science	5	0	1
AEGIS003W0009	Male	PG	Computer Science	3	0	1
AEGIS003W0010	Female	PG	Computer Science	0	0	0
AEGIS003W0011	Male	PG	Computer Science	0	0	1
AEGIS003W0012	Male	PG	Computer Science	2	0	1
AEGIS003W0013	Female	PG	Computer Science	0	0	0
AEGIS003W0014	Male	PG	Computer Science	0	1	1
AEGIS003W0015	Female	PG	Computer Science	0	0	0
AEGIS003W0016	Female	PG	Computer Science	0	0	0
AEGIS003W0017	Female	PG	Computer Science	0	0	0

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Qualification	Gender	Qualification Level	Expertise in	Expertise Level (0-5)	Research Experience (0-5)	GD Experience (0-5)
AEGIS003W0018	Male	PG	Computer Science	2	0	1
AEGIS003W0019	Male	PG	Computer Science	2	0	0
AEGIS003W0020	Male	PG	Computer Science	2	0	0
AEGIS003W0021	Male	PG	Computer Science	0	0	0
AEGIS003W0022	Male	PG	Graphic Design	2	0	1
AEGIS003W0023	Male	PG	Computer Science	3	0	2
AEGIS003W0024	Male	PG	Computer Science	2	0	2
AEGIS003W0025	Male	PG	Computer Science	2	0	0
AEGIS003W0026	Female	PG	Computer Science	0	0	0
AEGIS003W0027	Female	PG	Computer Science	2	0	0
AEGIS003W0028	Female	PG	Computer Science	2	0	0
AEGIS003W0029	Female	PG	Computer Science	2	0	0
AEGIS003W0030	Female	PG	Computer Science	2	0	0
AEGIS003W0031	Female	PG	Computer Science	0	0	0
AEGIS003W0032	Female	PG	Computer Science	2	0	0
AEGIS003W0033	Male	PG	Computer Science	3	0	0
AEGIS003W0034	Female	PG	Computer Science	0	0	0
AEGIS003W0035	Female	PG	Computer Science	0	0	0
AEGIS003W0036	Male	PG	Computer Science	0	0	0
AEGIS003W0037	Female	PG	Computer Science	3	0	0
AEGIS003W0038	Female	PG	Computer Science	0	0	0
AEGIS003W0039	Female	PG	Computer Science	1	0	0
AEGIS003W0040	Male	PG	Computer	1	0	0

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Qualification	Gender	Qualification Level	Expertise in	Expertise Level (0-5)	Research Experience (0-5)	GD Experience (0-5)
			Science			
AEGIS003W0041	Female	PG	Computer Science	1	0	0
AEGIS003W0042	Female	PG	Computer Science	1	0	0
AEGIS003W0043	Female	PG	Computer Science	1	0	0
AEGIS003W0044	Female	PG	Computer Science	1	0	0
AEGIS003W0045	Female	PG	Computer Science	0	0	0
AEGIS003W0046	Female	PG	Computer Science	3	0	0
AEGIS003W0047	Male	PG	Computer Science	3	0	3
AEGIS003W0048	Male	PG	Computer Science	3	0	0
AEGIS003W0049	Female	PG	Computer Science	1	0	0
AEGIS003W0050	Female	PG	Computer Science	0	0	0
AEGIS003W0051	Male	PG	Computer Science	0	0	1
AEGIS003W0052	Male	PG	Computer Science	2	0	3
AEGIS003W0053	Male	PG	Computer Science	3	0	4
AEGIS003W0054	Male	PG	Computer Science	0	0	0
AEGIS003W0055	Male	PG	Computer Science	0	0	0
AEGIS003W0056	Male	PG	Computer Science	2	0	0
AEGIS003W0057	Male	PG	Computer Science	2	1	1
AEGIS003W0058	Male	PG	Computer Science	0	0	0
AEGIS003W0059	Male	PG	IT	0	0	0
AEGIS003W0060	Male	PG	Computer Science	0	0	0
AEGIS003W0061	Male	PG	Computer Science	0	0	0
AEGIS003W0062	Male	PG	Computer Science	0	0	0

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Qualification	Gender	Qualification Level	Expertise in	Expertise Level (0-5)	Research Experience (0-5)	GD Experience (0-5)
AEGIS003W0063	Male	PG	Computer Science	0	0	0
AEGIS003W0064	Male	PG	Computer Science	0	0	0
AEGIS003W0065	Male	PG	Computer Science	0	0	0
AEGIS003W0066	Male	PG	Computer Science	1	0	0
AEGIS003W0067	Male	PG	Computer Science	2	0	2
AEGIS003W0068	Male	PG	Computer Science	2	0	3
AEGIS003W0069	Male	PG	Computer Science	0	1	0
AEGIS003W0070	Male	PG	Computer Science	3	0	3
AEGIS003W0071	Male	PG	Computer Science	0	0	0
AEGIS003W0072	Male	PG	Computer Science	0	0	0
AEGIS003W0073	Male	PG	Computer Science	0	0	0
AEGIS004W0001	1	PG	Business Administration	5	2	4
AEGIS011W0001	Male	UG	IT	2	1	1
AEGIS011W0002	Female	PG	IT	1	0	1
AEGIS011W0003	Female	UG	IT	3	0	1
AEGIS011W0004	Male	UG	Business Administration	3	0	1
AEGIS013W0001	Female	PG	Other	5	5	1
AEGIS014W0001	Female	PG	Computer Science	2	2	2
AEGIS015W0001	Male	UG	Business Administration	3	3	3
AEGIS000W0011	Male	UG	Computer Science	5	2	2

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AEGISQ11-Part B Questionnaire Data.

Questionnaire Personal Code	Brand Visual Asset Tell us about the project you want to execute today			Considering the non-digital tools and/or software you are using at present, please comment on and compare the processes/ outputs/ modules of AEGIS, for example: <ul style="list-style-type: none"> • Present manipulation process to achieve outputs in AEGIS. • Any process/ module in AEGIS (example selection of font configuration). • Any component of output image (eg background, etc). Comparison can be on the basis of criterion like: <ul style="list-style-type: none"> • Speed of implementation • Presence and absence of something in the elements of outputs (example effects on the line of the letter A), • Convenience and user friendliness of implementation, etc. 			
	Idea Chosen	Any logo used from an existing brand	What kind of outputs do you want to achieve from this project	Application/ Tool (Example AEGIS)	Element/ Process/ Sub tool criterion (Example how the manipulation of background takes place)	List of Criteria (E.g. Speed, presence, absence, user-friendliness to achieve that feature etc.)	Rating and Comments (Scale of 0-5) Please rate the feature/ element output or process on the scale in comparison to each other.
AEGIS000W0003	Impacting combination of images	Logo from a little known video game reviewer	Set as other but couldn't have been clear to act	<ul style="list-style-type: none"> • AEGIS • Illustrator • Photoshop • Paint 	<ul style="list-style-type: none"> • Overall final outcome 	<ul style="list-style-type: none"> • Very fast, simple • Slow • Bad for text, slow • Constricting, bad so far 	<ul style="list-style-type: none"> • 4/10 • 7/10 • 6/10 • 3/10

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AEGIS000W0004	A space agency	IBM/American Airlines	I wanted to bring the energetic and dynamic lines of the American airlines logo	<ul style="list-style-type: none"> • AEGIS • Photoshop • Illustrator 	<ul style="list-style-type: none"> • Background adaption 	<ul style="list-style-type: none"> • Speed 	<ul style="list-style-type: none"> • Good • Quite Slow • Slow
AEGIS000W0005	Branding for young toy	Android CBC	Clean, purple colours that appeal to young girls	<ul style="list-style-type: none"> • AEGIS • Paper • Illustrator 	<ul style="list-style-type: none"> • Graphic design 	<ul style="list-style-type: none"> • OK Speed • Slow • Fast 	<ul style="list-style-type: none"> • Doesn't produce clean desing needs backtool • Allows freedom • Allows more freedom
AEGIS000W0006	Promoting a pop up bar on a beach or any location	Pimm's brand	A clear logo	<ul style="list-style-type: none"> • AEGIS • Paper • Illustrator 	<ul style="list-style-type: none"> • Graphic design 	<ul style="list-style-type: none"> • Speed OK • Slow • Fast 	<ul style="list-style-type: none"> •
AEGIS000W0007	I chose the FIAT car logo and create a poster advertising their new punto car	I used the FIAT car logo and Nokia Phones logo	Bright colourful and extremely eye catching typography and background.	<ul style="list-style-type: none"> • AEGIS • AEGIS • Photoshop • Photoshop AEGIS 	<ul style="list-style-type: none"> • Typography • Import Files • Image size • Image quality • User interface 	<ul style="list-style-type: none"> • Quick • really quick • quick and simple • adjusting is easy • simple and clear 	<ul style="list-style-type: none"> • very good • loved it • text adjustment • image resolution • need a reset button
AEGIS000W0008	Promotional piece for a car	Yes Volkswagen Logo	Colourful, unique	<ul style="list-style-type: none"> • AEGIS • Pen+paper 	<ul style="list-style-type: none"> • Background easy 	<ul style="list-style-type: none"> • Very quick • slower 	<ul style="list-style-type: none"> • complex to follow

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	campaign, maybe a business card design				<ul style="list-style-type: none"> • Mark making 		<ul style="list-style-type: none"> • more control
AEGIS000W0009	A poster for Artistically Minded people	Yes	Create something fun and beautiful	<ul style="list-style-type: none"> • AEGIS • Pen + Paper 	<ul style="list-style-type: none"> • Elements, structure • Experiment 	<ul style="list-style-type: none"> • Fast but less effective • Easy to create 	<ul style="list-style-type: none"> • There is very limited control • Represents thought process
AEGIS014W0001	Promoting Medical Drug for Scabies.	Permethrine	Advertising the Brand	<ul style="list-style-type: none"> • AEGIS 	Manipulation takes place very nicely and gives us about 9 different outputs at a same time •	<ul style="list-style-type: none"> • This software has excellent speed 	<ul style="list-style-type: none"> • 3.5
AEGIS015W0001	Come to Dubai with FlyDubai Airlines	Yes, FlyDubai	I think this will be a very good promotion for Fly Dubai for which they can use in their social media and other corporate advertisements	<ul style="list-style-type: none"> • AEGIS 	I suggest to add more tool options like position the font exactly to users preference on the background image, and an option not to manipulate/	<ul style="list-style-type: none"> • On the plus side speed is very good • Very simplistic design layout 	<ul style="list-style-type: none"> • 3

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					change an image/ background, etc.		
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AEGISQ11-Part C Questionnaire Data.

Questionnaire Personal Code	The outputs you generated will possibly fit most for:	GD Stage where AEGIS can be useful.	Any areas of improvement in AEGIS	Any drawbacks in AEGIS	Any general suggestions or comment	What did you/ learn or achieve from this session
AEGIS000W0003	<ul style="list-style-type: none"> Creative Art (looks interesting and visuals appealing) Other (anything anyone could find suitable) 	<ul style="list-style-type: none"> Design- (could help generate ideas) 	<ul style="list-style-type: none"> Back button More control More choices 	Restrictive	It cannot be better than an actual designer deciding on aspects.	TRIZ seems complicated for a simple process.
AEGIS000W0004	<ul style="list-style-type: none"> Creative art (I feel it did a good job and allowed me to quickly conceptualize my ideas) 	<ul style="list-style-type: none"> Briefing (I think it would work well in initial concept creation) Design (Good at creativity patterns at random intervals) 		really shows AEGIS could easily push quick and iterative examples		
AEGIS000W0005	<ul style="list-style-type: none"> Packaging design (could be used as a box for the product) Presentation (could be used as part of a presentation about the product) Advertisement (selling the product) Fun (it is a fun, sweet, young image) 	<ul style="list-style-type: none"> Design (helps generate ideas) 	Cleaner designs Back-tool	No back tool Little control	Backtool	Sometimes certain images and colours don't go together however the mutations work well.

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Questionnaire Personal Code	The outputs you generated will possibly fit most for:	GD Stage where AEGIS can be useful.	Any areas of improvement in AEGIS	Any drawbacks in AEGIS	Any general suggestions or comment	What did you/ learn or achieve from this session
AEGIS000W0006	<ul style="list-style-type: none"> Packaging Design (promoting product) Creative Art (communication- appealing to an audience) General Purpose (advertising plus promoting) Advertisement (Appeal) 	<ul style="list-style-type: none"> Design (Useful showing the different elements plus different outcomes). 	Updates clearer, change the colours too immature use of white space.	<ul style="list-style-type: none"> Relies on other programmes Copyright issues Images are too small 	..	Nothing
AEGIS000W0007	<ul style="list-style-type: none"> Creative art (really quick and easy to use) General purpose (creates finished product in seconds) Advertisement (the ability to upload your own files it extremely handy) Fun (easy to save any work you create by accident) 	<ul style="list-style-type: none"> Briefing (AEGIS is easier to use for solving a brief rather than allowing the user to be given a brief) Design (the final designs and concepts are extremely creative) Artwork (the ability to create tools 100's of solutions makes work easier). Production (There should be an option to adjust the size of the file and quality when saving) 	I feel though you need to adjust the look of the user-interface and add a refresh / reset and back button and if possible add a part for adjusting the text size and logo size as the finished image compositions.	<ul style="list-style-type: none"> You should be able to adjust the amount of text and logo layers you can implement per design Should be able to save more than one outcome 	I found it really easy to use and it was very quick, I was surprised at how creative the final outcomes were and this is definitely something to look out for in the future.	I learnt how powerful computer programmers can be and learnt about the principles of TRIZ and how you can apply Genetics to real life problem solving.
AEGIS000W0008	<ul style="list-style-type: none"> Advertisement 	<ul style="list-style-type: none"> Design (When brainstorming ideas or experimenting to gain effects for typography). 	Needs to be simplified for the average person Fairly complex to get your head around	<ul style="list-style-type: none"> Computer does all of the work you don't have much input other than clicking on certain 	Really like the idea, the software produces some experimental and very useful	The TRIZ Principles were very interesting to learn about and the software though complex could be

Engineering Innovation (Computer Aided Innovation)

Questionnaire Personal Code	The outputs you generated will possibly fit most for:	GD Stage where AEGIS can be useful.	Any areas of improvement in AEGIS	Any drawbacks in AEGIS	Any general suggestions or comment	What did you/ learn or achieve from this session
				options.	interesting results.	really interesting to use to produce experimental type and imagery.
AEGIS000W0009	<ul style="list-style-type: none"> Creative art (example poster design) 	<ul style="list-style-type: none"> Briefing-as a quick way to sketch up brief ideas or visual aids. 	<p>The ability to move components on the image</p> <p>To revert back</p> <p>Layout and usage of the software needs to be improved for easier use</p>	<ul style="list-style-type: none"> Severe limitations in the design process Confusing to use 	<p>The basic idea is good, but needs a lot of considerations about page layout, type layout, use of colour, etc.</p>	
AEGIS014W0001	<ul style="list-style-type: none"> Packaging design Creative art General purpose Presentation Image enhancement Advertisement Fun Research purpose 	<ul style="list-style-type: none"> Briefing (as a quick way to sketch up brief idea or visual aids) Design Artwork Production 	AEGIS	<ul style="list-style-type: none"> Manipulation takes place very nicely 	This software has excellent speed	Using this software
AEGIS015W0001	<ul style="list-style-type: none"> Packaging design Creative art General purpose Presentation (can be possible as this software is easy and quick in assembling the images needed) Image enhancement 	<ul style="list-style-type: none"> Briefing Design Artwork Production 	<ul style="list-style-type: none"> I would like to add more than five letter texts, and would like to add more text position options 	<ul style="list-style-type: none"> None 	<ul style="list-style-type: none"> Was able to come up with output within 5 minutes 	<p>I learned how to use a new type of software and was able to make a campaign design for an airline company in 5 minutes</p>

Engineering Innovation (Computer Aided Innovation)

Questionnaire Personal Code	The outputs you generated will possibly fit most for:	GD Stage where AEGIS can be useful.	Any areas of improvement in AEGIS	Any drawbacks in AEGIS	Any general suggestions or comment	What did you/ learn or achieve from this session
	<ul style="list-style-type: none"> Advertisement (yes this is very quick in assembling images together making this software an easy tool for almost any one with good computer literacy to make use for it in advertising especially on social media) Fun Research purpose 					
AEGIS000W0011	<ul style="list-style-type: none"> Packaging Design – Used for project Creative Art – really useful for this area General Purpose – can be used easier than Adobe Image Enhancement Advertisement Fun Other 	<ul style="list-style-type: none"> Briefing – can be used to run with an idea and generate ideas in front of real world client Design – hugely useful for design, far easier to use than competitors and also generates more iterations of the image in a short space of time Artwork – useful for developing your finished art and using as a concept idea for a business. Production – I would use this software to produce packaging for a product 	<ul style="list-style-type: none"> Confirmation Message after applying Triz to font. 	<ul style="list-style-type: none"> None that I can see 	It is good software that I feel could be commercialised and sold as a competitor to Adobe	Lots, much more about how Computers and design need to work in more harmony together and how Triz can be used to generate the designs of the future.

AEGISQ11-Part D Group 2 (for Text outputs and final designs rating) Questionnaire Data.

Questionnaire Personal Code	Useful Parameter Output Rating (from 5-0) (Example 5=clear communication and 0 = confusing communication)																													
	Commu nication		Recogni tion		Tone		Colour		Shape		Form		Fabric		Time		Style		Demea nour		Voice		Langua ge		Geogra phy		Feel		Aesthet ic strengt h	
	Text/ Font	Final Design	Text/ Font	Final Design	Text/ Font	Final Design	Text/ Font	Final Design	Text/ Font	Final Design	Text/ Font	Final Design	Text/ Font	Final Design	Text/ Font	Final Design	Text/ Font	Final Design	Text/ Font	Final Design	Text/ Font	Final Design	Text/ Font	Final Design	Text/ Font	Final Design	Text/ Font	Final Design	Text/ Font	Final Design
AEGIS014W0001	5	4.5	4	3	4	3	4	4	3	3	4	4	3	3	4	4	4	3	5	4	2	3	2	3	3	3	4	4	4	3
AEGIS015W0001	5	4	5	4	5	3	4	3	3	3	4	4	3	3	4	4	4	4	5	5	2.5	2.5	2.5	2.5	2.5	2.5	3	4	4	4
AEGIS003W0002	2	3	4	2	5	3	5	1	3	1	4	2	3	5	0	1	5	4	3	0	1	5	2	2	3	3	4	4	5	4
AEGIS003W0003	0	2	4	3	1	4	2	3	0	4	2	5	5	1	0	2	1	0	0	4	2	5	3	0	4	1	1	1	0	2
AEGIS003W0004	3	3	1	5	2	2	5	3	4	0	0	4	2	3	3	5	1	3	3	3	5	4	2	4	5	2	2	2	2	0
AEGIS003W0005	1	4	5	4	4	1	5	1	1	1	0	2	5	2	2	5	3	3	5	4	1	5	1	2	1	0	4	0	3	4
AEGIS003W0007	3	0	5	3	1	4	5	2	5	0	5	0	3	2	2	5	1	2	0	3	2	4	3	0	2	2	5	0	4	3
AEGIS003W0008	4	4	3	2	4	1	3	4	1	0	1	1	2	0	4	5	2	3	2	5	4	0	5	2	5	3	0	2	4	5
AEGIS003W0010	2	1	0	0	4	0	3	5	1	0	2	3	3	1	5	5	2	0	5	4	1	4	2	5	2	4	4	0	2	0
AEGIS003W0011	1	1	0	1	3	5	0	2	2	4	2	3	1	2	2	0	2	4	2	0	0	5	2	5	4	4	4	1	3	5
AEGIS003W0013	1	3	5	1	2	3	0	5	1	3	1	3	5	4	0	4	1	2	3	2	0	2	1	1	4	0	4	2	0	2
AEGIS003W0014	3	3	3	5	1	2	1	2	4	5	2	4	1	2	0	4	4	0	4	2	1	3	3	0	2	1	2	3	3	0
AEGIS003W0016	5	0	0	5	0	4	1	4	1	4	1	4	2	1	5	5	5	4	2	2	4	0	4	1	4	1	4	4	4	2
AEGIS003W0018	3	1	2	1	5	0	2	2	4	5	0	4	2	0	4	1	0	2	4	0	1	1	2	0	2	3	2	1	4	4
AEGIS000W0003	1	1	5	5	3	3	5	5	3	3	3	3	3	3	5	5	4	4	1	1	4	4	2	2	1	1	5	5	4	4
AEGIS000W0004	3	3	1	1	2	2	5	5	3	5	3.5	5	3	3	5	5	5	5	4	4	5	5	4	4	5	5	5	5	5	5
AEGIS000W0005	0	0	1	1	4	4	4	4	4	3	0	0	3	3	3	3	2	2	0	0	0	0	1	1	4	4	4	4	3	3
AEGIS000W0006	0	0	0	0	2	2	5	5	3	3	3	3	2	2	2	2	2	2	2	2	3	3	3	3	5	5	3	3	0	0

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AEGIS000W0007	4	4	3	3	5	5	5	5	0	0	4	4	0	0	5	5	4	4	5	5	5	5	0	0	5	5	0	0	5	5
AEGIS000W0008	0	0	2	2	3	3	4	4	4	4	5	5	0	0	5	5	5	5	0	0	5	5	2	2	2	2	5	5	1	1
AEGIS000W0009	1	1	0	0	2	2	3	3	3	3	4	4	0	0	3	3	4	4	0	0	4	4	4	4	0	0	4	4	0	0
AEGIS000W0011	4	4	4	4	5	5	3	3	3	3	2	2	3	3	4	4	3	4	4	5	4	4	3	3	4	5	5	3	4	5

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AEGISQ11-Part D Group 1 and Group2 (for Final Design outputs against what was expected) Questionnaire Data.

Questionnaire Personal Code	Comparing the outputs against what the user wanted to achieve (from 5-0) (Example 5=exactly what you wanted and 0 = it is not all all what you wanted)														
	Communication	Recognition	Tone	Colour	Shape	Form	Fabric	Time	Style	Demeanour	Voice	Language	Geography	Feel	Aesthetic strength
AEGIS014W0001	4.5	3.5	4	4	3	4	3	5	4	4	3	3.5	3	4	4
AEGIS015W0001	5	5	5	4	4	4	3	5	4	4	3	3	3	5	5
AEGIS003W0002	2	1	5	4	5	3	2	2	0	0	0	4	3	5	4
AEGIS003W0003	0	2	3	0	0	1	4	4	4	5	1	2	2	5	1
AEGIS003W0004	1	2	0	5	5	1	3	4	4	0	0	4	3	1	5
AEGIS003W0005	1	1	1	2	1	2	1	5	5	4	0	1	5	1	3
AEGIS003W0007	4	3	5	1	1	4	0	4	4	5	4	0	2	3	0
AEGIS003W0008	5	1	0	2	4	3	4	3	2	2	4	3	4	5	4
AEGIS003W0010	5	2	3	5	1	3	1	1	2	1	0	4	1	1	2
AEGIS003W0011	2	0	2	5	3	1	3	0	5	3	0	2	0	2	1
AEGIS003W0013	3	5	0	3	1	3	1	1	0	0	5	5	3	2	4
AEGIS003W0014	5	0	1	2	5	1	4	4	4	0	1	0	5	3	5
AEGIS003W0016	0	3	2	1	1	2	5	4	4	4	3	3	2	5	4
AEGIS003W0018	4	5	1	3	1	2	2	1	4	2	2	4	4	0	2
AEGIS000W0003	2	3	2	4	3	4	2	5	4	3	3	4	2	5	3
AEGIS000W0004	3	2	1	4	0	5	0	3	4	4	4	3	5	4	4
AEGIS000W0005	0	2	5	3	2	0	3	3	2	0	0	1	4	4	3
AEGIS000W0006	0	0	3	5	3	2	3	4	3	2	3	3	5	5	0
AEGIS000W0007	4	3	2	5	5	5	5	5	4	5	5	4	5	3	5
AEGIS000W0008	2	3	2	5	5	5	5	5	4	5	5	4	5	3	5
AEGIS000W0009	4	3	2	5	5	0	5	5	4	3	4	5	2.5	4	5
AEGIS000W0011	4	4	4	3	5	5	5	4	5	5	4	4	5	4	5

AEGISQ11 Questionnaire Structure.

A-1 Questionnaire Data

Questionnaire Code	
University/ Organization	
Mode of Registration	Offline <input type="radio"/> Online <input type="radio"/>



Please fill the following section (A-2) only if you are registering offline; otherwise skip to section B on page 3.

Data Protection: Please note the research team will not use any of your personal data for any purpose other than this research. You will not be spammed by emails or by call agents.

A-2 Personal Information

Name: (First Name, Last Name)	
Gender:	Male <input type="radio"/> Female <input type="radio"/>
Email id: (Example abc@xyz.com)	
Phone Number: (Example +xxxxxx.. format)	
Address: (Street, House Name/ Number)	 (If you wish, you can prefer to mention office/ university address)
District/ County: (Example Devon or Baramulla)	
Pin/Post Code:	

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(Example 190005 or PL4 8AA)			
Age in Years:			
Education Level:	U.G	<input type="radio"/> .G	<input type="radio"/> Doctorate
Speciality : (Your field of expertise)	Graphic Design <input type="radio"/> IT <input type="radio"/> Computer Science <input type="radio"/> Engineering <input type="radio"/> Business Administration <input type="radio"/> Arts <input type="radio"/> Other _____	Social <input type="radio"/> Photography <input type="radio"/> Creativity <input type="radio"/> Architecture <input type="radio"/> Fashion <input type="radio"/>	
Speciality Level: (The level of expertise you have in above field)	No experience <input type="radio"/> Weak experience <input type="radio"/> Starter experience <input type="radio"/>	Settled experience <input type="radio"/> (Well settled in your field) Supervisory experience <input type="radio"/> (Team lead/ senior trainer) Advanced experience <input type="radio"/> (Run the department)	
Research Experience: (Any previous or current involvement in research)	No experience <input type="radio"/> Weak experience <input type="radio"/> Starter experience <input type="radio"/>	Qualified experience <input type="radio"/> (Doctorate/ Post Doc) Substantial experience <input type="radio"/> (Published in journals) Advanced experience <input type="radio"/> (IP owner of patents)	
Graphic Design Experience: (Any graphic design experience)	No experience <input type="radio"/> Weak experience <input type="radio"/> Casual experience <input type="radio"/>	Qualified experience <input type="radio"/> (Hold a qualification) Substantial experience <input type="radio"/> (Designed many packages) Advanced experience <input type="radio"/> (Sometimes play with tools) (Successful at commercial level)	

B- Brand Visual Asset



The section B-1 needs to be executed before using or running AEGIS.

B-1 Today, a project work will be executed using AEGIS

Tasks (Brand Visual Asset):

- ✓ Start with an idea
- ✓ Choose background, logo and extra logo
- ✓ Upload them to AEGIS
- ✓ Start Atomic Transformations
- ✓ Start Molecular Transformations
- ✓ Finalize the Design



The section B-2 needs to be executed before using or running AEGIS.

B-2 Tell us about your project idea:

Idea Chosen	
Any logo used from an existing brand?	
What kind of outputs do you want to achieve from this project?	



The section B-3 needs to be executed after running AEGIS and obtaining the relevant output files.

B-3 Graphic Design Outcomes Feedback

(Usage of Outputs)

The outputs you obtained using AEGIS will possibly be used by you for:

Purpose	Please Select	Comments
Packaging Design	✓	
Creative Art	✓	
General Purpose	✓	
Presentation	✓	
Image Enhancement	✓	
Advertisement	✓	
Fun	✓	
Research Purpose	✓	
Other	✓	

B4. Stage (Graphic Design Process) at which AEGIS will be useful

Please answer this section considering overall features of AEGIS and the outputs obtained.

Process	Tick	Comments
Briefing	✓	
Design	✓	
ArtWork	✓	
Production	✓	
If you do not have any knowledge or information about above processes, then please mention in your own words where AEGIS software/ outputs could be used according to your knowledge.	✓	

B5. Rate Your Output Image with respect to following:

Usefulness Parameter	Please mark the output images you obtained.			Comment on and compare the outputs to what you wanted to achieve.	Suggest any improvement to the AEGIS to achieve this better.		
	Please rate on a scale between 5 (e.g., Clear) to 0 (Confusing)'						
	Ratings Guide	Applicable to:					
		Text Output	Full Design (Final Output)	Rating Guide			
		Please rate on a scale between 5 (e.g., It is exactly what you wanted) to 0 (It is not at all what you wanted)'					
Communication	Clear (5) Confusing (0)						
Recognition	Known (5) Stranger (0)						
Tone	Warm (5) Cold (0)						
Color	Bright (5) Muted (0)						

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Shape(s)	Round (5) Square (0)				
Form	Complex (5) Simple (0)				
Fabric	Soft/Natural (5) Hard/Mechanical (0)				
Time	Modern (5) Traditional (0)				
Style	Confident (5) Reserved (0)				
Demeanour	Formal (5) Informal (0)				
Voice	Loud(5) Quiet (0)				
Language	Poetic (5) Prosaic (0)				

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Geography	Global (5) Local (0)				
Feel	Dramatic (5) Calm (0)				
Aesthetic Strength	Pleasure (5) Displeasure (0)				

PART-C Comparative Evaluation

Considering the non-digital tools and/or software you are using at present, please comment on and compare the processes/ outputs/ modules of AEGIS, for example:

- Present manipulation process to achieve outputs in AEGIS.
- Any process/ module in AEGIS (example selection of font configuration).
- Any component of output image (eg background, etc).

Comparison can be on the basis of criterion like:

- Speed of implementation
- Presence and absence of something in the elements of outputs (example effects on the line of the letter A),
- Convenience and user friendliness of implementation, etc.

Application/ Tool (Example AEGIS)	Element/ Process/ Sub tool criterion (Example how the manipulation of background takes place)	List of Criteria (E.g. Speed, presence, absence, user- friendliness to achieve that feature etc.)	Rating and Comments (Scale of 0-5) Please rate the feature/ element output or process on the scale in comparison to each other.
AEGIS			

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PART-D Software Feedback

D-1. With respect to the version of AEGIS 7.1 currently installed on your machine, please indicate the extent to which you agree or disagree with the following statements:

SD = Strongly Disagree D = Disagree N = Neutral

A = Agree SA = Strongly Agree

Criteria	1 st Choice									
This software is easy to use.	<input type="radio"/>	SD	<input type="radio"/>	D	<input type="radio"/>	N	<input type="radio"/>	A	<input type="radio"/>	SA
I am in control of the contents of the menus and toolbars.	<input type="radio"/>	SD	<input type="radio"/>	D	<input type="radio"/>	N	<input type="radio"/>	A	<input type="radio"/>	SA
I will be able to learn how to use all that is offered in this software.	<input type="radio"/>	SD	<input type="radio"/>	D	<input type="radio"/>	N	<input type="radio"/>	A	<input type="radio"/>	SA
Navigating through the menus and toolbars is easy to do.	<input type="radio"/>	SD	<input type="radio"/>	D	<input type="radio"/>	N	<input type="radio"/>	A	<input type="radio"/>	SA
This software is engaging.	<input type="radio"/>	SD	<input type="radio"/>	D	<input type="radio"/>	N	<input type="radio"/>	A	<input type="radio"/>	SA
The contents of the menus and the toolbars match my needs.	<input type="radio"/>	SD	<input type="radio"/>	D	<input type="radio"/>	N	<input type="radio"/>	A	<input type="radio"/>	SA
Getting started with this version of the software is easy.	<input type="radio"/>	SD	<input type="radio"/>	D	<input type="radio"/>	N	<input type="radio"/>	A	<input type="radio"/>	SA
This software is flexible.	<input type="radio"/>	SD	<input type="radio"/>	D	<input type="radio"/>	N	<input type="radio"/>	A	<input type="radio"/>	SA
Finding the options that I want in the menus and toolbars is easy.	<input type="radio"/>	SD	<input type="radio"/>	D	<input type="radio"/>	N	<input type="radio"/>	A	<input type="radio"/>	SA

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It is easy to make the software do exactly what I want.	<input type="radio"/>	SD	<input type="radio"/>	D	<input type="radio"/>	N	<input type="radio"/>	A	<input type="radio"/>	SA
---	-----------------------	----	-----------------------	---	-----------------------	---	-----------------------	---	-----------------------	----

AEGIS= AEGIS Tool

*Fill the name of other tool(s) in blank spaces.

Equal = Other tool and AEGIS satisfy this criteria equally

Discovering new features is easy.	<input type="radio"/>	SD	<input type="radio"/>	D	<input type="radio"/>	N	<input type="radio"/>	A	<input type="radio"/>	SA
I get my graphic tasks done quickly with this software.	<input type="radio"/>	SD	<input type="radio"/>	D	<input type="radio"/>	N	<input type="radio"/>	A	<input type="radio"/>	SA
This software is satisfying to use.	<input type="radio"/>	SD	<input type="radio"/>	D	<input type="radio"/>	N	<input type="radio"/>	A	<input type="radio"/>	SA

D-2. There are a number of criteria listed below. Please select the software that would be your 1st choice according to each of the criteria. If you really cannot make a choice for a given criteria please select "Equal".

Criteria	1st Choice
This software is easy to use.	AEGIS <input type="radio"/> _____ <input type="radio"/> Equal <input type="radio"/>
I am in control of the contents of the menus and toolbars.	AEGIS <input type="radio"/> _____ <input type="radio"/> Equal <input type="radio"/>
I will be able to learn how to use all that is offered in this software.	AEGIS <input type="radio"/> _____ <input type="radio"/> Equal <input type="radio"/>
Navigating through the menus and toolbars is easy to do.	AEGIS <input type="radio"/> _____ <input type="radio"/> Equal <input type="radio"/>
This software is engaging.	AEGIS <input type="radio"/> _____ <input type="radio"/> Equal <input type="radio"/>

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The contents of the menus and the toolbars match my needs.	AEGIS <input type="radio"/> _____ <input type="radio"/> Equal <input type="radio"/>
Getting started with this software is easy.	AEGIS <input type="radio"/> _____ <input type="radio"/> Equal <input type="radio"/>
This software is flexible.	AEGIS <input type="radio"/> _____ <input type="radio"/> Equal <input type="radio"/>
Finding the options that I want in the menus and toolbars is easy.	AEGIS <input type="radio"/> _____ <input type="radio"/> Equal <input type="radio"/>
It is easy to make the software do exactly what I want.	AEGIS <input type="radio"/> _____ <input type="radio"/> Equal <input type="radio"/>
Discovering new features is easy.	AEGIS <input type="radio"/> _____ <input type="radio"/> Equal <input type="radio"/>
I get my graphic tasks done quickly with this software.	AEGIS <input type="radio"/> _____ <input type="radio"/> Equal <input type="radio"/>
This software is satisfying to use.	AEGIS <input type="radio"/> _____ <input type="radio"/> Equal <input type="radio"/>

D-3 Suggestions

In view of your answers to sections D1 and D2, please suggest any improvements in AEGIS which will help to address above issues.

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PART-E General Feedback

E1. Please comment on any areas of improvement in AEGIS Interface Elements.	
Buttons of Software	Background of Software
Colour and Theme of the Software	Layout of Elements with respect to each other
Menus, Header(Control box), Footer, icons, etc.	Navigation from one form to another
E2. Please comment on any drawbacks in AEGIS and any suggestions to improve them (especially	

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keeping in view the other tools you might have used for graphic design).

E3. Any general suggestions or comments

E4. What did you learn/ achieve from this session?

E5. Would you suggest coupling this software with other existing software (or designing the graphics using AEGIS at one stage and another software package/ non-digital tool at other stage), please suggest?

E6. Do you consider this software as innovative? (please explain)

E7. If your answer to E6 was yes, what percentage of all processes/ modules of this software are innovative.

0-15 % <input type="radio"/>	15-30 % <input type="radio"/>
30-45 % <input type="radio"/>	45-60% <input type="radio"/>
60-75 % <input type="radio"/>	75-100 % <input type="radio"/>

E8. Do you consider any process/ module of this software implementing automated innovation (innovates without considerable manual manipulation)? (please explain)

E9. If you answered yes to E8, what percentage of innovation do you consider is automatically implemented through this software?

0-15 % <input type="radio"/>	15-30 % <input type="radio"/>
30-45 % <input type="radio"/>	45-60% <input type="radio"/>
60-75 % <input type="radio"/>	75-100 % <input type="radio"/>

Thank you for helping develop AEGIS. I really appreciate your thoughts and time.

You can contact us at admin@designforwow.com

Appendix-VIII- AEGIS v7.0/7.1 User Guide

AEGIS Introductory Form

How to use this form:

This form is used to enter the:

1. Questionnaire personal code (this code is generated from Design for Wow) website after user registration.
2. Select your field of expertise from the drop down list below the Questionnaire Code box.
3. Select the mutation percentage and crossover rates from the drop down boxes respectively (these will be used for font transformations later on).
4. User preferences for font transformations can be selected from the 9 mini sections on the left of form (these will be used for font transformations later on).
5. User Key (enter user key if you are installing your software for first time or the key has expired, the form will indicate if the key has expired).
 - a. This key is supplied by researcher and is valid for 31 days and for 1000000 uses.
 - b. The key is case sensitive so be careful while copy pasting key.
6. Finally press the start button and you are ready to go to next form.

AEGIS Introductory Form

Font Chromosome Preferences

☐ Would you like text outlining effects

☐ Would you like the colouring effects

☐ Would you like fragmented text

☐ Would you like spheroidal effects

☐ Would you like duplicated text

☒ Would you like slanted text

☒ Would you like segmented text

☐ Would you like symbol introduction

☐ Would you like shapes introduction

start

Enter Your Questionnaire Personal Code

AEGIS000W0001

Select Your Speciality

Mutation % Age 3

Cross Over Points 2

Aegis 7.0 is Activated on your System on OEM Basis.

Programmer's

Finally press the button to go

Enter Questionnaire Personal Code here

Select the mutation and crossover rate

Enter your AEGIS key here

Select the effects you want in text

AEGIS Main Form (for text configuration)

How to use this form:

After entering this form through the introductory form, you need to follow following steps to configure the text and apply TRIZ Principles to the font letters.

First step is to select the font congirutaion on this form. You can select/ provide following information for your font.

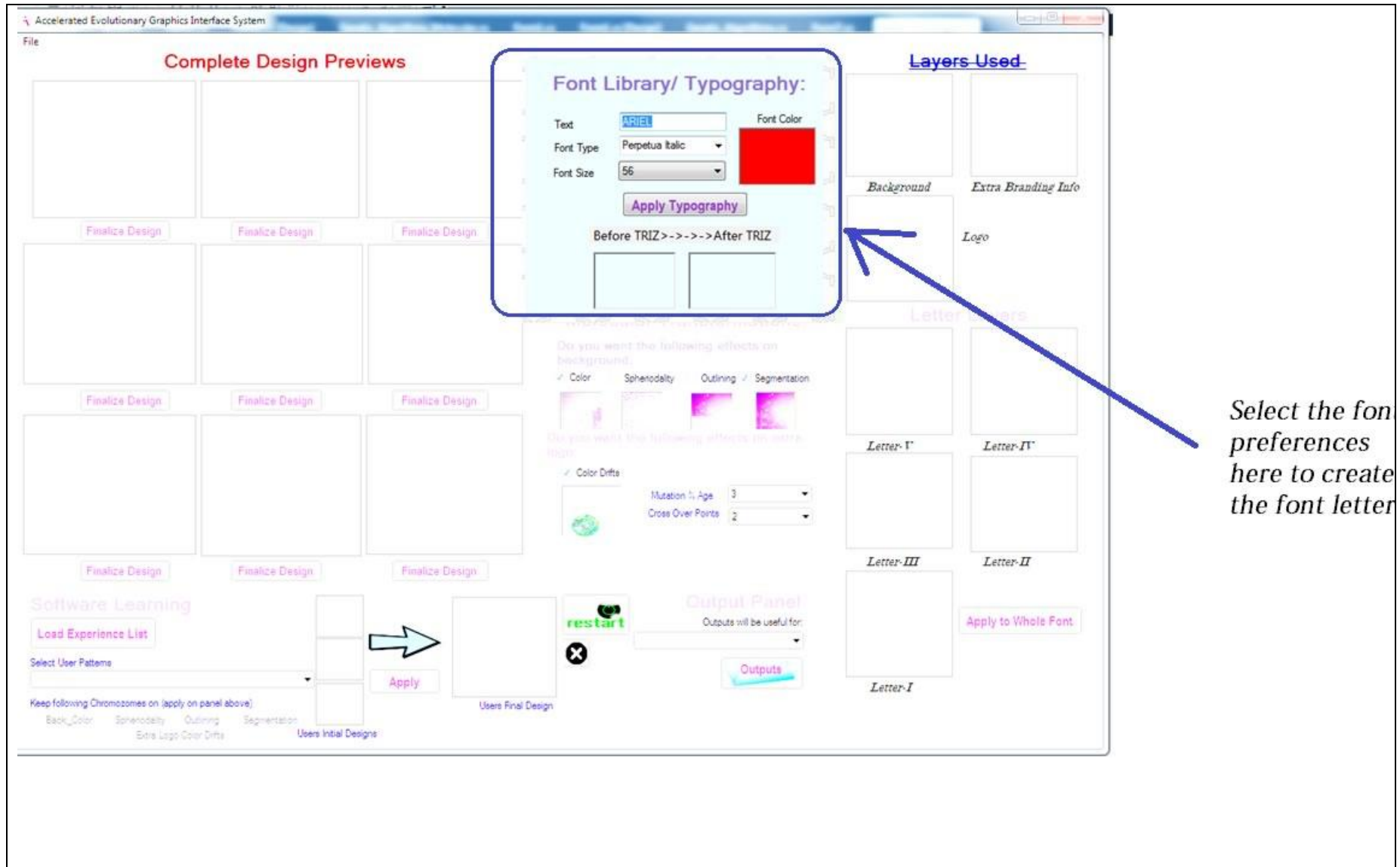
Text- Input five letters example the brand name);

Font Type- Select from the list);

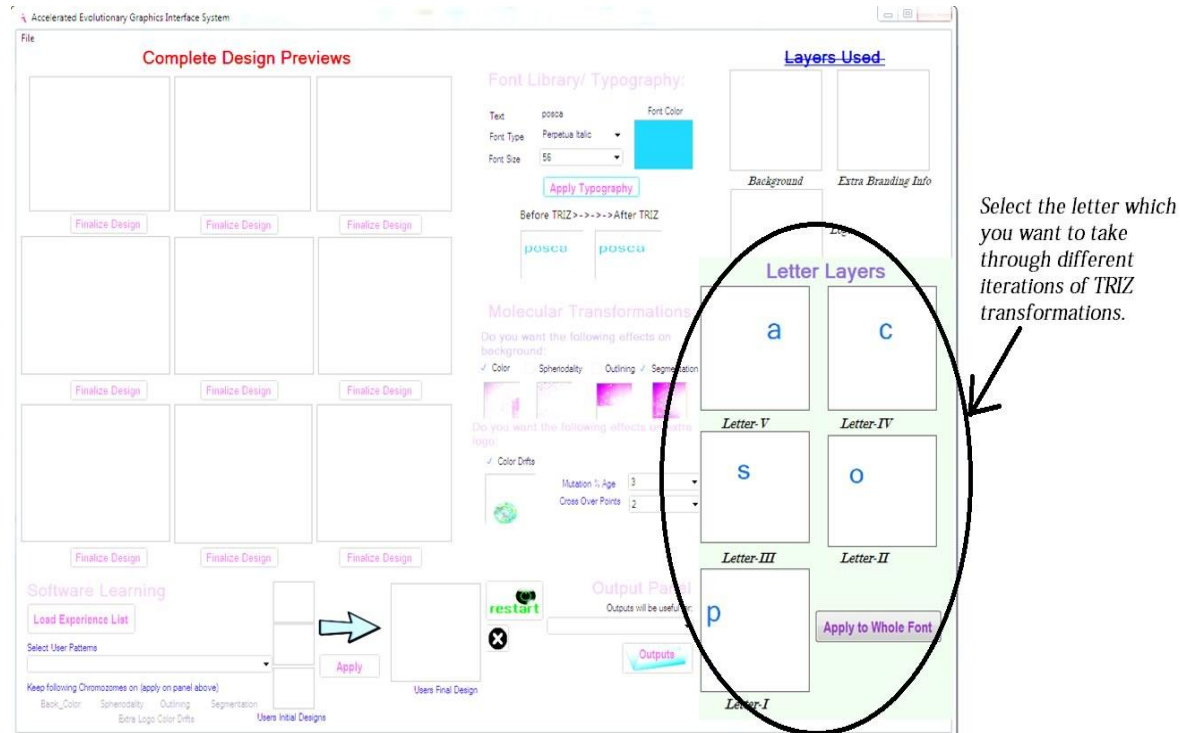
Font size- optimum is approximately 50);

Font color- choose from the advanced pallet);

Then press the button- Apply Typography.



After this step, the form will display 5 letter layers and you can choose which letter you want to take through different iterations/generations for TRIZ application.



3. This will take you to the letter transformation form which is explained in the next section of this help document.

AEGIS Text Transformation Form (for applying TRIZ to text)**How to use this form:**

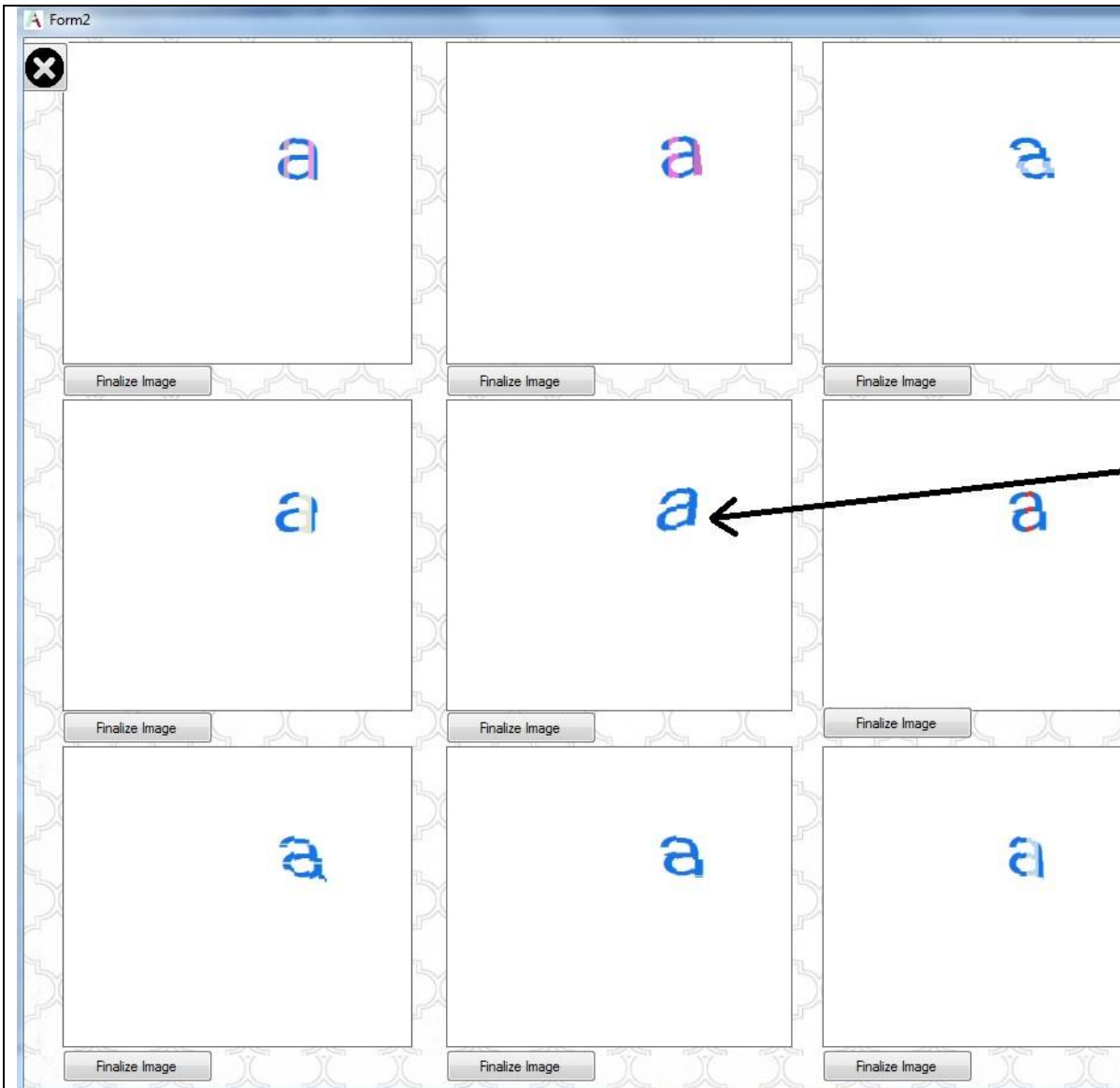
After entering this form through the main form, you will find nine transformations of your letter on the left hand side (this is called as generation one).

1. If you already like some letter format (and want to stop here), then you can click the "Finalize Image" button as shown below.



2. If you like few images and want to explore further generations baed on their genomes, then you need to select three parents. Selection of parents is done by clicking on the image itself (not on any button) as shown below.

If you like few images and want to explore further generations baed on their genomes, then you need to select three parents. Selection of parents is done by clicking on the image itself (not on any button) as shown below.



Select on an image to choose it as a parent image for the next generation.

Engineering Innovation (Computer Aided Innovation)

3. When you have completed selecting the three parents, you can then proceed for next generation by clicking the "Generate New Generation" button on the right side of this form as shown below. During each iteration, you can also change the mutation rate, chromosomes applied and crossover points rate for the parents crossover and mutation. Once you are satisfied with any output, you can go to step 1. You can any time press reset button to restart the first generation randomly again.

The screenshot shows a web-based interface titled "TRIZ Principles". It features a section titled "Atomic Mutations" with a sub-header "Chromozomes Applied". Below this, there is a list of nine checkboxes for different mutation effects: "Would you like the colouring effects", "Would you like slanted text" (checked), "Would you like text outlining effects" (highlighted with a dashed border), "Would you like fragmented text", "Would you like duplicated text", "Would you like segmented text" (checked), "Would you like spheriodical effects", "Would you like symbol introduction", and "Would you like shapes introduction". Below the checkboxes, there are two dropdown menus: "Mutation % Age" set to 3 and "Cross Over Points" set to 2. At the bottom of the form, there are two buttons: "Generate New Generation" (purple text) and "Reset" (grey text). The background of the interface has a decorative geometric pattern.

AEGIS Software Learning Module

Special AEGIS Software Learning Module:

While you are on the text transformations page, you can also checkout what how others have utilized this software.

1. Press the loadexperience button, that will enable you to view and select from the user sessions list- what patterns/ designs have they created using this software.
2. If you like any of the user designs, you can apply these genes to your design by clicking the apply button.
3. Once you click the apply button, these genes will be applied to the box number 2 (ofthe 3x3 grid on the left).
4. You can repeat as many times as you want.

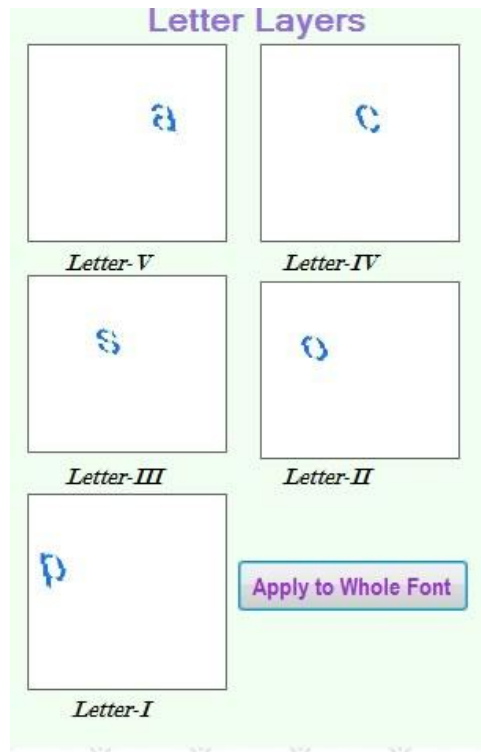


AEGIS Complete Design Transformation Form (for applying TRIZ to Complete Design)

How to use this form:

After selecting the finalized font on font form, you will be redirected to main form.

1. You need to apply the effects to all letters to your design-word (all five letters).
2. This can be done by pressing the "Apply to Whole Font" button on right hand side as shown below.

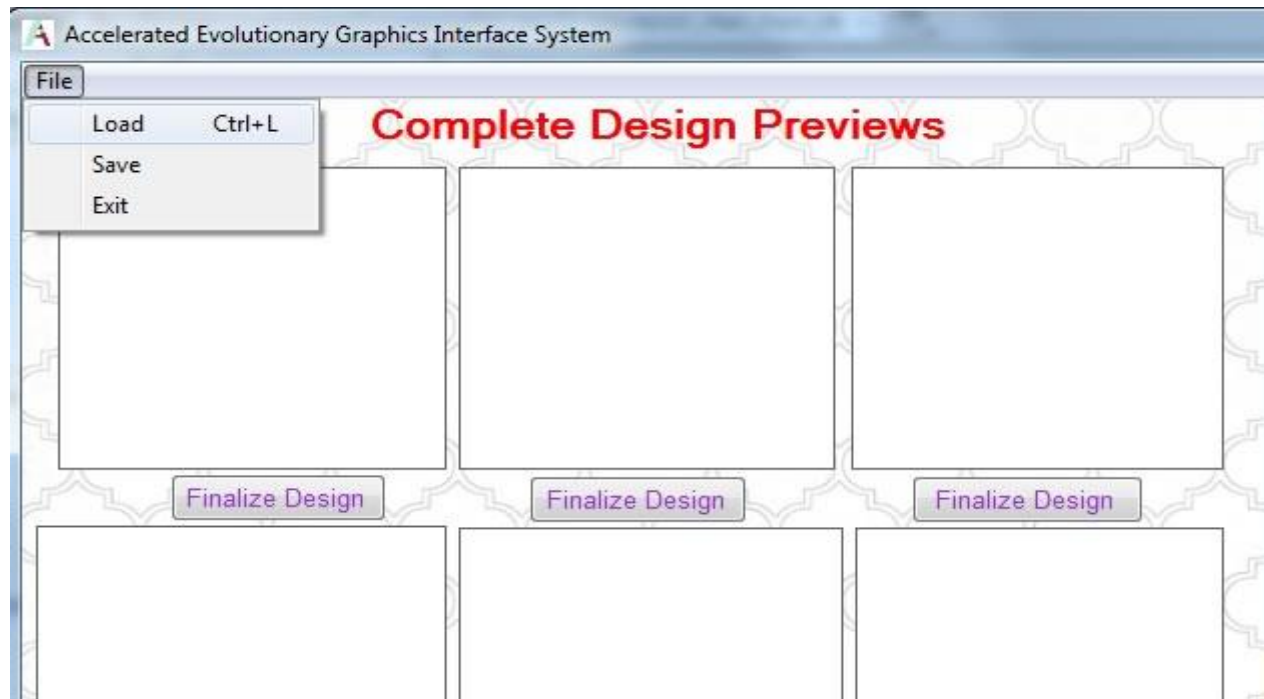


1. After this you need to load your initial design files for the components- Background Image, Logo Image and Extra Branding Information Image (example slogan text, etc). This can be done by clicking on file menu -> Load as shown below.

The minimum width x height dimensions acceptable are (in px):

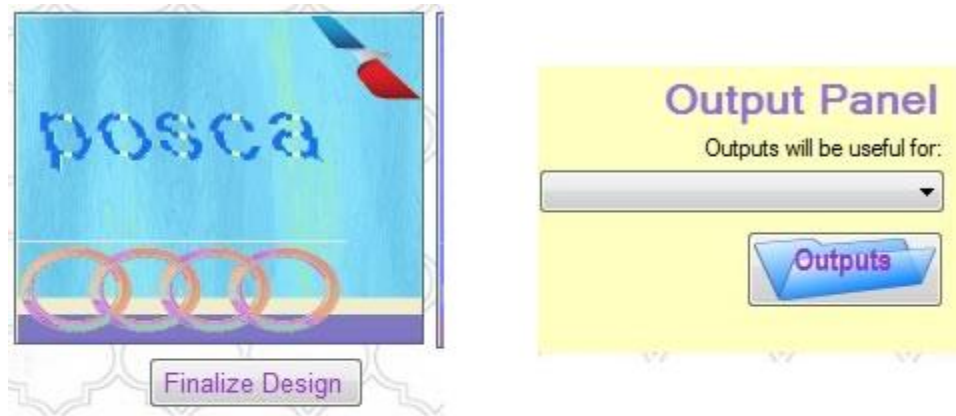
Background (150,161) Logo (40x40) Extra Logo (40x40)

The images should be uploaded in above sequence as the software will prompt you every time about this sequence to guide you promptly.

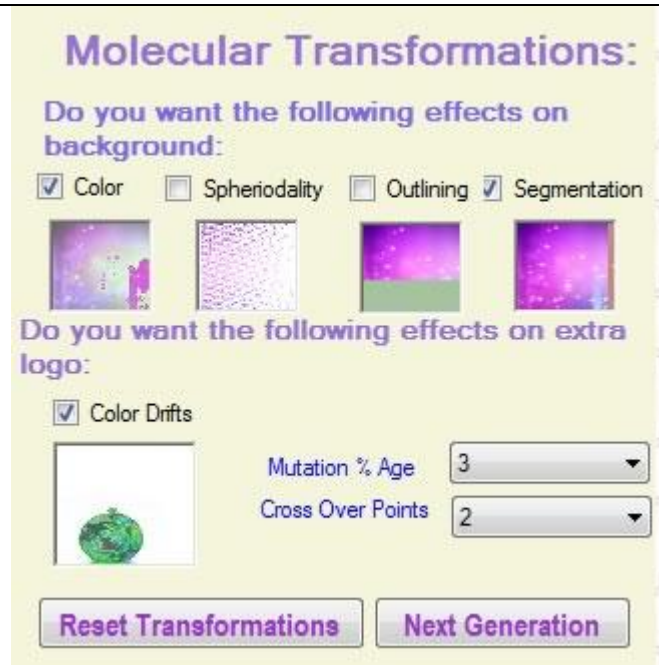


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2. After this step all your files will be loaded. If you are satisfied with any of the complete designs on left, you can press the finalize design button below it (you will also need to provide the information that what purpose this output can be used for). This can be done on the Output panel as shown below.



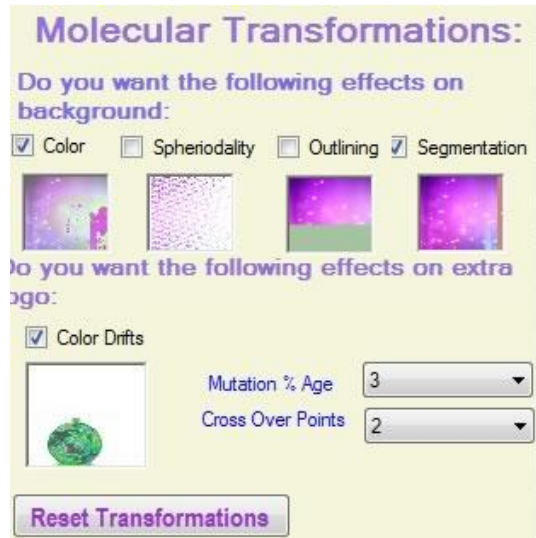
3. If you are not satisfied with the output, you can select three parents by clicking on the images (not on any button) and to generate the next generation you need to press the next generation button as shown below. You can start with a random first generation any time by clicking on the "Reset Transformations" button as shown below.



6. During each generation, you can change your preferences as follows:

- You can change the chromosomes which are active during each generation.
- You can change the mutation rate and crossover rate.

This is shown below.



AEGIS Software Learning Module

Special AEGIS Software Learning Module:

While you are on the complete design transformations page, you can also checkout how others have utilized this software.

1. Press the Load Experience button, that will enable you to view and select from the user sessions list- what patterns/ designs have they created using this software.
2. If you like any of the user designs, you can apply these genes to your design by clicking the apply button.
3. Once you click the apply button, these genes will be applied to the box number 2 (of the 3x3 grid on the left).

Engineering Innovation (Computer Aided Innovation)

4. You can repeat as many times as you want.



AEGIS Buttons

Button Formats:

Pages have different buttons for common functionality.



Close button is used to close the application in case of introductory form and main form. In case of text transformations form, it will take you to the main form.



Restart button is used to restart the application (you need to be patient to allow enough time for the application to close and start again). This allows you to reload every file and input every information again. This is not mostly needed as almost all forms allow you to repeat your actions if you feel you want to make a new design.

While this software is running you can create more than one design. The software is capable of displaying more than 20,000 generations every time.

AEGIS What is Applied Where

Brief about the transformations:

1. The font transformations are applied to the font letter selected first.
2. The three chromosomes are applied to the background layer as on main form - Color Change, Spheriodality, Outlining and Segmentation.
3. One chromosome is applied to extra branding information (extra logo) - Color Drifts.

AEGIS Software Settings

Mutation and Crossover Rate settings:

While you are on the iterations, you can adjust these settings for each iteration.

Wide Search Space

In the initial generations, you can use higher values of mutation and crossover this will enable the software to produce highly versatile results.

Narrow Search Space

When you have reached an advanced stage of generations where you have started liking some designs, you can use lower values of mutation and crossover this will enable the software to produce slightly varied results of the parents.

-----End of -----AEGIS 7.1 Help File 2013 November Version-----End -----

Appendix IX- (New Layout of Design for WoW Web Portal)

The site was shifted to new server (refer to IV.2 -Appendix). The following figures reveal the latest design of wow site. The template of this portal was changed. A more innovative theme was selected; the users were given a new feel and look of user interface. In this design the slideshow of home page changes the pictures randomly and dynamically from the wow website/2D and 3D sections of this web portal database. Figure IX.1 reveals the latest home page on <http://designforwow.com>.

The content is also listed industry wise and latest wow content (up to three documents) are displayed on home page).

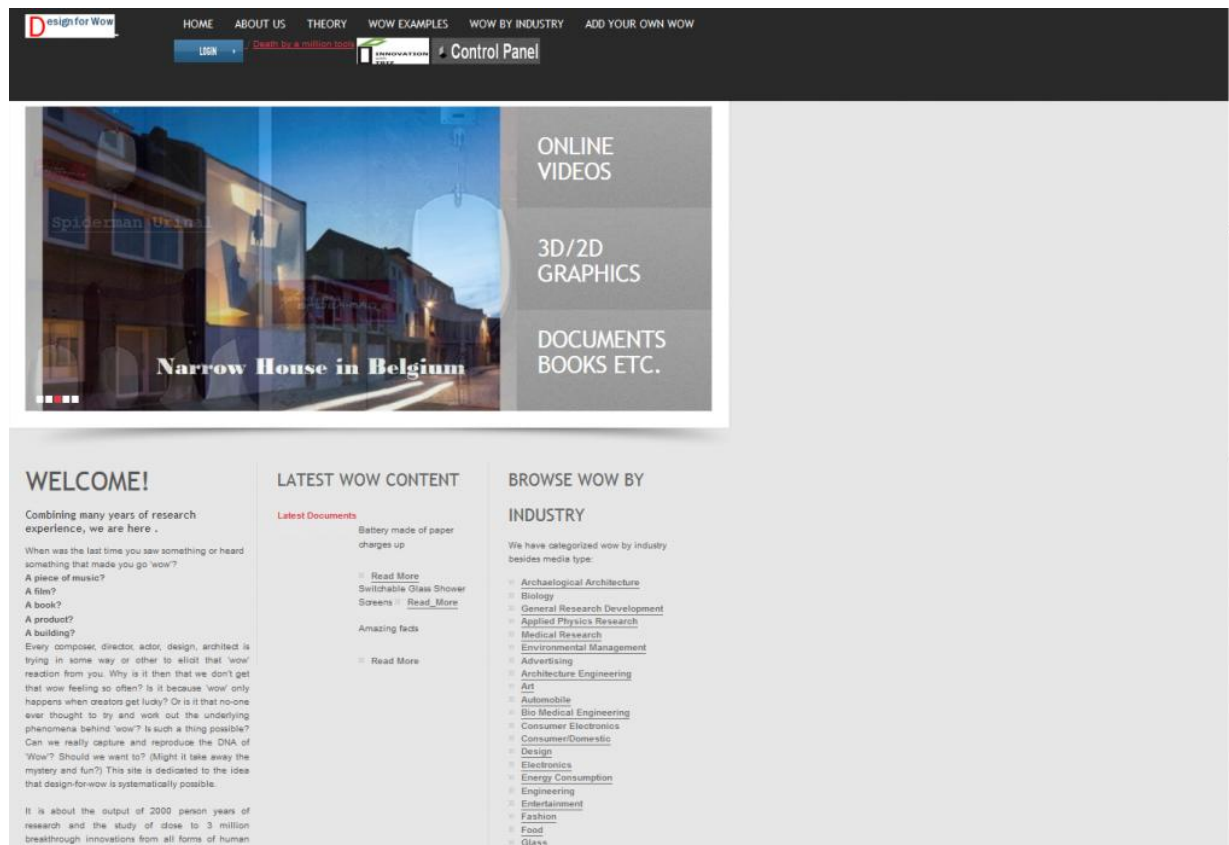


Figure IX.1: Home page of new version of Wow (the slide show on left is dynamically and randomly linked to the database).

IX.1 Site Maps (Navigation Structure)

The Figure IX.2 reveals a detailed sitemap of this portal with detailed name of each dynamic and static file. This site map also reveals the dynamically generated url's resulting in more than one apparent pages on each page (separated by querystring variables viz-id,min,max and Industry Category etc). Figure IX.3 shows the specific site diagram of wow.

Here it may be noted that the menu and lists of industrial sectors are dynamically generated.

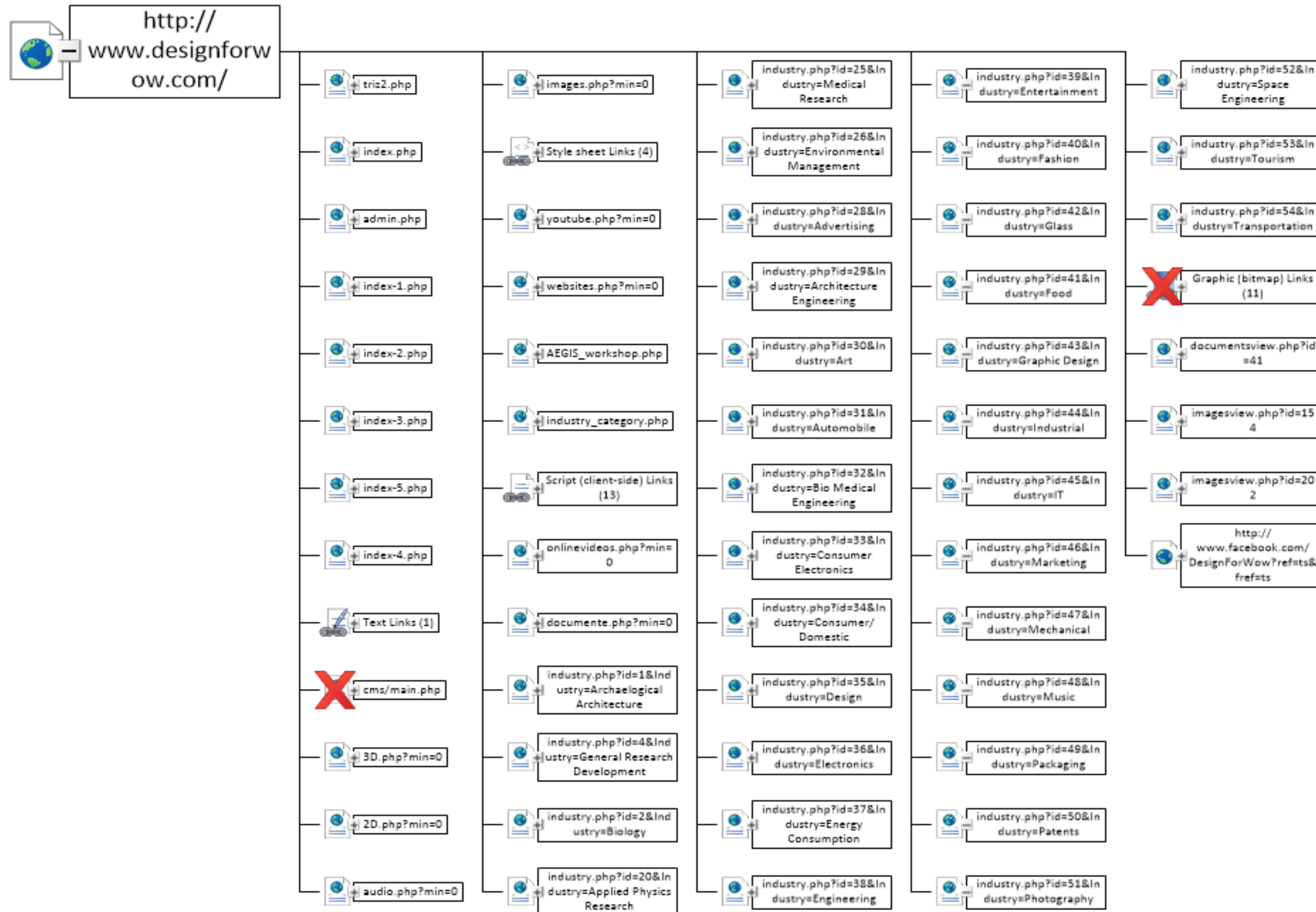


Figure IX.2: Detailed Site Map of wow site generated detailing each dynamic and static page on web root.

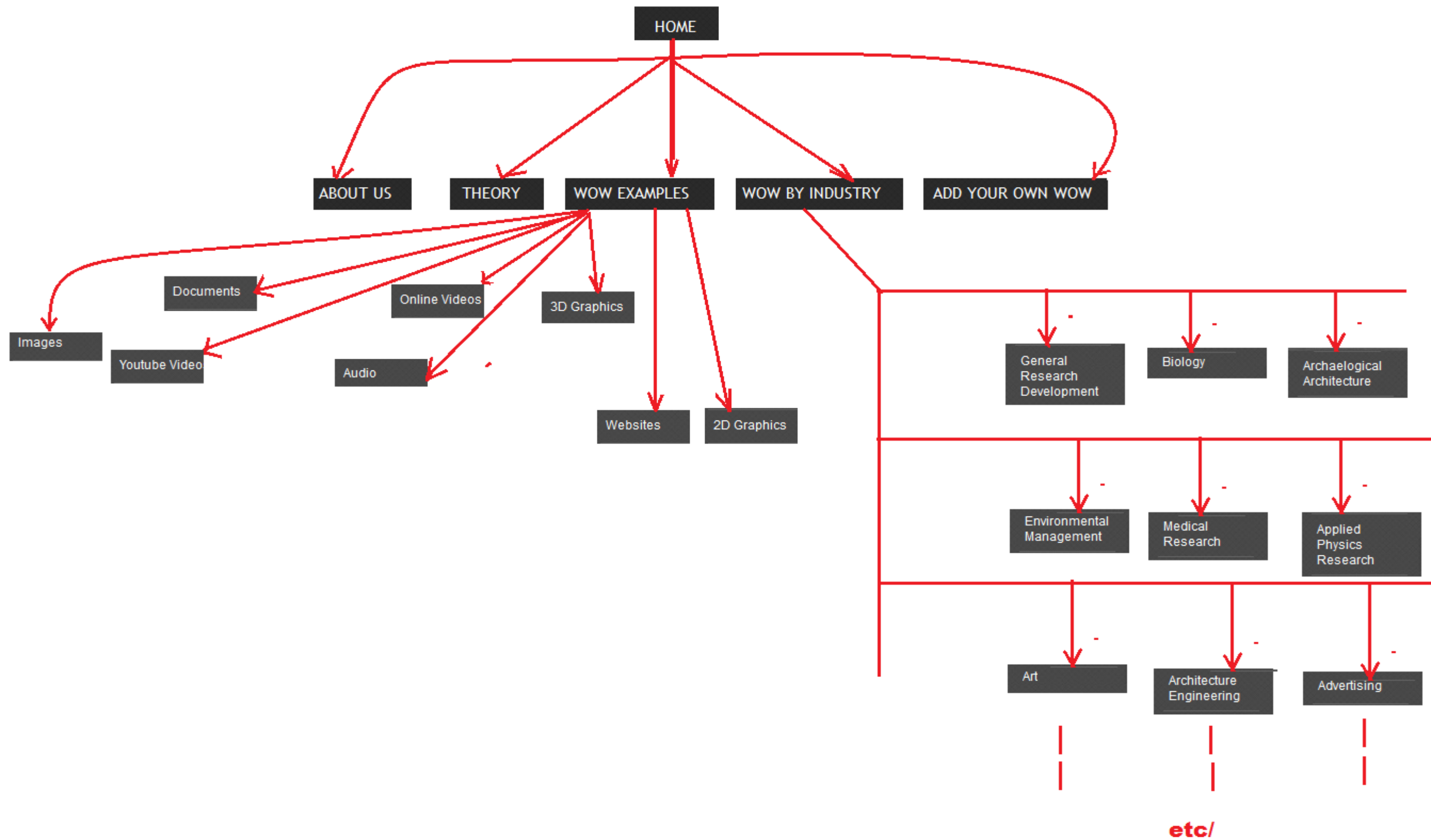


Figure 60:

IX.3 Site Map of wow site detailing main pages.

IX.2 Design for Wow Pages (current version)

Figure IX.4 shows the team associated with this project. Anyone interested about the project can then email the contacts for any queries. The team involved people from Plymouth University and other universities of South West UK along with some leading South West UK companies (innovation solution consultants).

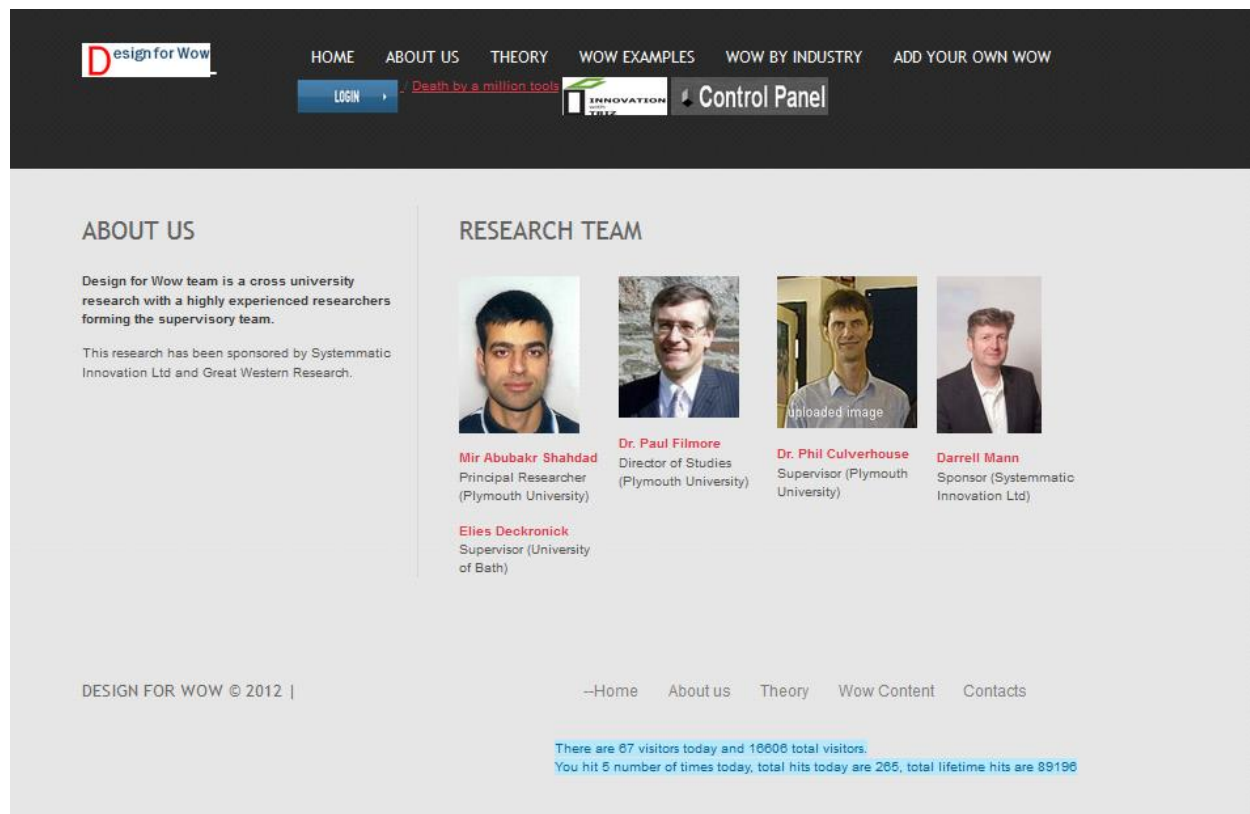


Figure IX.4: Team page (About Us).

The theory page (shown in figure IX.5) is of paramount important to this project website. Any user will be able to have a brief outlook of the TRIZ and a brief about thinking out of the box (at least will be informed that innovation is not random but is a science in itself).


[HOME](#)
[ABOUT US](#)
[THEORY](#)
[WOW EXAMPLES](#)
[WOW BY INDUSTRY](#)
[ADD YOUR OWN WOW](#)

[LOGIN](#)
[Death by a million tools](#)

[Control Panel](#)

DESIGN FOR WOW THEORY



So much for a bunch of examples. The big question now is, what happens when we bring together many thousands of examples and try and distill from them any common features? The start of an answer is that 'wow' happens when some kind of an expectation in the mind of the recipient is confounded. They expect one thing to happen, but something else happens instead. Put another way, wow is about identifying and resolving conflicts, paradoxes and contradictions.

If this is true, then the next thing we need to think about is what that 'something else' might be. Clearly, it seems to us, that something else could just as easily be something negative as it is positive. Actually, like random mutation, there appear to be many more ways to get something wrong than get it right. The global patent database gives us ample evidence of this phenomenon. 97% of inventions will never even pay back the cost of filing the patent application. Spend a few hours looking through patents and two things will become very apparent: there is a lot of rubbish there is a lot of 're-inventing the wheel'

We propose that we will see exactly the same phenomena when we look at any other form of human endeavour – lots of bad solutions, and lots of repetition. With this as a background, what we did next in our research was to look at the successful solutions and try and see what makes them successful. The perhaps startling result of this research – nearly three million analyses (and counting!) later – is that the extent of the wheel re-invention is massive. If creating wow is all about challenging conflicts and paradoxes, what the research shows is that, so far, there are only 40 known ways of achieving that end. Take a look at each of our 'design for wow' categories and you will notice how each and every one can be related to one or more of these 40 ways.

There may be a 41st or (Douglas Adams fans please note) a 42nd way, but so far, wherever we look we can't find them. To all intents and purposes, therefore, creating our 'wow' is going to be all about using one or more of these 40 ways; 40 shortcuts to wow. If you are like us, you will not believe that this can be true. Only 40 ways to create a wow? Nonsense, surely. If this is you, we invite – nay challenge – you to try and find a wow solution that has come from something other than these 40 ways. This is the main reason we are asking for people to contribute their own wow examples. Every day we are trying to test and extend these 40 ways to find new ones. Why would we want to do this, and how difficult will it be? The way we think about it is this. If every 'wow' in the world has come from one or more of these 40 ways, and suddenly we find ourselves armed with a 41st way, we have a tool that will allow us to re-invent the way the world works. If every patent that has ever been comes from one of the 40 ways, and we suddenly have a 41st way, we have the key to re-inventing every one of those patents. That kind of re-inventing the world.

Okay, enough of the theory. Here are links to those 40 wow short-cuts. We have segmented them into different industry and interest topics. If you look at each different category, you will quickly see that the 40 ways, strategies or 'Principles' are all the same, but the examples of where they have been used is different. If you would like to use the 40 short-cuts to solve your problem or create your own wow solution, the way it works is this: find a trade-off, conflict, contradiction or paradox (usually easiest to, first, think of something you would like to improve, and then to work out what is it that prevents you from making the improvement) working through the 40 Principles, try to connect the Principle to the paradox and see if the direction suggested by the Principle solves the paradox.

CASE STUDY

1

Here's a simple example: I want a pen that is able to draw thick lines AND thin lines. This is my paradox. How can one pen do this? Or how about one from the world of film: in the classic boy-meets-girl/boy-loses-girl/boy-gets-girl-back-again movie plot. The paradox usually involves how the boy gets the girl back again. According to our theory, there are only 40 ways the boy can achieve this aim. In actual fact, the movie industry seems to use a far smaller selection. Or, from nature (yup, biology uses the same 40 inventive strategies too): (whale – bubble netting or shark-skin)

2

Check out the 'conflict case study' part of the bibliography to see other examples. (Note: these 40 strategies make it systematically possible to create wow solutions, but the job will absolutely require your creativity. Systematic is not the same thing as 'easy'. We're lucky because we get to practice using the 40 Principles every day in everything we do. If you want help in applying them, you can get in touch with us here.)



DESIGN FOR WOW © 2012 |

[--Home](#) [About us](#) [Theory](#) [Wow Content](#) [Contacts](#)

There are 67 visitors today and 18606 total visitors.
You hit 8 number of times today, total hits today are 288, total lifetime hits are 99197

Figure IX.5: Theory page (TRIZ and thinking out of the box).

Engineering Innovation (TRIZ based Computer Aided Innovation)

The wow example link on home page directs the user to wow category page, wherefrom the user can select the appropriate categories of wow content to view the contents in that category. Currently the portal hosts following type of content (figure IX.6 shows the page):

Images Documents YouTube Videos 2D Graphics

Audio/Music 3D Graphics Online Videos Videos Websites

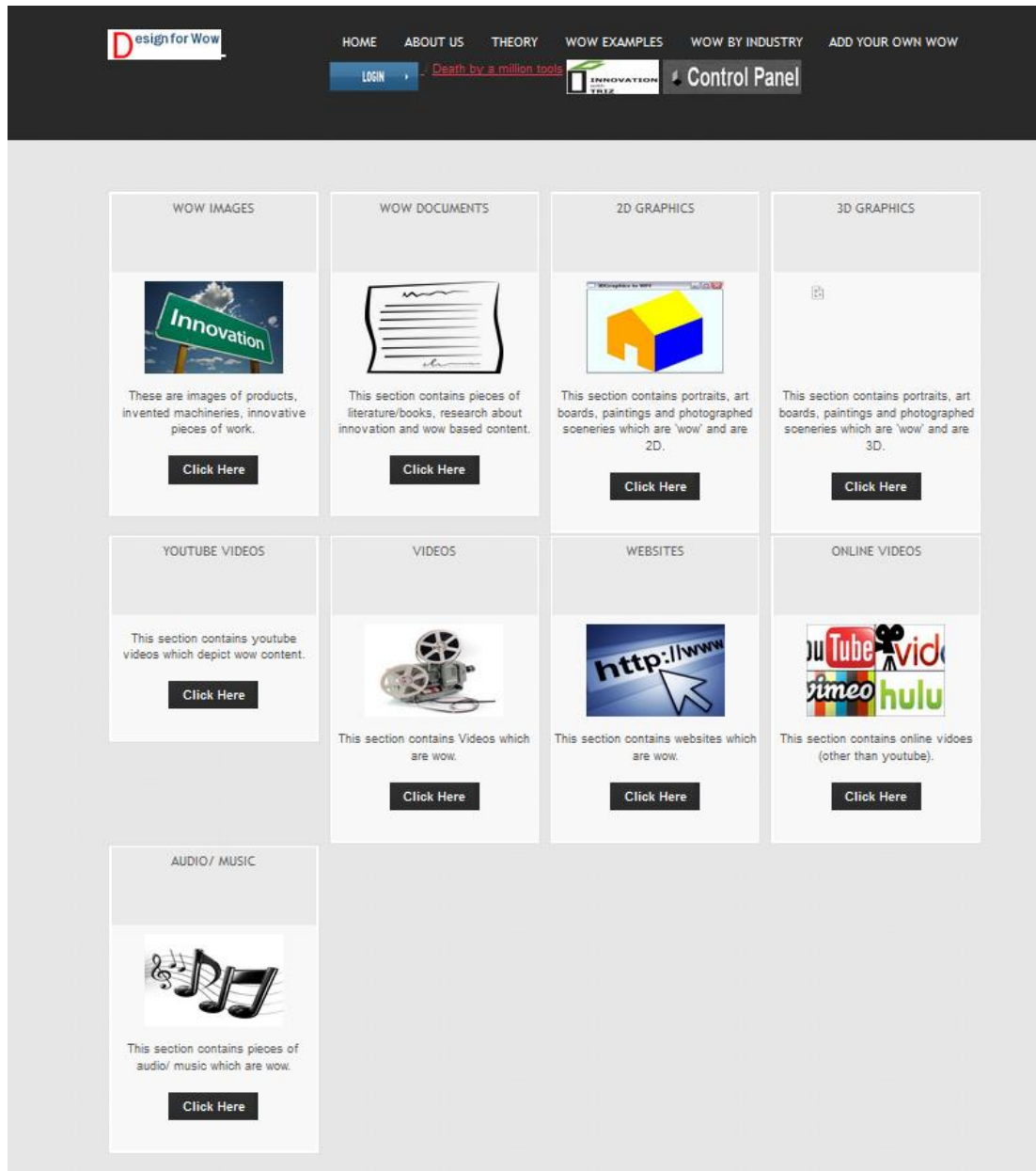


Figure IX.6: Wow Examples category page.

Engineering Innovation (TRIZ based Computer Aided Innovation)

Right from the beginning of this project, it has been made sure that the users are given a choice of freedom and flexibility to submit content to the site. The content is then approved by the researcher (please see figure IX.7, user does not need to register for this operation).

DesignforWow

HOME ABOUT US THEORY WOW EXAMPLES WOW BY INDUSTRY ADD YOUR OWN WOW

LOGIN [Death by a million tools](#) **Control Panel**

SUBMIT YOUR OWN WOW

Anything which makes you say 'wow', please feel free to inform us below about that 'wow'.

Title

Source

What the viewer expects from this wow

What is done in this theme to achieve wow

Any Innovation triggered by this 'wow' content

Industry

Media Type

Reference

File for upload No file selected.

User_Email

Any technical problems, please report to following email id, or use our contact page to reach us.
admin@designforwow.com

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There are 67 visitors today and 16806 total visitors.
You hit 11 number of times today, total hits today are 271, total lifetime hits are 89202

Figure IX.7 Submit own wow page.

Engineering Innovation (TRIZ based Computer Aided Innovation)

The current version of site only allows the registered users (mostly researcher and the research team and reviewers) to edit and add the content more efficiently through a CMS panel as shown in figure IX.8.

Design for Wow Hi abubakr.shahdad@yahoo.com Sign out

HOME | YOUTUBE VIDEOS | ONLINE VIDEOS | IMAGES | MUSIC | DOCUMENTS | 3D'S | 2D'S | WEBSITES |

Online Video

Go to **Page 1**

ID	Title	Source	What the viewer expect from this content	What is done in this theme to achieve wow	Any innovation triggered or achieved from this	Industry Related	Type of media	Reference	Dated	Preview	IP Address	User
47	Audio slideshow - Britain from the Air	http://www.bbc.co.uk/news/uk-11427007	'Britain from the Air' is a free exhibition - jointly created by The Royal Geographical Society, IBG, Weccommunic8 and Ordnance Survey.	From glacier-carved mountain valleys to jagged saw-toothed coastlines, the UK's diverse physical and human geography - as seen from above - is being celebrated in a new street exhibition in Bath.	Britain from the Air is a major national touring exhibition offering an exhilarating perspective of some of the UK's most breath-taking and thought provoking landscapes and landmarks, from the well-known to the less familiar. Since its launch in 2010 Britain from the Air has visited Bath, Oxford and Chatham, and has been seen by more than	Tourism	Online Video	Hannah	2012-01-01 15:15:15	website_preview_112423britain.png	192.168.0.108	1

Figure IX.8: Edit page for CMS for research team and review panel.

Figure IX.9 shows the page which is shown to user after selecting a particular wow content on the CMS panel.

<<<<Previous Online Video Online Video Live Demo:

Field Name	Edit Facility
ID	47
Title	Audio slideshow - Britain from the Air
Source	http://www.bbc.co.uk/news/uk-11427007 http://www.bbc.co.uk/news/uk-11427007
What the viewer expect from this content	'Britain from the Air' is a free exhibition - jointly created by The Royal Geographical Society, IBG, Weccommunic8 and Ordnance Survey.
What is done in this theme to achieve wow	From glacier-carved mountain valleys to jagged saw-toothed coastlines, the UK's diverse physical and human geography - as seen from above - is being celebrated in a new street exhibition in Bath.
Any innovation triggered or achievement from this	Britain from the Air is a major national touring exhibition offering an exhilarating perspective of some of the UK's most breath-taking and thought provoking landscapes and landmarks, from the well-known to the less familiar. Since its launch in 2010 Britain from the Air has visited Bath, Oxford and Chatham, and has been seen by more than five million people.
Industry Related	Tourism ▼ Tourism
Type of media	Online Video ▼
Reference	Hannah
Dated	2012-01-01 15:15:15
File_Name	<input type="button" value="Browse..."/> No file selected website_preview_112423britain.png
IP Address	192.168.0.108
User	1

Confirm Edited Changes [Next Online Video>>>>](#)

Online Video Screenshot (File_Name):




Figure IX.9: Edit page for CMS.

Engineering Innovation (TRIZ based Computer Aided Innovation)

Figure IX.10 shows the TRIZ Principles page for the users who are curious to know about the TRIZ 40 Principles with some practical examples for each Principle. Each Principle section is associated with the information about its sub-Principle.

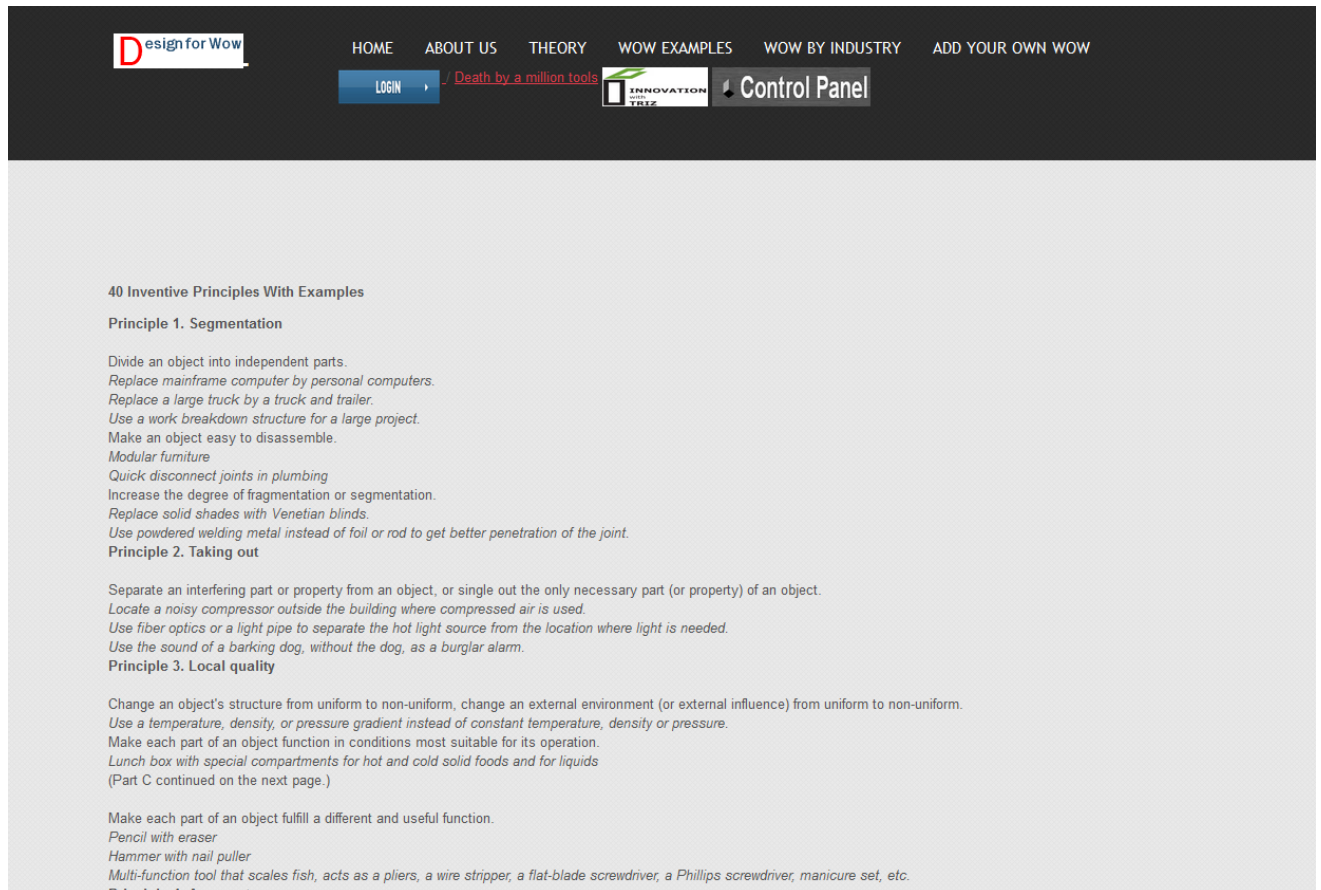


Figure IX.10: TRIZ Forty Principles page.

‘Death by a Million Tools’ is the name given to the bunch of tools which were studied by the researcher in this research to gain knowledge and then categorize the tools in to various problem and solution based tools from the innovation and creative problem literature (Mann, 2008). The information about these tools can be found on the ‘Death by a Million Tools’ link. Figure IX.11 reveals this page (opens separately in new tab as a pdf file attachment).

Specific findings about this section of this research can be found in Appendix-IX of this thesis and section 2.1.1 of chapter 2 of this thesis.

2.1.1 TRIZ

Name: TRIZ

Type: Set of Methodologies, tools and frameworks

Origin: Former USSR

Context: Set of problem solving tools and methodologies and innovation framework.

Description: **TRIZ** means "The theory of solving inventor's problems" and is also called as "The theory of inventor's problem solving". Developed by a Soviet patent investigator and researcher Genrich Altshuller and his colleagues starting in 1946, TRIZ has been evolving ever since (Altshuller 1984).

TRIZ is a

- Methodology
- Tool set,
- Knowledge base,
- Model-based technology for generating innovative ideas and solutions for problem solving.

TRIZ provides tools and methods for use in problem formulation, system analysis, failure analysis, and patterns of system. TRIZ, in contrast to techniques such as brainstorming (which is based on random idea generation), aims to create an algorithmic approach to the invention of new systems, and the refinement of old systems (Altshuller 1984).

Some TRIZ is in the public domain. Some TRIZ resides in knowledge bases held by commercial consulting organizations. A complete and open TRIZ development process is not yet evident. Various camps vie for control of TRIZ and interpretation of its findings and applications.

This research is based mainly on three TRIZ tools (besides many other additional tools) (Altshuller 2009),

Figure IX.11: 'Death by a Million Tools' page.

Appendix-X –Image breeder and Other Graphic Tools

Image Breeder, Pic Breeder and Adobe Photoshop CS 2009

Adobe Photoshop

Adobe Photoshop is one of the most popular tools used by graphic designers. This fact was revealed in the questionnaires. One of Photoshop's most powerful features is the use of layers. Each layer in a Photoshop document is a separate image which can be edited apart from any other layer. A layer can be envisioned as an image on a sheet of clear material. Together, all the layers form a stack of images (Adobe Products 2010).

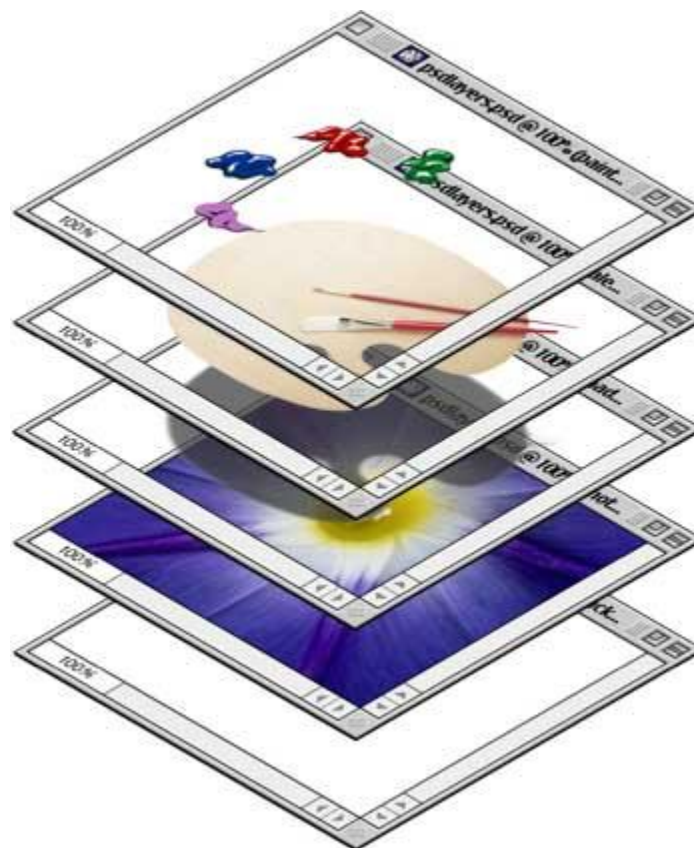


Figure X.1: Depicting the working of adobe Photoshop in layers.

Layers are managed with the Layers palette. The Layers palette displays a small thumbnail view of each layer to help identify it. The appearance of a Photoshop document is a view of the layer stack from the top down.

Image-Breeder and Pic Breeder

The idea of AEGIS started Image-Breeder (Image Breeder 2009), which was the basic and first step towards an automated 'wow' design capability. What was desirable about the site, that it allowed users to mutate and create new images in a nice and user-friendly format? What was undesirable about it is was that the mutations were random and therefore it took too long to generate an attractive (useful) image.

Engineering Innovation (TRIZ based Computer Aided Innovation)

One of the things desirable in this project was to make a better version of image breeder. Rather than have it as a tool for making just pretty pictures, making to do a more useful design job.

A considerable step was to integrate some of the TRIZ Principles into the mutation algorithms so that instead of being random they are much more guided towards the 'wow' direction. A sample preview of the transformations has been provided in Figure X.1.

There are three modules in image breeder website namely gallery, breeder and blog. In the breeder module, evolution / mutation start with very simple images. Users click on any one that shows more complexity to get things moving forward in the direction of evolution (increasing complexity). “Fast and free” clicking is entertained in the site to enable users at some point of execution select some images of the interest. If nothing more interesting than last image pops up then users can click it again.

There are two modes of working of image breeder- simple and advanced. In the simple version, the image selected is mutated randomly and random off springs are displayed in 16 boxes (4x4). After that the user can select on the desired mutation to carry on. The execution of breeder module of image breeder does not start with any input image; hence the random images are displayed in the 16 boxes during the first iteration. This webtool basically generates combinations four basic shapes- circle, rectangle, line and curve.

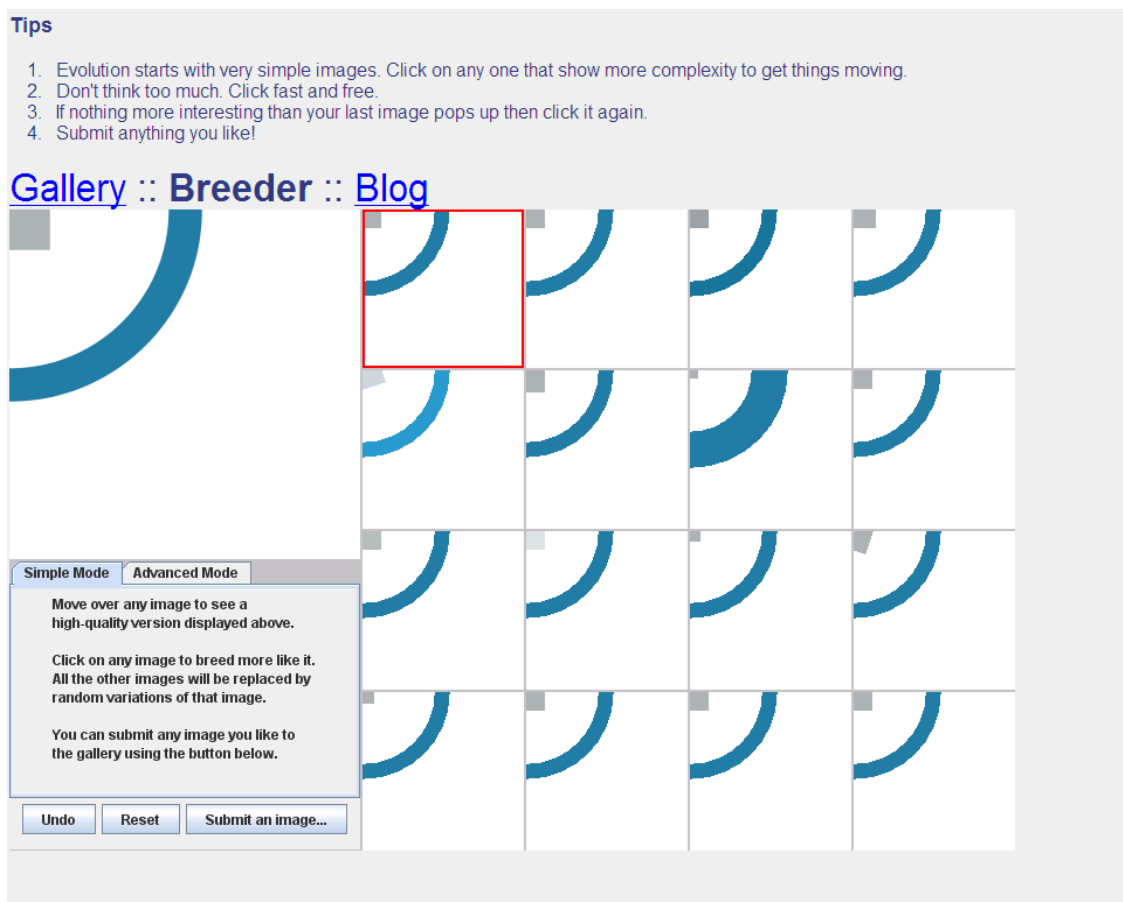


Figure X.2: A preview of how the image breeder manipulates the images in simple mode.

Engineering Innovation (TRIZ based Computer Aided Innovation)

To summarize, the drawbacks in image breeder which were necessary to be removed and hence AEGIS development was inevitable to achieve the objectives of this research are listed as under:

- Initial images are not supplied by the user; hence the user is forced to start with the randomly generated parent images.
- All the mutations are random in nature as mentioned in the website specifications (see figure X.2)
- The user is not given any option of choosing any particular algorithm or direction of the evolution of images. The only control which the user has over the evolution is the ability to select the off springs during each iteration.
- The webtool enters a deadlock phase if the user selects all 16 images in advanced mode as parents.

Another mode of operating the image breeder is the advanced mode (see figure 3.26) in which the user can cross-breed the parents. The user in this mode can select more than one (up to 16 off springs) as new parent. Hence in this case, the iterations can have more than one parent. Off springs can be toggle locked. If the user likes any offspring, that offspring can be toggle locked, in subsequent iterations the toggle locked image will remain static irrespective of the iterations going on.

The gallery module of image breeder allows the user to 'remember' good images and rate them. The blog module allows the users to interact with each other to discuss the functionalities of image breeder and to compare it with other tools like picbreeder using blog threads.

To summarize, the features from which the design team got some aspirations about the design of advanced features in AEGIS are listed below:

- The 'good' images can be saved in gallery by the user.
- The images can be rated by users.
- Advanced mode allows users to pick and choose more than one parent image for the subsequent mutations.

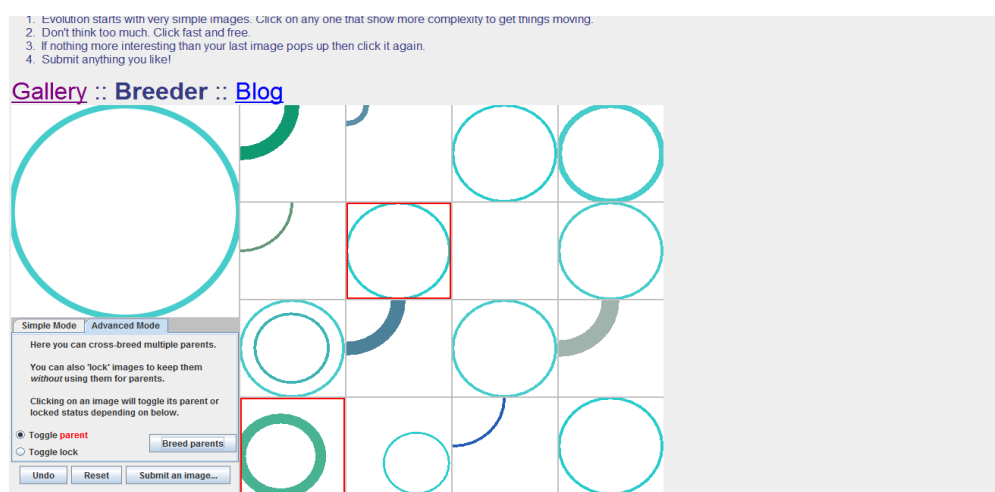


Figure X.3 : A preview of how the image breeder manipulates the images in advanced mode

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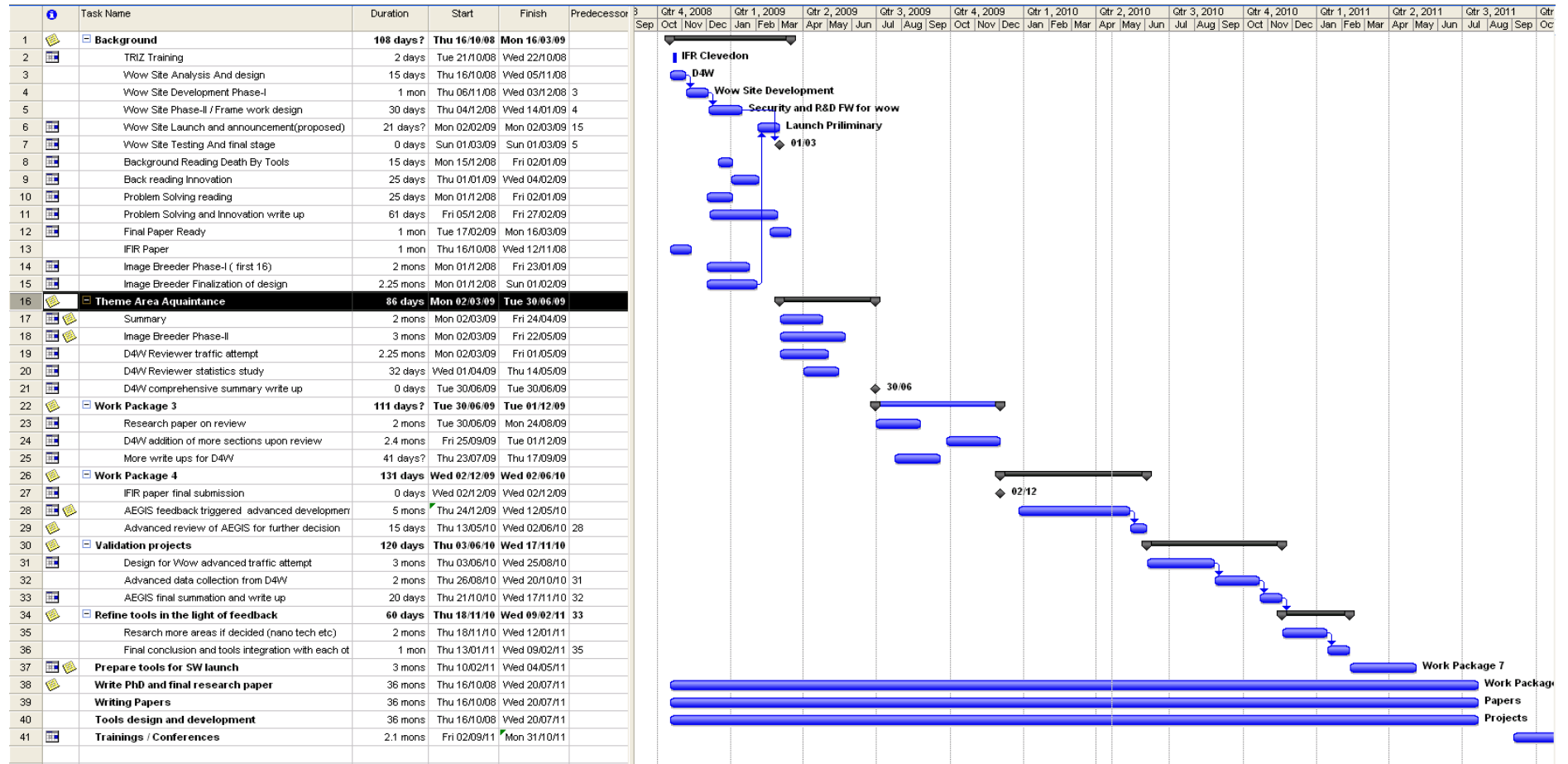
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Engineering Innovation (TRIZ based Computer Aided Innovation)

Appendix XII- Previews Work Plan (2010 report)



Appendix-XIII (Papers Published on this Research)

Mann, D., Shahdad, A., Filmore, P. and Dekoninck, E., 2009. From Computer-Aided Invention To Computer-Aided Innovation. In: 11th International TRIZ Conference (TRIZCON2009), 2009-03-16 - 2009-03-18, Woodland Hills, CA. http://www.aitriz.org/index.php?option=com_content&task=view&id=335&Itemid=128	2
Shahdad, A., Filmore, P., Mann, D., Dekoninck, E. (2009) Automating the Innovation Process using Computer-Aided Innovation, Proceedings of the 2nd ISPIM Innovation Symposium: Stimulating Recovery – The Role of Innovation Management, Huizingh, Torkkeli, Conn, Bitran (Eds.), New York City USA, 6-9 th Dec 2009, ISBN 978-952-214-864-3 (2009).	0
Shahdad, A. (2009) From Computer Aided Invention to Computer Aided Innovation, Proceedings of UK TRIZ Symposium 1, 14/5/09, Clevedon, UK, ISBN 978-1-906769-12-13.	0
Shahdad, A. (2010) AEGIS- Intelligent Mutation Design Support Software Capability Development, Proceedings of UK TRIZ Symposium 2, 13/5/10, Clevedon, UK, ISBN 978-1-906769-23-9.	9
Shahdad, A. (2010) AEGIS- Intelligent Mutation Design Support Software Capability Development, Proceedings of UK TRIZ Symposium 2, 13/5/10, Clevedon, UK, ISBN 978-1-906769-23-9.	2
Filmore, P., Mann, D., Shahdad, A. (2010) Computer-Aided (Systematic) Innovation – new tools and new ways of thinking, Proceedings of the Sixth TRIZ Symposium in Japan 2010, 9-11 September 2010, Kanagawa Institute of Technology, Atsugi, Kanagawa, Japan.	0
	1
	0

Shahdad, A. (2011) Design for Wow- Analysis of TRIZ Principles in Wow, Proceedings of UK TRIZ Forum #3, Clevedon, Nr. Bristol, 12 th May 2011, ISBN 978-1-906769-16-1.	2
Shahdad, A. (2011) Computer Aided Innovation -Design for Wow and AEGIS, PC CAT 2011, Exeter, 26 May 2011.	0
	1
	1
Shahdad, A., Filmore, P. (2011) Using TRIZ Principles to Analyze the Degree and Patterns of Innovation in Designs DESIGN FOR WOW, Proceedings of 3 rd International Conference on Systematic Innovation& Global TRIZCON 2012, Korea, July 2012	2
	0
	1
Shahdad, A (2012) Automating Innovation using TRIZ for Graphic Designers-AEGIS- Software Package , PC CAT 2012,Plymouth, May 2012.	2
	2
Shahdad, A., Filmore, P. (2013) Applying TRIZ to Graphic Design using Genetic Algorithms, The Joint International Conference on Systematic Innovation & IFIP Computer-Aided Innovation, Hsinchu, Taiwan, 27-29 th June 2013.	2
	0
	1
Shahdad, A., Filmore, P. (2013) Applying TRIZ to Graphic Design using Genetic Algorithms, Proceedings of TFC2013, Paris 28-31 st October 2013, ETRIA/ Elsevier.	3
Shahdad, A., Filmore, P. (2013) Applying TRIZ to Graphic Design using Genetic Algorithms – an Update, Proceedings of UK TRIZ Symposium 5, 1/11/13, Clevedon, UK	

Abstract of Paper at TRIZCON (2009)

From Computer-Aided *Invention* To Computer-Aided *Innovation*

Mir Abubakr Shahdad
Dr Paul Filmore
Plymouth University

Dr Elies Dekoninck
University of Bath

Darrell Mann
Director, Systematic Innovation Ltd, UK
Phone: +44 (1275) 337500
E-mail: darrell.mann@systematic-innovation.com

Abstract

The paper describes the form, content and initial results from an on-going three year programme of research to create a TRIZ-based computer-aided innovation capability.

While several previous attempts have been made to integrate the ability to automatically and autonomously create discontinuous inventive steps through computer-based design tools (*computer-aided invention*), none so far has been able to discriminate between steps that are likely to be useful versus steps that are merely steps.

The difference between useful and non-useful step-changes is shown to be dependent on the *context* within which a technical or business system being evolved is expected to operate. Or, to take a specific example, while it is very simple to automate the process of segmenting (Inventive Principle 1) a given design feature, it is very difficult to establish whether such a jump is something that will be useful to a potential customer.

The paper describes tools and strategies that, first, permit the automatic capture of large quantities of user contextual information, and then second, can help determine which of the possible discontinuous jumps are most likely to fit that context.

Slides from TRIZ Practitioners Event Conference Presentation (2009)

Quick Introduction

From Computer Aided Invention to Computer Aided Innovation

Mir Abubakr Shahdad

- Doing PhD in CAI in Univ. of Plymouth.
- Basic theme of my research is CAI.
- TRIZ is an integral part of my research.

IFR, Clevedon, UK TRIZ Practitioner Event 2009 May, 14

5/14/2009

IFR, Clevedon, UK TRIZ Practitioner Event 2009 May, 14

5/14/2009

Slides from TRIZ Practitioners Event Conference Presentation (2009)

Need for Innovation

- Technological change is also the history of human beings evolution.
- Product performance, user friendliness and velocity of evolution compel industries to change their designs and advance for competition and globalization.

Race of competition

- In this rapid race of competition, some industries just try to change rapidly and hence more randomly and non systematized manner.
- Somehow this change is not last longing fruitful.
- Only a good design wont do the job, an ideal design is the ultimate solution (IFR).

IFR, Clevedon, UK TRIZ Practitioner Event 2009 May, 14

5/14/2009

IFR, Clevedon, UK TRIZ Practitioner Event 2009 May, 14

5/14/2009

Slides from TRIZ Practitioners Event Conference Presentation (2009)

Some rules for Innovation

- Many research activities have more or less proven that innovation is systematic (Common sense is not the best solution).
- Some rules need to be applied to check the ideal solution.
 - Example– Law of completeness as depicted by Darrell Mann in his book.
 - Example– Solving contradictions.

IFR, Clevedon, UK TRIZ Practitioner Event 2009 May, 14

5/14/2009

Difference

- The difference between computer aided design and computer aided innovation is a big one if analysed properly.
- For example, difference between CAI tools and CAD/CAM/CAE tools is a good example.
 - CAI is a young domain in CAx technologies.
 - These new CAI tools stand out from other tools.

IFR, Clevedon, UK TRIZ Practitioner Event 2009 May, 14

5/14/2009

Slides from TRIZ Practitioners Event Conference Presentation (2009)

Goal of CAI in industries

- To support enterprises throughout the complete innovation process.
- Role of CAI tool starts from helping identifying customer requirements.
- Many CAI tools help design engineers to design better products.
- Lastly, helping turn inventions in to market successful and sustainable innovations.

Our current efforts and research in CAI

- To make some CAI tools which automate the process of TRIZ tools implementation.
- Example, automation of TRIZ trends.
- After that we analyse that which part was useful and which was not in context of user requirements.
- Our other tools include knowledge capture mechanism and capture of WOW moments and comparing with TRIZ principles.

IFR, Clevedon, UK TRIZ Practitioner Event 2009 May, 14

5/14/2009

IFR, Clevedon, UK TRIZ Practitioner Event 2009 May, 14

5/14/2009

Slides from TRIZ Practitioners Event Conference Presentation (2009)

Some research questions

- Is every ideal solution covered by TRIZ principles.
- Does TRIZ always give more ideal solutions as compared to other methods.
- Is it possible to 100% automate innovation .

Thank you

- Thank you for listening to me

IFR, Clevedon, UK TRIZ Practitioner Event 2009 May, 14

5/14/2009

IFR, Clevedon, UK TRIZ Practitioner Event 2009 May, 14

5/14/2009

Slides from Sixth TRIZ Symposium Presentation in Japan (2010)

Computer-Aided (Systematic) Innovation

– new tools and new ways of thinking



Dr Paul Filmore, University of Plymouth
Darrell Mann, Systematic Innovation Ltd.
Mir Abubakr Shahdad, University of Plymouth



6th Japanese TRIZ Symposium, 9-10 September 2010

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Computer-Aided (Systematic) Innovation

– new tools and new ways of thinking

- 1) Setting The Scene
- 2) AEGIS
- 3) ApolloSigma
- 4) iTrenDNA
- 5) Conclusions/Future Work

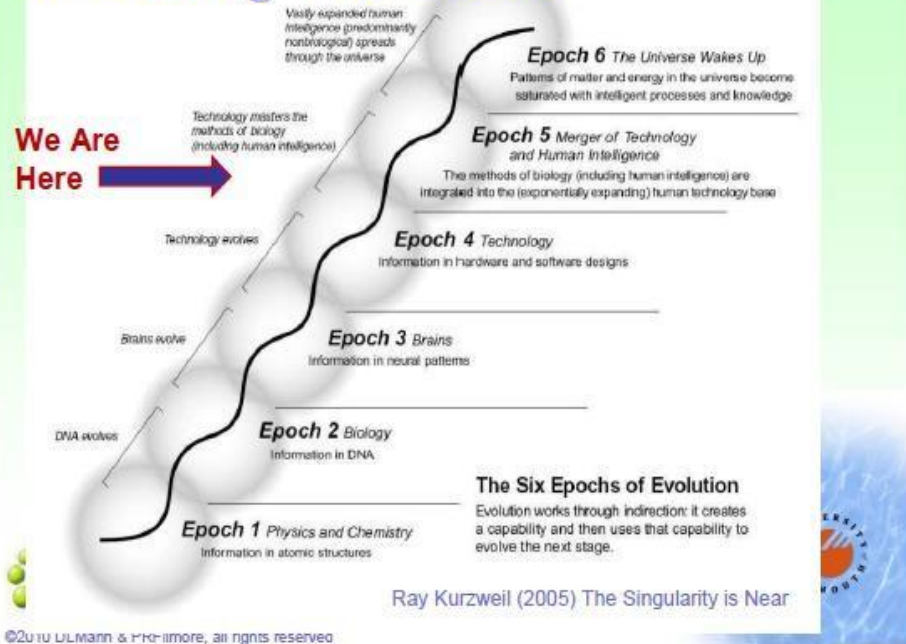


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Slides from Sixth TRIZ Symposium Presentation in Japan (2010)

1. Setting The Scene



When...

- Computers are 'more intelligent' than humans (2020)
- Software writes software (2025 (some does already))
- Robots manufacture (already here)
- Robots control agriculture....



...a lot of industries will be transformed beyond recognition...
It will happen whether we like it or not.
Play or die. These are the options.

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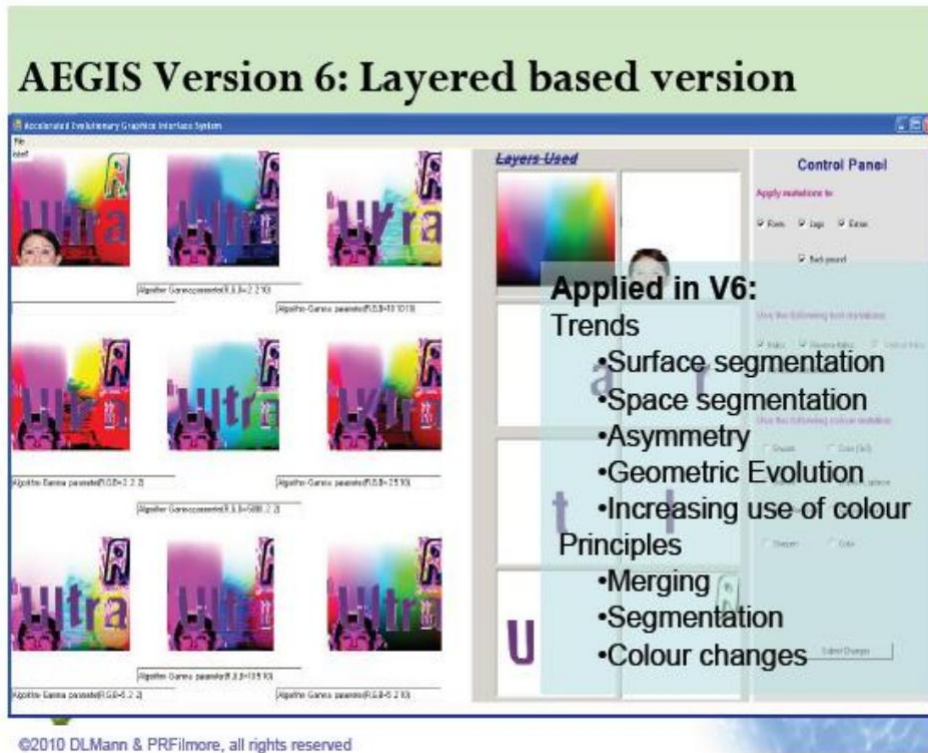
AEGIS: Accelerated Evolutionary Graphics Interface System

AEGIS- Version 4

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AEGIS- Version 5

Slides from Sixth TRIZ Symposium Presentation in Japan (2010)



Slides from Sixth TRIZ Symposium Presentation in Japan (2010)

How Much Is My IP Worth?

Short Answer:
whatever someone is prepared to pay for it

But:
organisations are increasingly expected to include patents and other IP onto their balance sheet

Why Value IP?

- Evaluating potential merger or acquisition candidates
- Identifying and prioritising assets that drive value
- Strengthening positions in technology transfer negotiations
- Making informed financial decisions on IP maintenance, commercialisation and donation
- Evaluating commercial prospects for early stage R&D
- Valuing R&D efforts and prioritising research projects
- Supporting a valuation for loan collateral



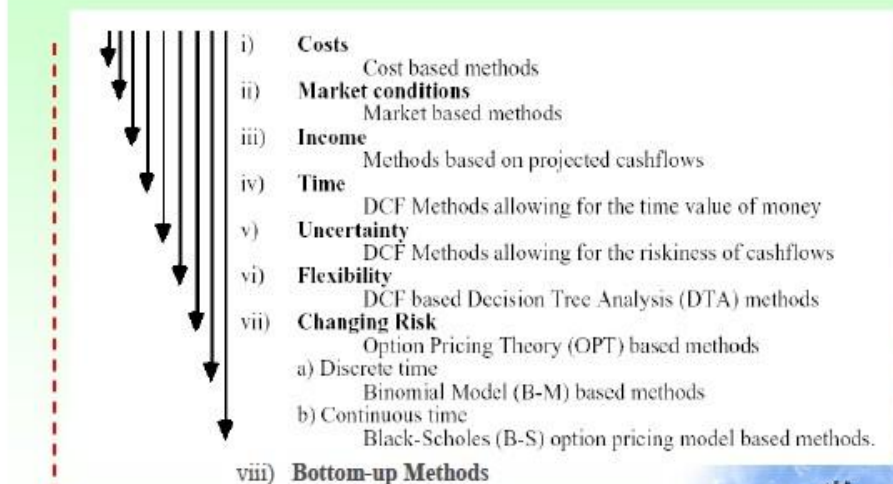
"The new millenium will see a new breed of corporate raiders who strip out and sell intellectual property, just as their predecessors did with undervalued tangible assets in the 1980s."

Susan Chaplinsky, University of Virginia

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Re-Thinking IP Valuation

Patent Valuation Methods



Increasing sophistication

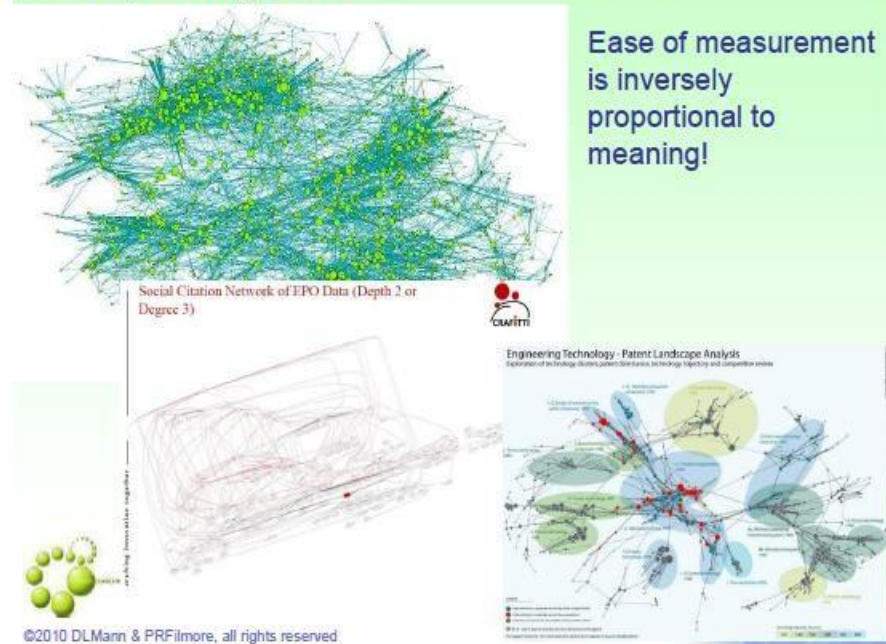
Robert Pitkethly, University of Oxford

<http://bus6900.alliant.wikispaces.net/file/view/EJWP0599.pdf>

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Slides from Sixth TRIZ Symposium Presentation in Japan (2010)

Crackpot Rigour?



- * How much is my IP portfolio currently worth?
- * How will its value change in the coming months and years?
- * What are the disruptive threats that could appear from other industries, what impact could they have on mine, and what do I need to do about it?
- * What are the possibilities for me to exploit my existing IP into other industries?

IP valuation is divorced from business strategy because today it delivers the wrong information, too late.



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Slides from Sixth TRIZ Symposium Presentation in Japan (2010)

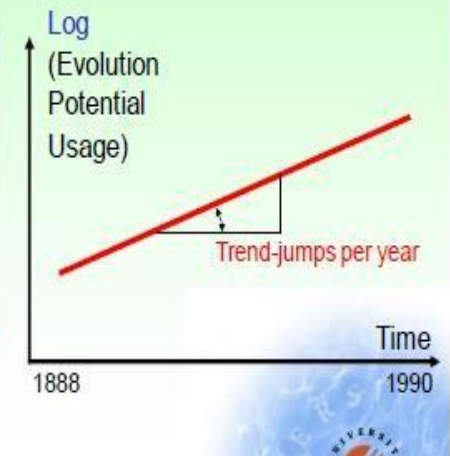
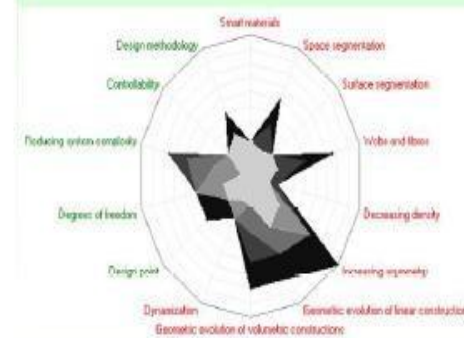
Calculating IP Value (Index)

Current Value = $f \{ \text{problems being solved} \}$

problems • alignment problems • alleviate the impact degree • availability problems • avoids problems •
cause problems • collision of a robot arm • communication problems • constraint satisfaction problems • control
problems • conventional cable arrangement system of the industrial • conventional control method for the mobile
variations • feeding problems • flash problems • hardware malfunction of software bugs •
heat resistance of the glass substrate • increase in the cost • increased cost of the robot controller •
insufficiencies in the point • interaction problems • interference between the first arm • interference problems •
interference with peripheral equipment • irregularity problems • leakage problems • multiple triggering on speckle effect •
operator cause problems • presents problems • robotics problems • safety problems •
scrap problems • speckle in the resultant image due • term drift problems • variations in
orientation due • verifying that the wireless connection • vision problems • wafer
slippage on a robot blade

Calculating IP Value (Index)

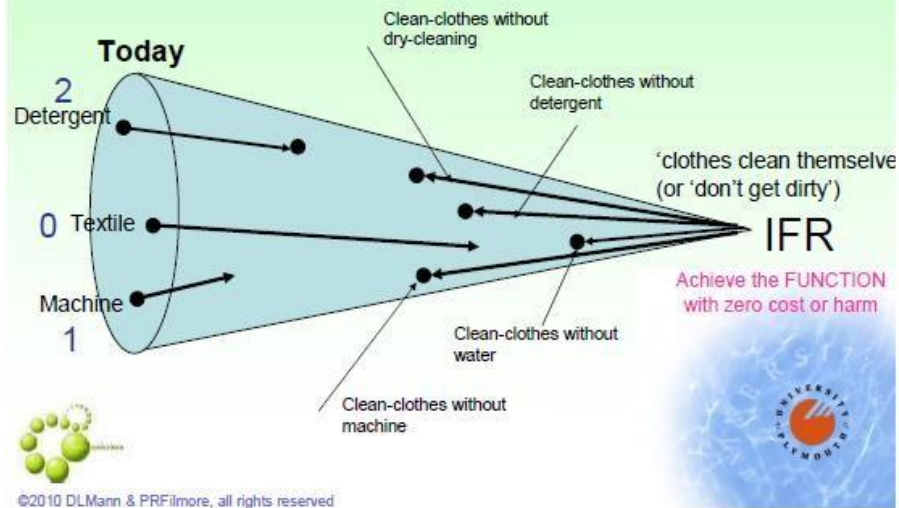
Future Value = $f \{ \text{untapped evolution potential, rate of change} \}$



Slides from Sixth TRIZ Symposium Presentation in Japan (2010)

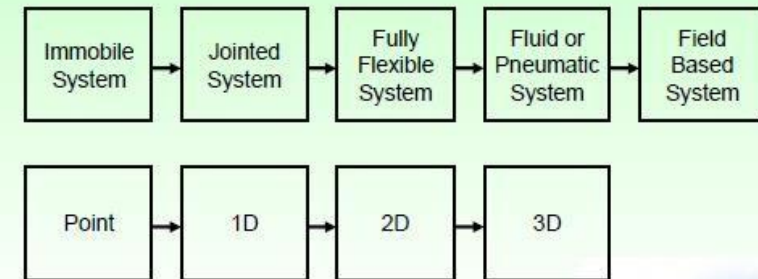
Calculating IP Value (Index)

Future Value = $f \{ 1/\text{number of steps from MUF IFR} \}$



Calculating IP Value (Index)

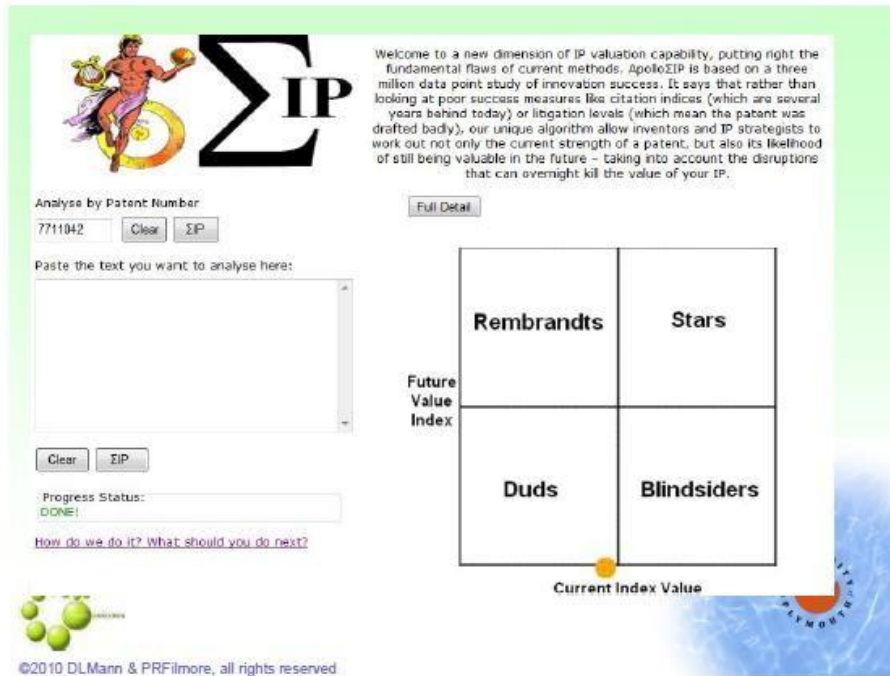
'Good' Words: flexible, fluid, field...



Bad words: immobile, rigid, straight, perpendicular, etc



Slides from Sixth TRIZ Symposium Presentation in Japan (2010)



Welcome to a new dimension of IP valuation capability, putting right the fundamental flaws of current methods. ApolloΣIP is based on a three million data point study of innovation success. It says that rather than looking at poor success measures like citation indices (which are several years behind today) or litigation levels (which mean the patent was drafted badly), our unique algorithm allow inventors and IP strategists to work out not only the current strength of a patent, but also its likelihood of still being valuable in the future – taking into account the disruptions that can overnight kill the value of your IP.

Analyse by Patent Number
7711042

Paste the text you want to analyse here:

Progress Status:
DONE!

[How do we do it? What should you do next?](#)

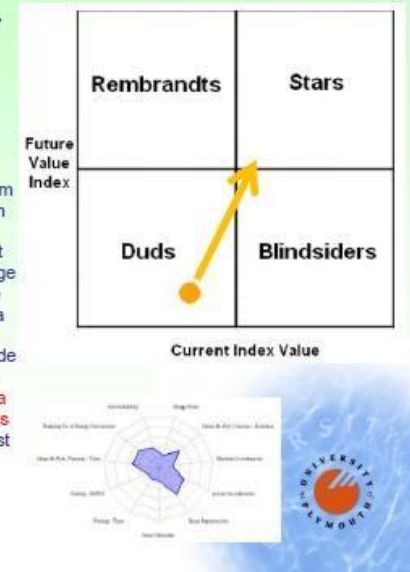
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From Analysis To Design

1) Inventor analyses solution prior to filing:

2) Recommendations based on bad and good words

1. A method of updating a code image in a storage medium storing an operating system having a first region, on which a boot code is loaded, a second region, in which a first code image is stored, and a third region, in which the boot code and a first check data for verifying the first code image are stored, the method comprising: storing a second code image in the second region; extracting information about a secure one-way function from the first check data; and generating second check data for verifying the second code image using the extracted information of the secure one-way function and storing the generated second check data in the third region, wherein, when the second check data is set as a parameter of the secure one-way function, the first check data is generated.



Slides from Sixth TRIZ Symposium Presentation in Japan (2010)



What Makes These Things So Successful?



Slides from Sixth TRIZ Symposium Presentation in Japan (2010)

Innovation Happens When....

Voice
Of The
Customer



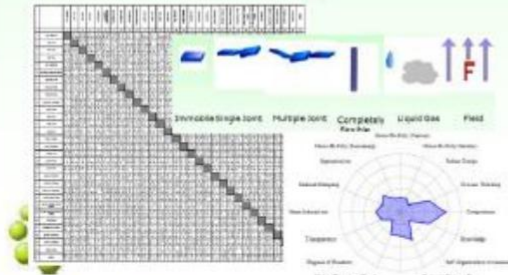
matches

Voice
Of The
System

TRIZ very good
at this job



Voice
Of The
System



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The Perfect Shirt?



- Big AND small
- Thick AND thin
- Cheap AND expensive
- Sport AND formal
- Harmonious AND striking...
- 'X-Factor'
- SELF – cleaning
- SELF – ironing
- SELF - repairing

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Slides from Sixth TRIZ Symposium Presentation in Japan (2010)

TRIZ great for
getting this far...



...but which directions
should we pursue?
And in what order?



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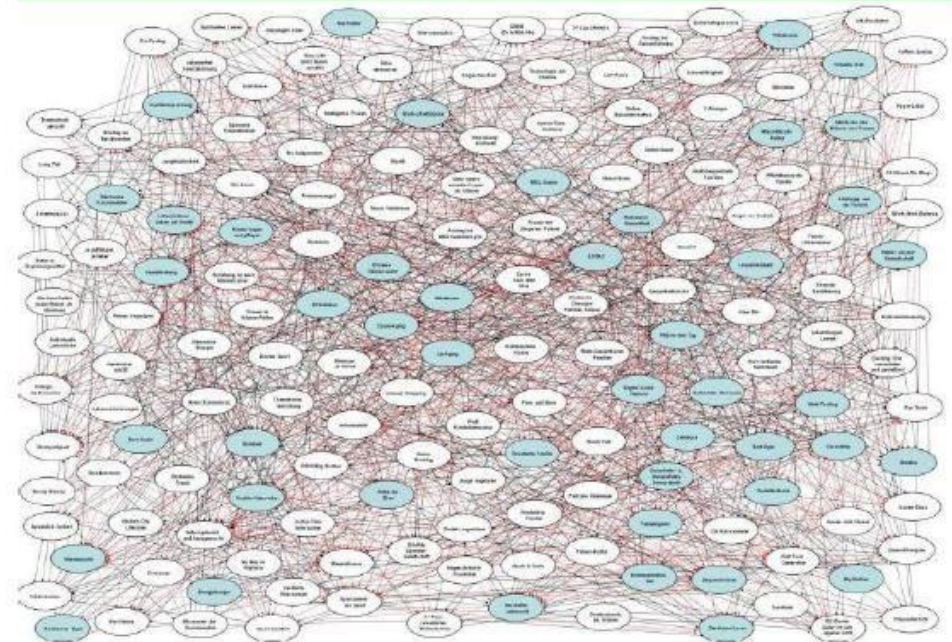
Big AND small
Thick AND thin
Cheap AND expensive
Sport AND formal
Harmonious AND striking...

'X-Factor'

SELF – cleaning
SELF – ironing
SELF - repairing



Everything Connected To Everything Else



Slides from Sixth TRIZ Symposium Presentation in Japan (2010)

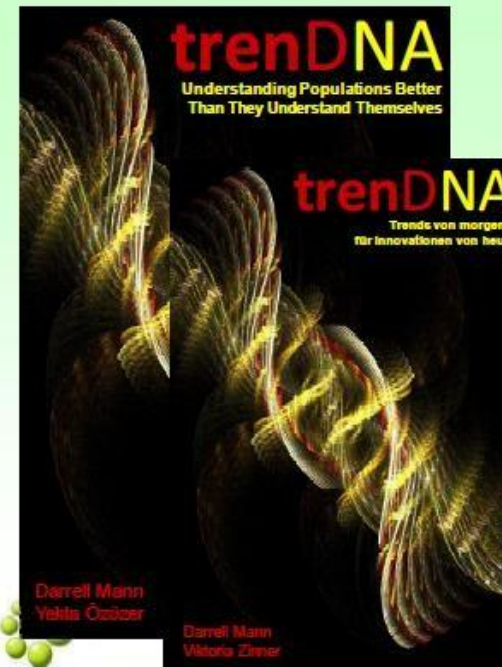
Consumer Trends – What's Going On?

Every retailer spends time capturing and analysing consumer trend information. Almost invariably, once the information is captured, the future will very quickly deviate from what the trend predicts. Even though, we can look at any individual trend and say to ourselves 'yes, I can see that this is a logical trend relevant to my operations' What is going on here?

- ageing population
- longer life expectation (active for longer)
- greater determination to live life to the full
- sharp increase in single-occupancy homes/single parent families
- increasing importance of the extended family
- increasing property prices – children staying home longer
- increasingly sedentary lifestyle (compensated by guilt-trips to gym)
- increasing safety/health consciousness
- increasing religious/spiritual awareness
- 'chutneys' – hand-made goods
- authenticity
- increasing risk aversion
- increasing awareness of sustainability/environmental issues
- Internet shopping/delivery of consumables
- desire for 'little luxuries' – affordably expensive rewards
- highly aspirational materialistic lifestyles ('I-want-more' culture)
- increasing desire to simplify a complex world
- desire for more convenience in mundane tasks
- rising power and influence of female
- disappearance of Mr/Mrs 'Average' – desire for individuality
- desire for 'cocooning' (nest-building)
- higher expectations as customer/greater inclination to complain
- 'Big Mother'



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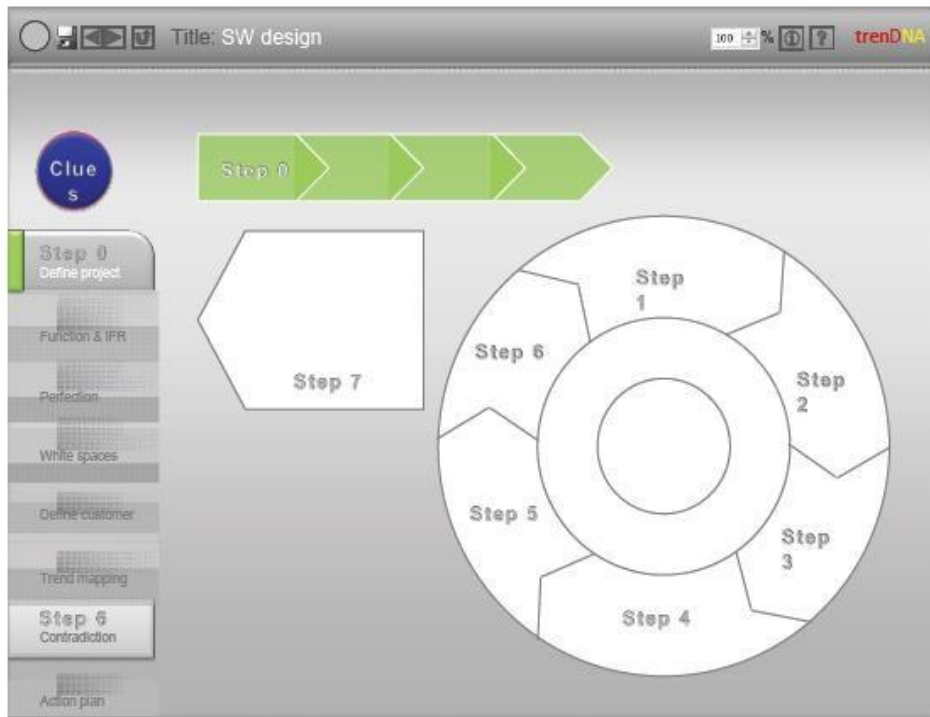
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UK
Germany

Australia
Brazil
Japan
China
India?



Slides from Sixth TRIZ Symposium Presentation in Japan (2010)



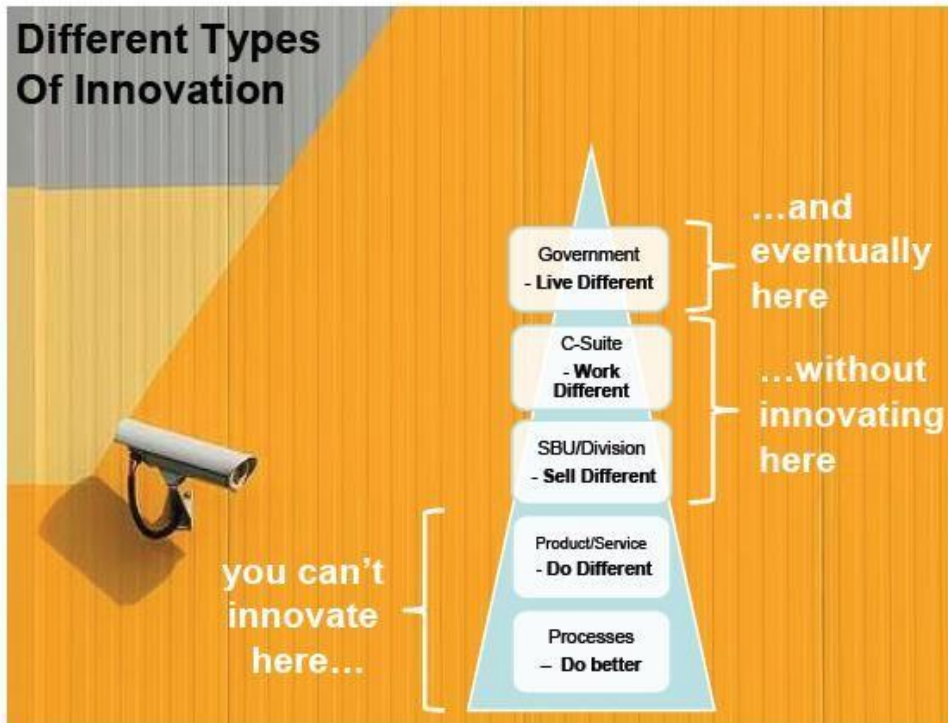
the (computer-aided) science of intangibles

Intangibles:
80% of the
new
innovation
challenge...

...20% of the
knowledge
database

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Slides from Sixth TRIZ Symposium Presentation in Japan (2010)



Thank you

Dr Paul Filmore (University of Plymouth)

pfilmore@plymouth.ac.uk

&

Darrell Mann

darrell.mann@systematic-innovation.com

www.systematic-innovation.com

- Strategic Studies
- Problem Solving Consulting
- IP Generation/Design-Around/Strategy
- ‘Voice Of The Product’
- Unspoken Voice Of The Consumer
- Consumer Insight



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Slides from UK TRIZ Forum Presentation (#2 2010)

TRIZ Introduction

TRIZ

- **TRIZ** means “The theory of solving inventors problems.”
- “Theory of inventor’s problem solving.”
- Developed by a Soviet Engineer & Researcher Genrich Altshuller and his colleagues– 1946
- TRIZ is a Methodology, Tool set, Knowledge base, Model-based technology for generating innovative ideas and solutions.

UK TRIZ Forum #2 -Clevedon/Bristol 12/13 May 2010

Mir Abubakr Shahdad

Computer Aided Innovation Introduction

Computer Aided Innovation

- Computer Aided Design is different from Computer Aided Innovation
- History of computer applications consists of tools like CAD, CAM and CAx series tools.
- The future potential of computer tools lies in the application of computer tools to aid innovation.

UK TRIZ Forum #2 -Clevedon/Bristol 12/13 May 2010

Mir Abubakr Shahdad

Slides from UK TRIZ Forum Presentation (#2 2010)

Computer Aided Innovation Introduction

Application of TRIZ Principles

- TRIZ Principles are being applied to Graphic Design in this project.
- Some research questions are being addressed through this research
 - Can Innovation be automated to the full extent- application in case of Graphic Design?
 - Can application of TRIZ Principles be more useful when applied through computer tools.

UK TRIZ Forum #2 -Clevedon/Bristol 12/13 May 2010

Mir Abubakr Shahdad

Computer Aided Innovation Introduction

AEGIS- Technology

- C#.NET Technology
- Mathematica Technology

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Mir Abubakr Shahdad

Slides from UK TRIZ Forum Presentation (#2 2010)

Computer Aided Innovation Introduction

AEGIS- Version 1

Version 1 was implemented in C#.NET Technology. The AEGIS concept started with the idea of applying TRIZ Trends to packaging of products, particularly washing products. The following TRIZ trends were originally specified as appropriate to this project:-
Surface Segmentation, Space Segmentation, Asymmetry and Geometric Evolution. Introducing curves, introducing concave gaps on corners, curving, intelligently text change, segmentation – includes horizontal holes, vertical holes, diagonal holes, oriented shapes, colour of half of object or a proportionate colour inversion and holes

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Computer Aided Innovation Introduction

AEGIS- Version 1



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Computer Aided Innovation Introduction

AEGIS- Version 2

Version 2 produced 7 mutations of the parent image. Mutations included: rounding of corners, oval shaped perforations, compression, curves and vertical rotation.

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Computer Aided Innovation Introduction

AEGIS- Version 3

Version 3 produced 9 mutations of the parent image. Mutations included: rounding of corners, oval shaped perforations, compression, curves and vertical rotation, asymmetry, introduction of foreign shapes (triangles) at various positions, encircling the parents image with different colours, changing the conjure of half of the parent image, half parallelogram, rectangular holes were the effects implemented in this version.

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Slides from UK TRIZ Forum Presentation (#2 2010)

Computer Aided Innovation Introduction

AEGIS- Version 4

This version was an experimentation to check if Mathematica can be more useful in implementation of trends as compared to .NET. The conclusion (already submitted in 2009) was that two features were missing:-

- Iterations- Mathematica does not support the mechanism of iterations which is the basic design specification of AEGIS
- Shapes- Mathematica does not easily support shape mutations which are related to TRIZ directly. However, this version produced a good variety of colour mutations with some standard algorithms. Shifting back to .NET was preferred for further versions.

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Computer Aided Innovation Introduction

AEGIS- Version 4



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Computer Aided Innovation Introduction

AEGIS- Version 4



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Computer Aided Innovation Introduction

AEGIS- Version 4



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Slides from UK TRIZ Forum Presentation (#2 2010)

Computer Aided Innovation Introduction

AEGIS- Version 4



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Computer Aided Innovation Introduction

AEGIS- Version 5

Version 5 has been implemented in C#.NET Technology (Versions 5.1, 5.2 and 5.3). In this version of AEGIS, all the mutations implemented change the colour channels of the input image through various well defined standard algorithms . They are achieved using a 3x3 convolution matrix. The algorithms used are :-

Convolution Matrix, Gamma Function
Smooth Function, Color, Gaussian Blur
Mean Removal, Emboss Laplacian

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Original Image

Algorithm Smooth (weight=100)

Algorithm Conv 3x3 matrix

Algorithm Gamma x=2, y=2, z=10

Algorithm Mean Removal factor=9

Algorithm Emboss Laplace, pool=6, offset=100

Algorithm Gaussian Blur factor=4

Algorithm Color x=50, y=10, z=50

Algorithm Sharpen offset=11

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Original Image

Algorithm Smooth parameter (weight=101)

Algorithm Smooth parameter (weight=21111)

Algorithm Smooth parameter (weight=21111)

Algorithm Smooth parameter (weight=5111111)

Algorithm Smooth parameter (weight=5000)

Algorithm Smooth parameter (weight=511)

Algorithm Smooth parameter (weight=10111111)

Algorithm Smooth parameter (weight=51)

UK TRIZ Forum #2

ahdad

Slides from UK TRIZ Forum Presentation (#2 2010)



UK TRIZ Forum #2

Shahdad

Computer Aided Innovation Introduction

AEGIS- Version 5



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Slides from UK TRIZ Forum Presentation (#2 2010)

Computer Aided Innovation Introduction

AEGIS- Version 6

Layered based approach has been implemented in the Version -6.x series of AEGIS.

Further development work is being done on the higher versions of AEGIS.

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Computer Aided Innovation Introduction

Conclusion and future work

Many useful images have been generated in the process.

At this stage, it cannot be concluded that whether the tool will be more useful to designers as compared to the traditional design tools.

If we are fully successful to make the mutations systematic and auto guide them according to TRIZ Principles, then results may be promising.

Further development is being carried out and feedback is being taken.

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Slides from UK TRIZ Forum Presentation (#3 2011)

Analysis of TRIZ Principles in 'WoW'
Design for Wow

UK TRIZ Forum #3
Clevedon, UK 12 May 2011
Mir Abubakr Shahdad

Contents

- Introduction
- CAI and TRIZ
- Design for Wow Concept
- Data Analysis and Review Mechanism
- Results and Future Work

UK TRIZ Forum #3

Mir Abubakr Shahdad

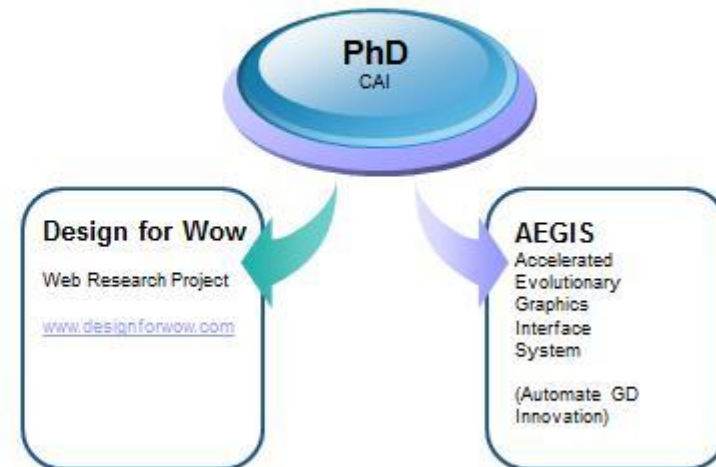
Introduction

Sub Projects

- ❖ **Engineering Innovation/ CAI**
- ❖ **Three year PhD project**
- ❖ **Sponsored by**
 - GWR
 - Systematic Innovation Ltd
- ❖ **At University of Plymouth**
- ❖ **Supervisors**
 - Dr Paul Filmore
 - Darrell Mann
 - Dr Elies Deckronick
 - Dr Phil Culverhouse

UK TRIZ Forum #3

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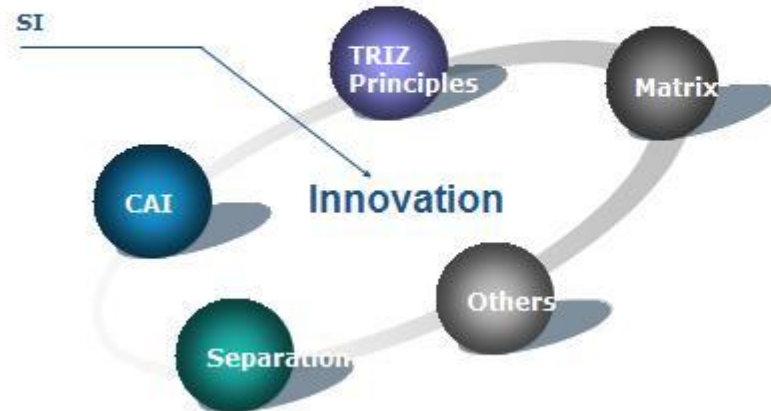


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Innovation

Design for Wow



- ❖ **Concept first mentioned in the book by Darrell Mann**
- ❖ **The 'WoW' Concept**
- ❖ **A 'WoW' can be**
 - Writing
 - Invention
 - Innovative piece of work
 - Innovative product
- ❖ **Which makes you say 'WoW'**

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Design for Wow

User types

- ❖ **Web presence of 'WoW'**
- ❖ **Users upload content**
- ❖ **Reviewers review content**
- ❖ **TRIZ Principles analysed in the content**



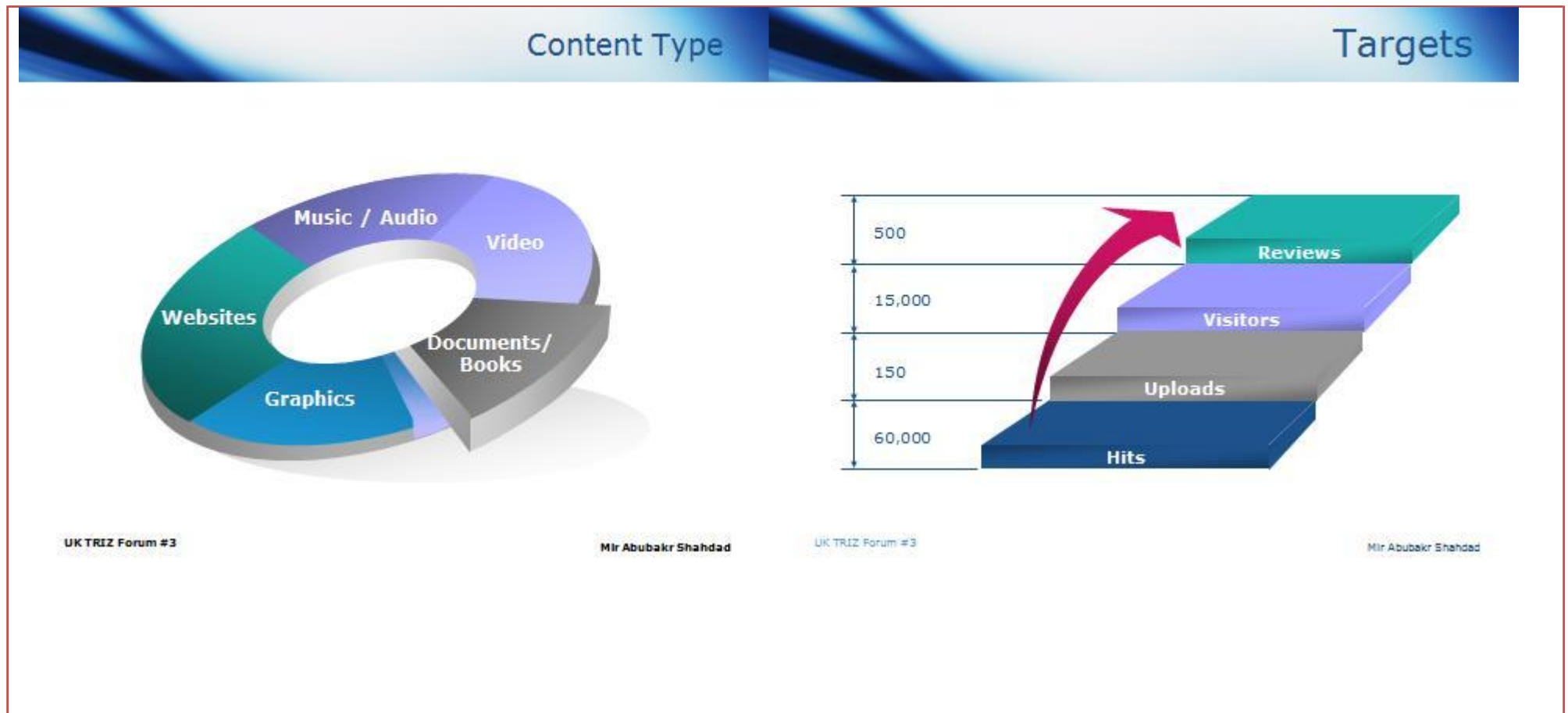
UK TRIZ Forum #3

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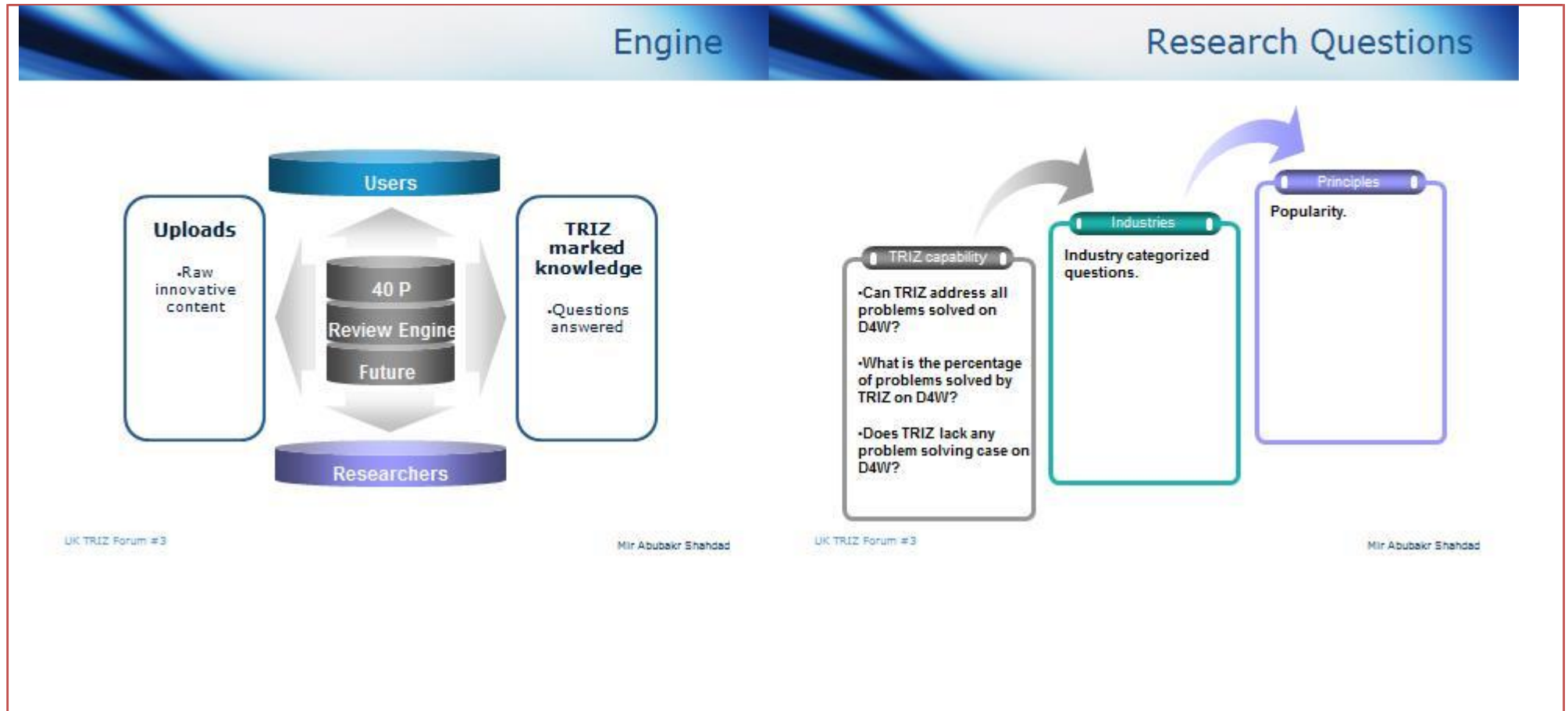
UK TRIZ Forum #3

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Engineering Innovation (TRIZ based Computer Aided Innovation)

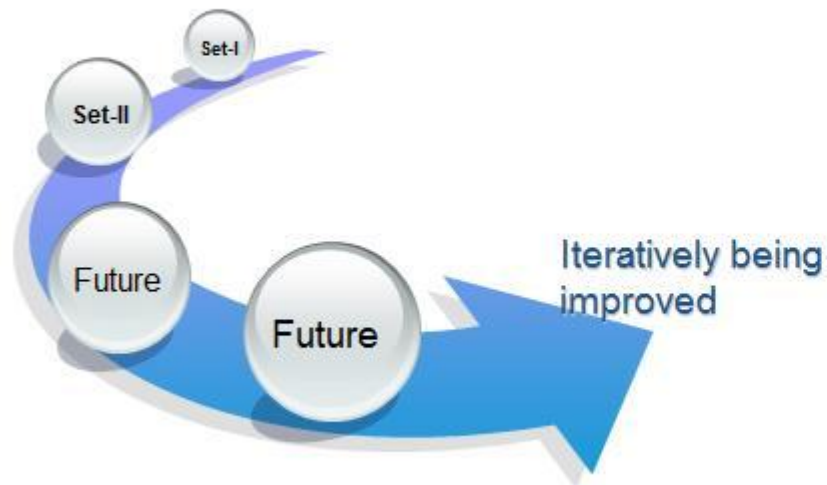


Engineering Innovation (TRIZ based Computer Aided Innovation)



Marking/ Analysis schemes

Review Mechanism Set-I



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- Initially the set of formula used to review the TRIZ in content was relatively simple.

title	medialid	industry	chemetot	(select COUNT(*))	(select COUNT(*)/relevan ce*3)
Pepsi Truck	11	advertising	make adusa appear to float to emphasize low caloric message	1	1.0000
Security Glass	12	Glass	Put something very valuable behind the glass	1	1.0000

- Count= Number of Principles in the content
- Rating relevance - 1 to 3 .1 means least relevant, 3 means most relevant.

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Review Mechanism Set-I

- ❖ $F = \text{select COUNT(*)/relevance*3}$.
- ❖ Any id with $F \leq 0.33$ - considered having no significant Principle numbers associated with them.
- ❖ After the set I was evaluated, it was found not sufficient to classify the content according to TRIZ properly.
- ❖ Hence, Set-II mechanism was introduced for reviews.

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Review Mechanism Set-I

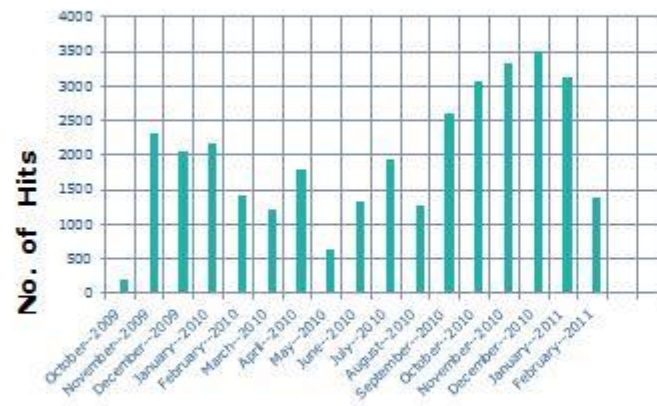
- ❖ $F = \text{select COUNT(*)/relevance*3}$.
- ❖ Any id with $F \leq 0.33$ - considered having no significant Principle numbers associated with them.
- ❖ After the set I was evaluated, it was found not sufficient to classify the content according to TRIZ properly.
- ❖ Hence, Set-II mechanism was introduced for reviews.

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Engineering Innovation (TRIZ based Computer Aided Innovation)

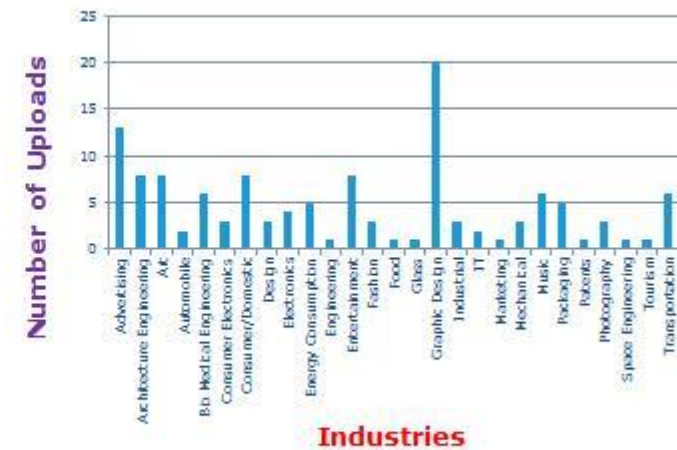
Hits



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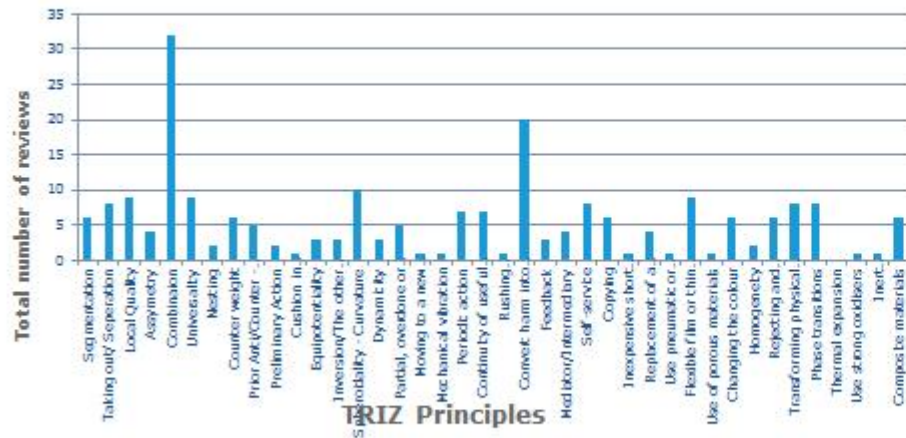
Industrial Matrix



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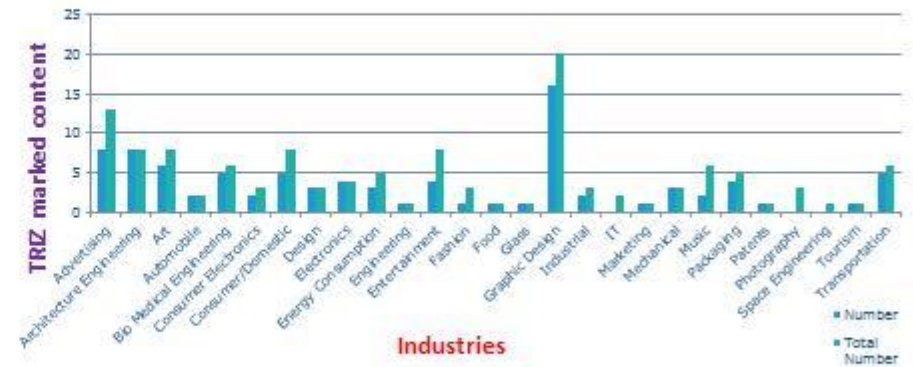
Popularity of TRIZ Principles



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TRIZ Marked Content

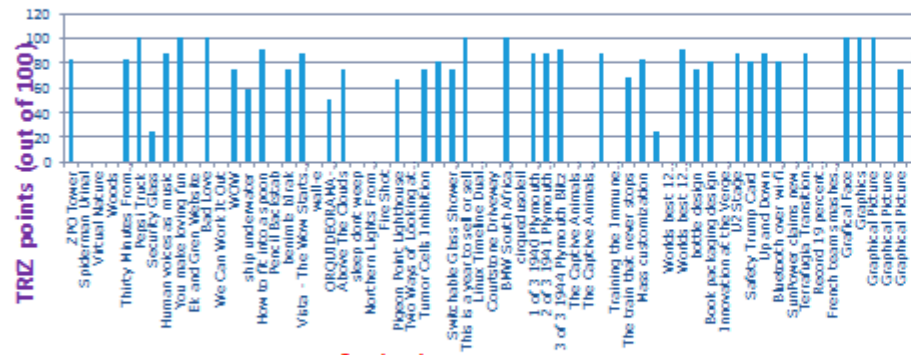


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Engineering Innovation (TRIZ based Computer Aided Innovation)

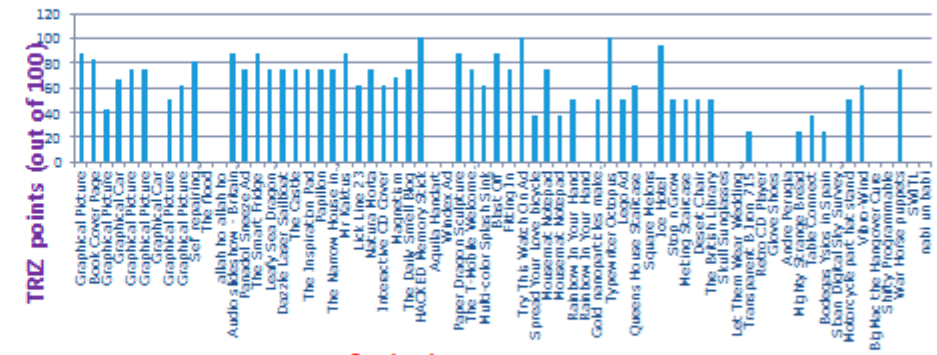
TRIZ Points



UK TRIZ Forum #3

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TRIZ Points

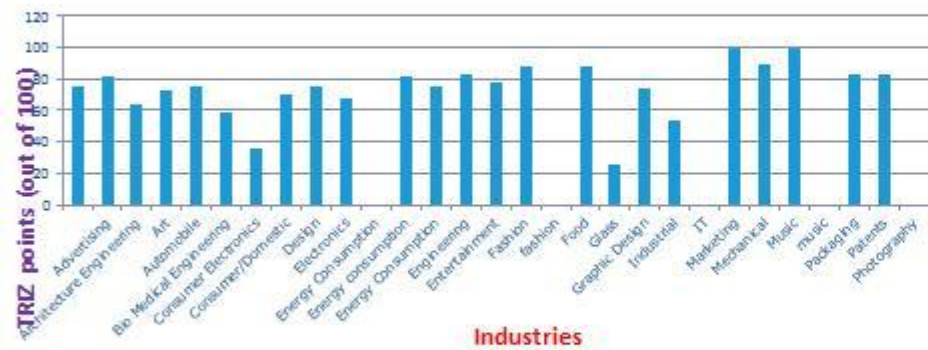


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TRIZ Points (Industry)

Analysis



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1

- Below 25% point scored is considered low TRIZ presence
- Some media content lacks TRIZ Principles

UK TRIZ Forum #3

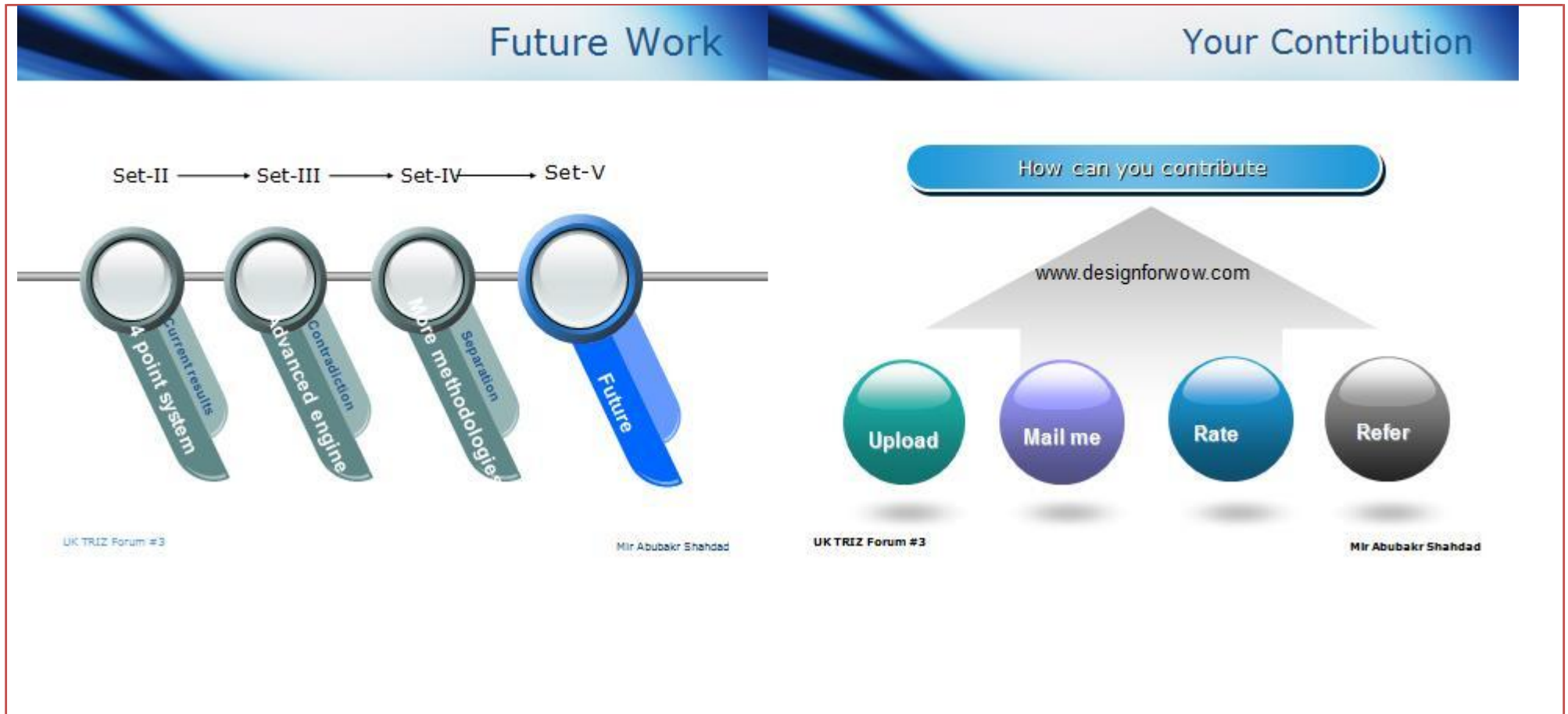
2

- Media with zero scores is being analysed and is more important.

3

- Some TRIZ Principles are clearly more popular.
- Popularity in industries sector is also becoming more clear.

Mir Abubakr Shahdad



Thank You !

Last but not the least!
Special Thanks to

Hannah Filmore
Ellen Domb

Feedback welcome
abubakr.shahdad@plymouth.ac.uk

PC CAT 2011, Exeter, UK (2011)

Computer Aided Innovation

Mir Abubakr Shahdad

University of Plymouth

PC-CAT conference , Exeter UK 2011



University of Plymouth



Research Project

Introduction

•Engineering Innovation/ Computer Aided Innovation

•Three year PhD project

•Sponsored by

- GWR
- Systematic Innovation Ltd

•Based at University of Plymouth

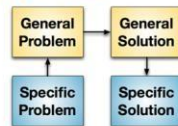
•Supervisors

- Dr Paul Filmore
- Darrell Mann
- Dr Elies Deckronick
- Dr Phil Culverhouse

TRIZ

•TRIZ is short for the Russian acronym 'The Theory of Inventive Problem Solving'.

•Developed by a Soviet Engineer & Researcher Genrich Altshuller and his colleagues- 1946



•TRIZ is a

- Methodology,
- Tool set,
- Knowledge base,
- Model-based technology for generating innovative ideas and solutions.

PhD Projects



Design for Wow

•A web portal designed to allow users to upload "wow" on the site.

•Users upload what they think is 'WoW'.

•The research team classifies marks the content with TRIZ Principles.

Design for Wow- Objectives

•Can TRIZ address all problems solved on D4W?

•What is the percentage of problems solved by TRIZ on D4W?

•Does TRIZ lack any problem solving capability, when compared to cases solved on "Design for Wow" website?

Different sections of Wow

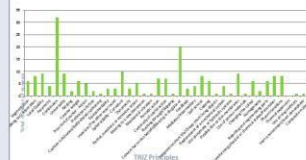


Design for Wow-Results

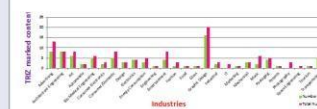
•Some media content lacks TRIZ Principles

•Some TRIZ Principles are clearly more popular.

•Popularity in industries sector is also becoming more clear as shown figure.



•Many of the industrial categories lack TRIZ Principles and some of them do not have any uploads marked with TRIZ, example space engineering, as shown in the figure.



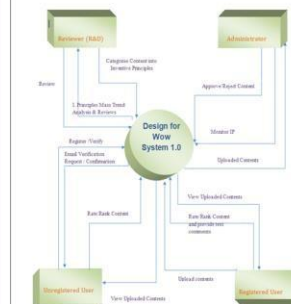
Work in progress

•TRIZ capability will be evaluated after further analysing the existing content on website.

•Questions like "Are TRIZ Principles enough?" may be answered at a later stage.

Data Flow Diagram

Content Level (1.0) Data Flow Diagram of Design For WOW Site



SHOWCASE YOUR WORK AT
www.DesignForWow.com

How can you contribute

How can you contribute



•Please email:-
Abubakr.Shahdad@plymouth.ac.uk

Slides from 3rd International Conference on Systematic Innovation & Global TRIZCON (2012)

3rd International Conference on Systematic Innovation & Global TRIZCON 2012

**Using TRIZ Principles to Analyze the Degree
and Patterns of Innovation in Designs**

DESIGN FOR WOW

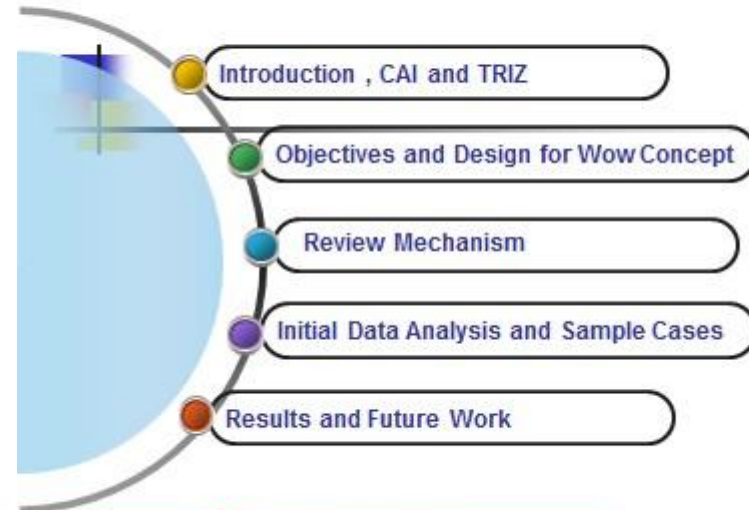


**Dr. Paul Filmore
Mir Abubakr Shahdad**

icsiGTRIZ 中華系統性創新學會 The Society of Systematic Innovation KATA Korea Academic TRIZ Association

3rd International Conference on Systematic Innovation & Global TRIZCON 2012

Outline



1 icsiGTRIZ 中華系統性創新學會 The Society of Systematic Innovation KATA Korea Academic TRIZ Association

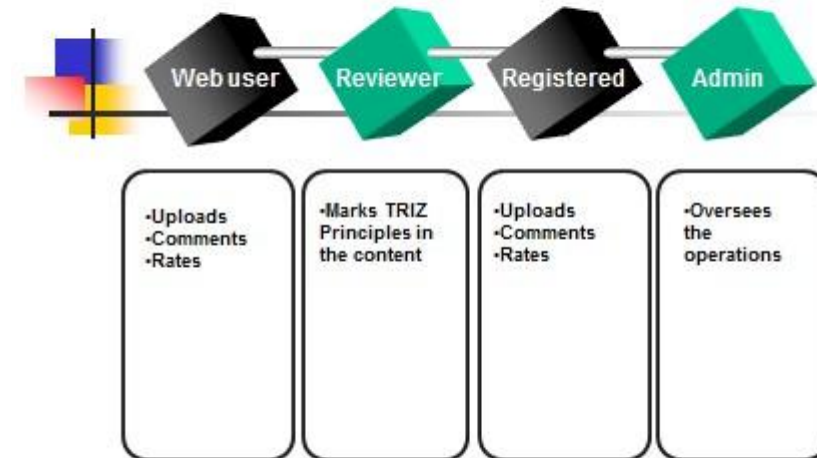
Slides from 3rd International Conference on Systematic Innovation & Global TRIZCON (2012)

3rd International Conference on Systematic Innovation & Global TRIZCON 2012



3rd International Conference on Systematic Innovation & Global TRIZCON 2012

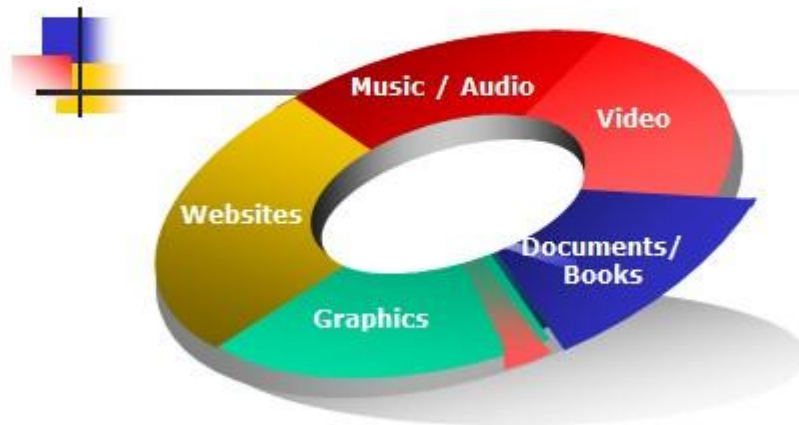
Users



Slides from 3rd International Conference on Systematic Innovation & Global TRIZCON (2012)

3rd International Conference on Systematic Innovation & Global TRIZCON 2012

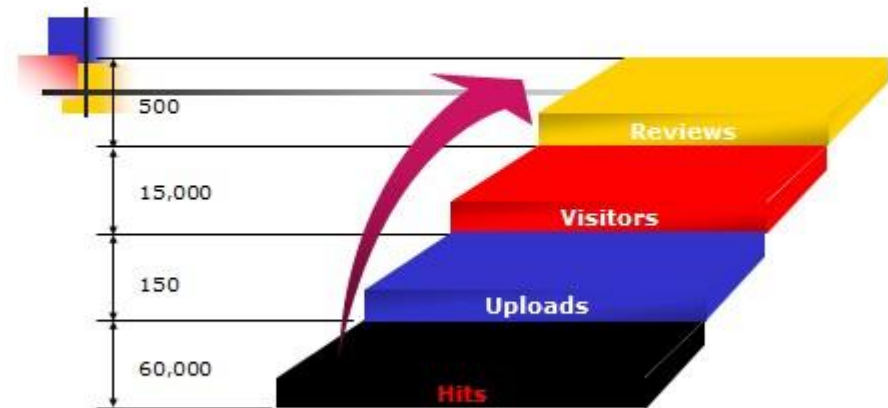
Content Type



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3rd International Conference on Systematic Innovation & Global TRIZCON 2012

Design for Wow 2011

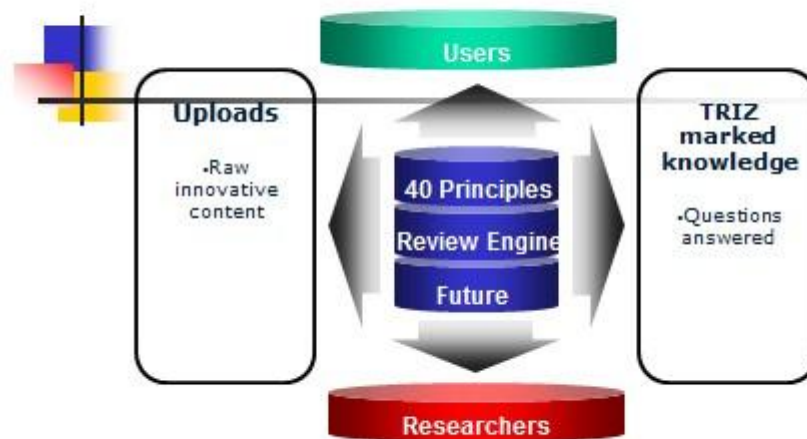


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Slides from 3rd International Conference on Systematic Innovation & Global TRIZCON (2012)

3rd International Conference on Systematic Innovation & Global TRIZCON 2012

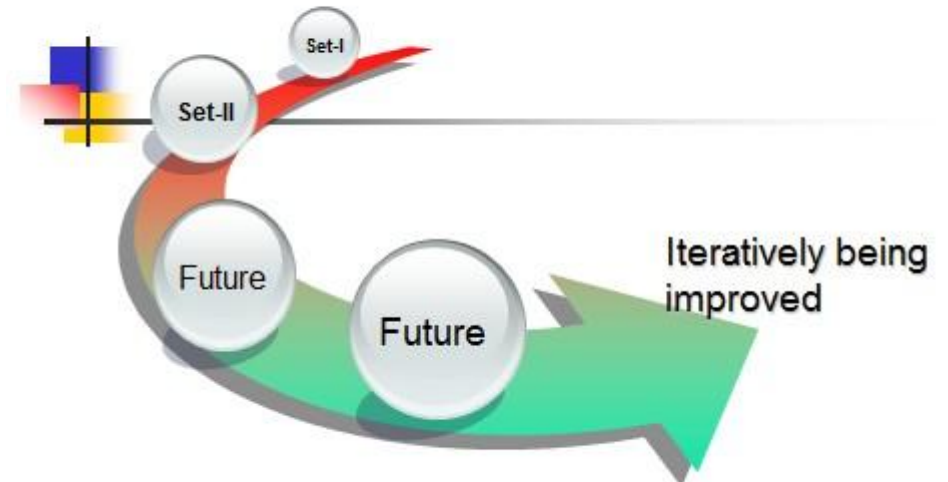
Engine



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Content Analysis Schemes



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Review Mechanism Set-I

- Initially the set of formula used to review the TRIZ in content was relatively simple.



title	mediaid	industry	themebxt	(select COUNT(*) relevance)	(select COUNT(*)/relevance+3)
Pepsi Truck	11	advertising	make sodas appear to float to emphasise low calorie message	1	1.0000
Security Glass	12	Glass	Put something very valuable behind the glass	1	1.0000

- Rating relevance was 1 to 3 , where 1 =least relevant, 3 = most relevant.
- Each user was allowed to tag one Principle during tagging process.

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Review Mechanism Set-I

- $$F(TP) = \sum \frac{c[i]}{3}$$

Any id with $F \leq 0.33$ - considered having no significant Principle numbers associated with them.

- However, it was not sufficient to classify the content by TRIZ Principles.
- Hence, Set-II mechanism was introduced for reviews.

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Review Mechanism Set-II

- Set-II has 4 levels of weighting of TRIZ in content.

Comment	Weighting
Sure- Pretty Sure	4
On Balance- Likely	3
Uncertain- but Likely	2
Not sure at all	1

- The user is allowed to tag up to 4 Principles to the wow example during each tagging process.
- The points system has been introduced in set-II scoring system. The formula used is:

$$\sum \frac{c[i]}{4} \cdot 100$$

- Where: n is the number of reviews.
- c[i] is the individual review.

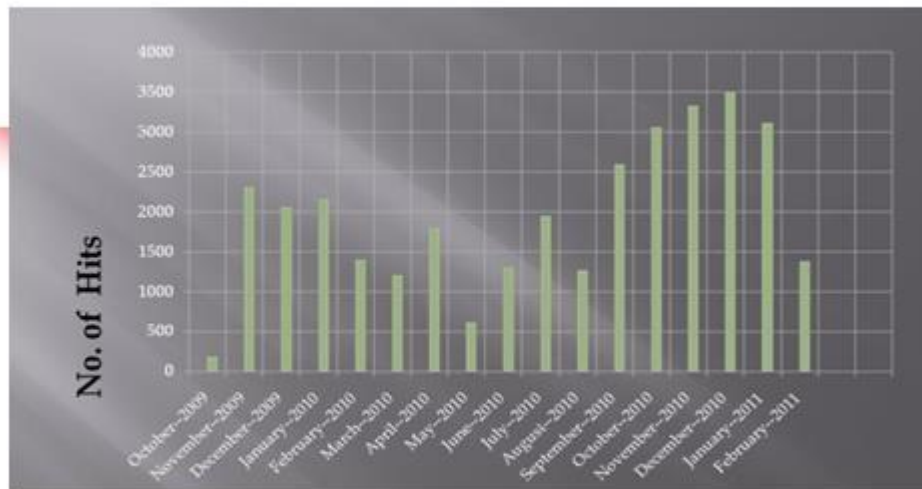
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Results

Slides from 3rd International Conference on Systematic Innovation & Global TRIZCON (2012)

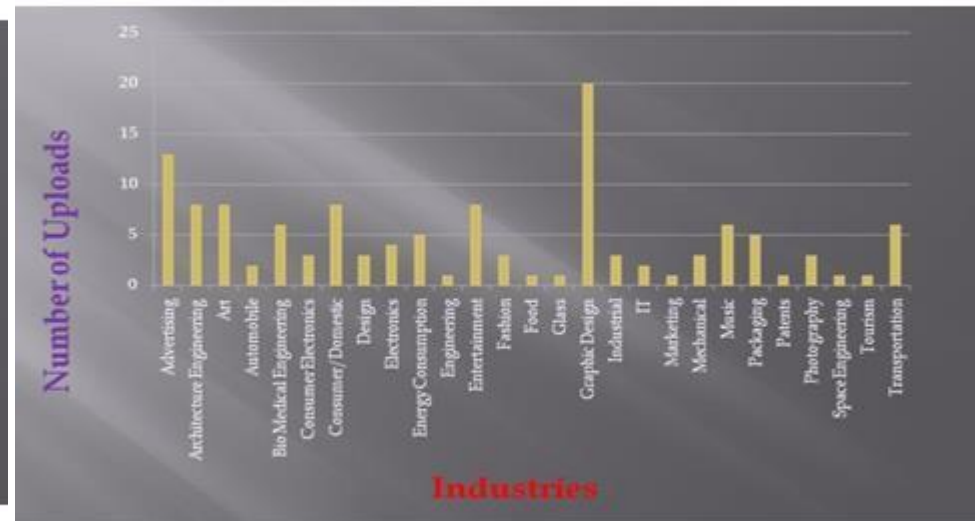
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Hits



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Industrial Matrix



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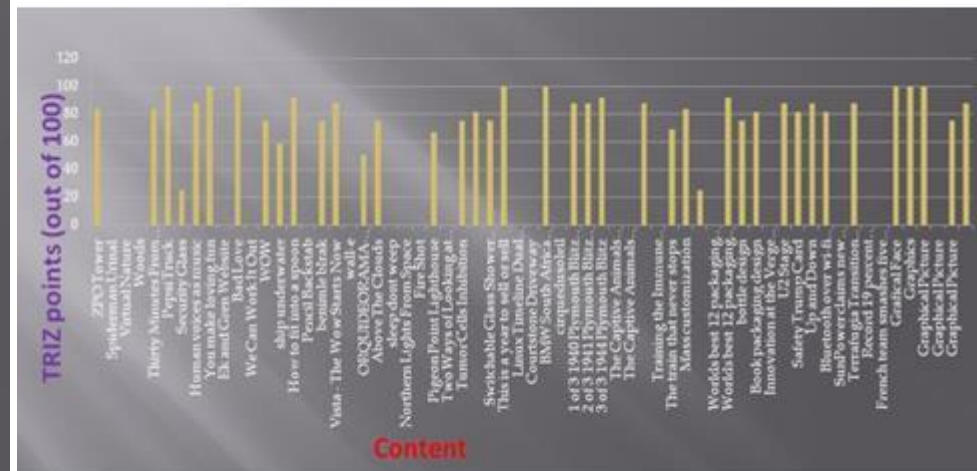
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TRIZ Marked Content



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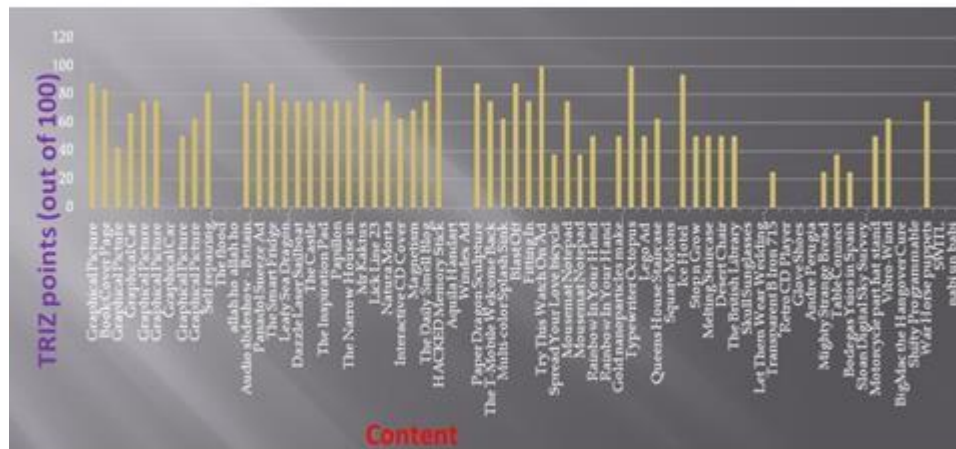
TRIZ Points (Set-II)



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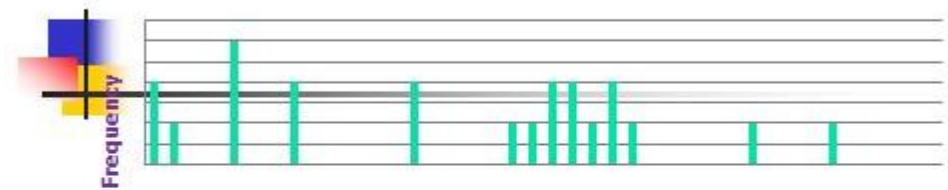
TRIZ Points (Set-II)



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TRIZ Points (Industry)

For each industry averaging all the examples.

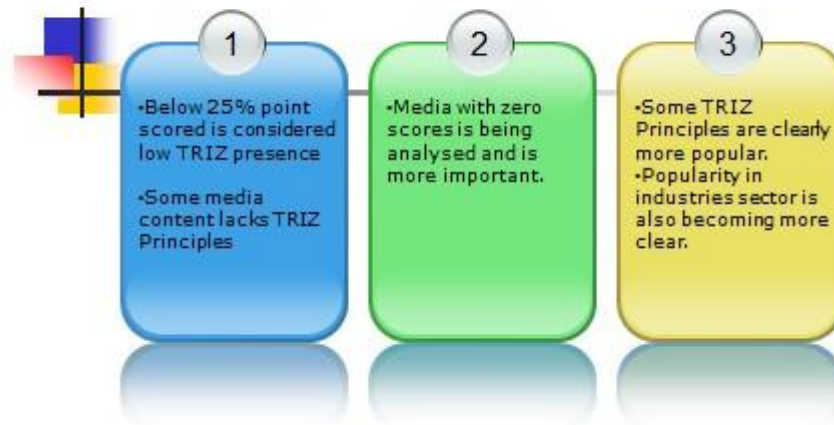


TRIZ Principles

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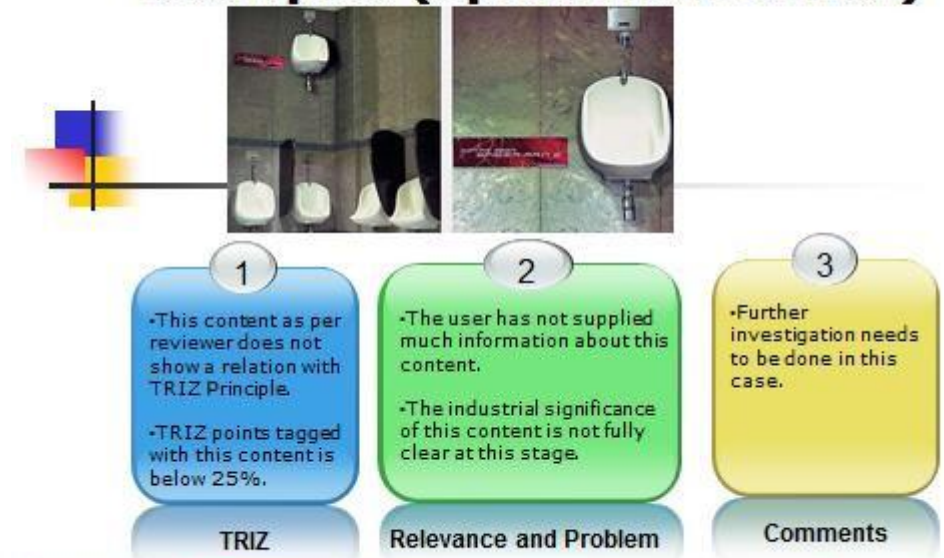
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Analysis



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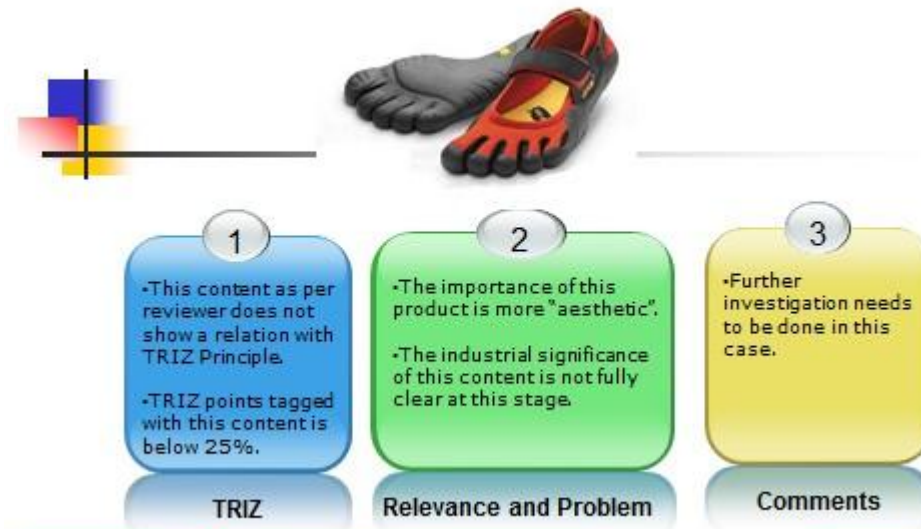
Examples (Spiderman Urinal)



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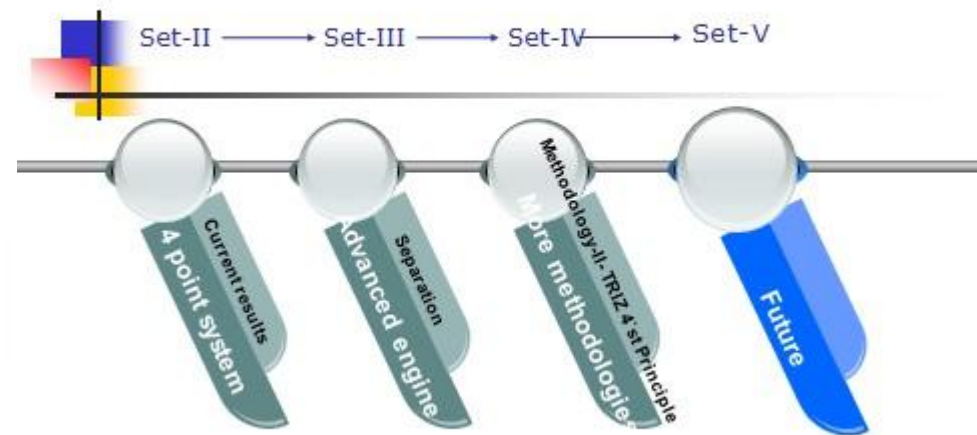
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Examples (Glove Shoe)



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Future Work



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3rd International Conference on Systematic Innovation & Global TRIZCON 2012

Summary

- Good spread of industries.
- We need a lot more uploads to generalise the results.
- Reviewers are working on the data.
- A number of wow examples are well frozen to zero TRIZ points in them.
- Set-III of review mechanism may include tools like "separation".

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Future Work

- More methodologies (e.g. separation in time/space).
- Future of TRIZ (this may be 41st Principle if needed).

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Your Contribution



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Thank You !

Last but not the least!
Special Thanks to

Hannah Filmore
Ellen Domb

Feedback welcome
pfilmore@plymouth.ac.uk
abubakr.shahdad@plymouth.ac.uk

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Slides from Joint International Conference on SI & IFIP CAI (2013)

The 2013 Joint International Conference on Systematic Innovation & IFIP Computer-Aided Innovation

Applying TRIZ to Graphic Design using Genetic Algorithms

**Dr. Paul Filmore
Mir Abubakr Shahdad**

Plymouth University, UK

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Outline

Introduction , CAI and TRIZ

Objectives and TRIZ Transformations

Genetic Algorithms Structure

Molecular and Atomic Transformations

Conclusion and Feedback

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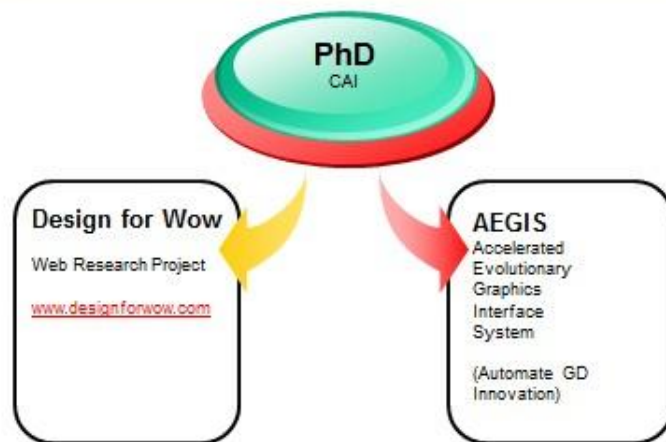
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Sub-Projects



TRIZ

- TRIZ (/ 'triz/; Russian: теория решения изобретательских задач, teoriya resheniya izobretatelskikh zadatch).
- A problem-solving, analysis and forecasting tool derived from the study of patterns of invention in the global patent literature.
- It was developed by the Soviet inventor and science fiction author Genrich Altshuller and his colleagues, beginning in 1946.

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TRIZ 40 Principles

- 1970's: Altshuller's initial insight about the patterns of inventive solutions and one of the first analytical tools was published in the form of 40 Inventive Principles.
- Don't accept compromises: Eliminate them.
- Somebody, someplace, sometime has already solved your problem or one similar to it.
- Creativity means finding that solution and adapting it to the current problem.

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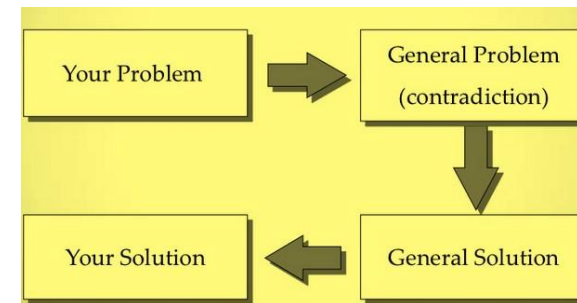
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Overall Approach of TRIZ



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Computer Aided Innovation

- Computer Aided Design is different from Computer Aided Innovation.
- History of computer applications consists of tools like CAD, CAM and CAx series tools.
- The future potential of computer tools lies in the application of computer tools to aid innovation

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Research Objectives

- TRIZ is a problem-solving, analysis and forecasting tool derived from the study of patterns of invention in the global patent literature.
- Is it possible to 100% automate innovation using TRIZ? If not, then how much?
- Can the DNA of Innovation be captured (using TRIZ)?

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AEGIS

- What is AEGIS

AEGIS

Accelerated
Evolutionary
Graphics
Interface
System

(Automate GD
Innovation)

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AEGIS Objectives & SRS

- Specifically, can AEGIS be developed as a tool to help graphic designers innovate (TRIZ Principles being used to guide the AEGIS algorithms) ?
- Functionality
 - To be able to mutate images
 - Iterative mutations based interface
- Outputs
 - In the form of finalized design (picture formats)
 - Intermediate images used and generated (for research and future use)

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Software Requirement Specs.

- Inputs
 - Initial sketches or seed image(s)
 - User preferences
- Performance
 - It will be designer's attempt to make its performance better as compared to commonly used graphic design tools like Adobe PS in certain aspects such as speed, choice of mutations, etc.

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Software Requirement Specs.

- External interfaces
 - It may be later used as a plug-in or a connection to other tools
 - It can take outputs from other tools like handwriting alphabet generation based tool.
- Design constraints
 - Most of the design patterns, algorithms should be guided by TRIZ Principles
 - Manual interpretation of users should be kept to minimum in case of guiding the design

*(The above SRS was valid at the beginning of AEGIS project and has been refined and more details added from time to time)

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Research Specifications.

Background: To develop CAI tools which automate some processes of TRIZ. Example: automation of TRIZ Trends.

- Generate test sets from industry
- Test CAI tools with the data sets
- Analyse results in terms of which image outputs were useful and which were not in context of user requirements (i.e., analysis by an industrial user).
- Optimise tools from lessons learnt
- Add self adjusting algorithms so that the software can evolve by learning user preferences.

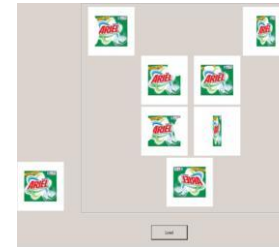
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AEGIS History.



AEGIS 2.0



AEGIS 3.0

Developed in C#.NET

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AEGIS Previous Versions.



AEGIS 4.0 (Mathematical)

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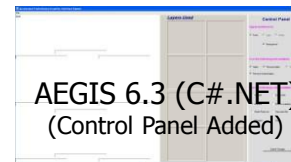
AEGIS Previous Versions.



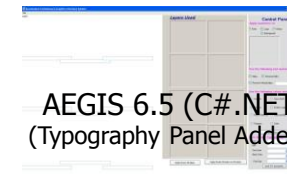
AEGIS 5.3 (C#.NET)



AEGIS 6.1 (C#.NET)
(Layered Approach)



AEGIS 6.3 (C#.NET)
(Control Panel Added)



AEGIS 6.5 (C#.NET)
(Typography Panel Added)

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AEGIS Previous Versions.



AEGIS 6.6_XML
(XML Logging Enabled)

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AEGIS 6.6_XML_GA (A & B).

- Takes Following Inputs:

Font library/ Typography

Font Type	Algerian
Text	ARIEL
Font Color	Black
Back Color	White
Font Size	49



Font Configuration

Logo

Extra Logo

Background

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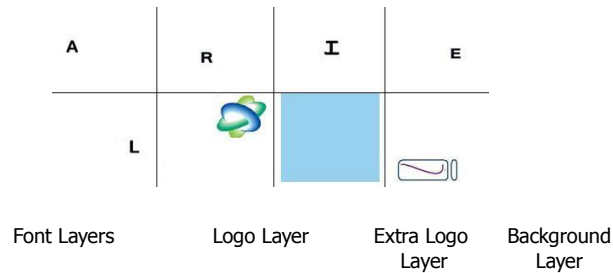


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AEGIS 6.6_XML_GA (A & B).

Layered Approach



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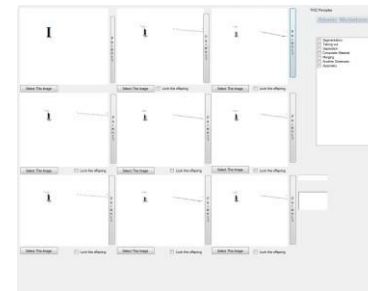
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AEGIS 6.6_XML_GA (A & B).

Atomic Level Transformations



Font Types Transformed Individually

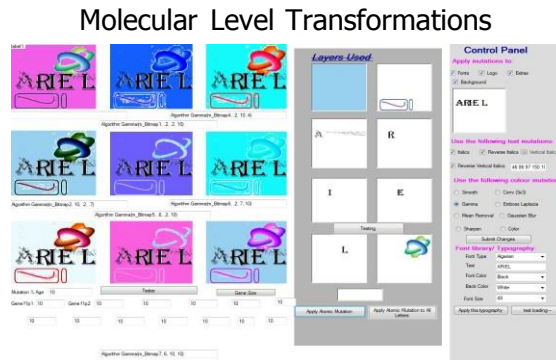
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AEGIS 6.6_XML_GA (A & B).

All layers presented to User during each iteration

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Genetic Algorithms.

- In GA approach, each organism is considered to be made of cells which in turn consist of chromosomes;
- Chromosomes are made of genes (which are functional blocks of DNA).
- Each gene controls a particular property of an aspect or behaviour or part of the organism.
- The different possibilities, which a property can have, are called 'Alleles'. Genes have a particular place in a chromosome that is called 'locus'.

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GA Structure in AEGIS.

Function/Method Parameters in c#.net

Function/ Method

The size, shape and degree of different mutations in AEGIS

Different colours, sizes, shapes of the gene controlled property

The point where the parameters of a function end.

The image

Group of all individuals (images) generated.

Collection of all chromosomes for an individual (image).

In the method alterItalics (001111,001111,000011) 001111,001111 and 000011 are the genes.

The method alterItalics (001111,001111,000011) altogether is called a chromosome.

Curvature of an alphabet.

The gradient colour of base

In the method above, the ';' represents a locus separation point as it marks the end of one gene and start of another.

One of the images in generated generation.

Images generated in each iteration (9).

Summation of all methods and their parameters for an image generated at point 3 of the 3x3 grid of AEGIS.

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Chromosome Examples.

Principle 35 Parameter Changes (B)
 Principle 26 Copying (B)
 Principle 32 Color changes(A)
 Principle 7. Nested Doll (A)
 Principle 8. Anti-Weight (A).
 Principle 2 Taking Out(A)
 Principle 7 (A)

Principle 1 Segmentation (A,B)
 Principle 21 Skipping (A)
 Principle 19 Periodic Action(A,C)

Principle 35 Parameter Changes(B)

Principle 1 Segmentation (A)
 Principle 2 Taking Out(A)

Principle 40 Composite Materials (A)

Principle 26 Copying (B)

Principle 35 Parameter Changes (B)

Principle 16 Partial or Excessive Actions (A)

Principle 14 Spheriodality Curvature (A)

Principle 14 Spheriodality Curvature (A)

Principle 32 Color Changes (A)

Principle 22 Blessing in Disguise (A)

Principle 22 Blessing in Disguise (A)

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Atomic Examples.

Parent Image

Snapshot of Live Output



Chromosome Applied
(With Gene Values converted to decimal values).

Chromosome Applied:
Spheroidality Trait

Parameter Values (Decimal):
(5,30,15,20)

Chromosome Applied:
Outlining

Parameter Values (Decimal):
(Blue,Line,0,5,0,1,0,1,0)

Atomic Examples

Parent Image

Spheroidality Trait

Outlining

Segmentations

Extensions And Shortenings

Fragmentations

Shapes Introduction












Symbols Introduction


Repetition(s)/ Copy


Rotation

Distortion Colouring


Distortion Mutating







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Molecular Examples.

Image Output	Brief Configuration	Comments
	Algorithms Applied: <ul style="list-style-type: none"> 'alterItalics' 'spheroidality_curve_v' 'Segmentation_pieces_hor'. Gene Size Limit :10	<ul style="list-style-type: none"> The texture of this image has been considerably changed. The text leaves a trailing effect due to extreme value of one of the parameter value of gene.

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Summary

- Outputs are promising.
- Designers are motivated to use this tool.
- Designers agree that it speeds up the design process.
- It aids designers in producing innovative designs.
- Few of the advantages as compared to Adobe PS are wide range of outputs in very quick span of time.

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Summary continued

- Further development could result design processes more or less being automated with the help of TRIZ triggered transformations which could potentially help graphic designers in their initial design phase.
- This will also highlight the potential of TRIZ application in graphic design field and also could establish the hypothesis that there is a possibility to automate innovation.

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Slides from FuTRIZ Presentation, France (2013)

Applying TRIZ to Graphical Design using Genetic Algorithms

29th October 2013

Mir Abubakr Shahdad &
Paul Filmore



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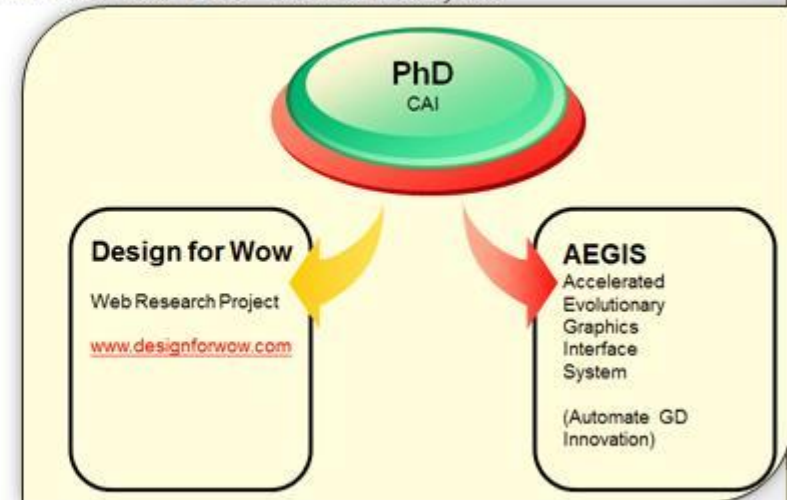
- Introduction
- TRIZ Overview
- Research Objectives
- Graphic Design Process
- TRIZ Application to Graphic Design
- Computer Aided Innovation
- Genetic Algorithms
- AEGIS
 - Software Requirement Specifications
 - Forms
 - Components
 - Functionality
- Feedback
- Current Conclusion
- Ongoing Work and Research

Slides from FuTRIZ Presentation, France (2013)

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 - Forms
 - Components
 - Functionality
- Feedback
- Current Conclusion
- Ongoing Work and Research

Introduction: Research Projects



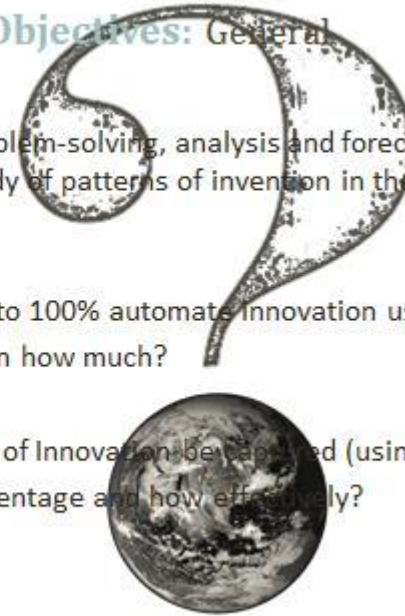
Slides from FuTRIZ Presentation, France (2013)

Introduction: Project Background

- Results of four year research are being introduced here.
- Funded by
 - Great Western Research, UK.
 - Systematic Innovation Ltd, UK.
- AEGIS is one of the tools being developed and tested in this research.
- AEGIS-Samples, feedback and design discussions are being presented here.

Research Objectives: General

- TRIZ is a problem-solving, analysis and forecasting tool derived from the study of patterns of invention in the global patent literature.
- Is it possible to 100% automate innovation using TRIZ?
 - If not, then how much?
- Can the DNA of Innovation be captured (using TRIZ)?
 - What percentage and how efficiently?



Slides from FuTRIZ Presentation, France (2013)

Graphic Design Process: Scope for Innovation

1. Briefing
 - Can there be a tool to help designers quickly generate samples of different ideas (design previews) to client?
2. Design
 - Can designer feed requirement to a system which generates TRIZ triggered design patterns?
3. Artwork
 - Can there be a tool to help designer generate different TRIZ triggered previews of same design?
4. Production
 - This stage has not been touched by our research.

TRIZ to Graphic Design:

Steps taken to Translate TRIZ Principles to Graphic Design Specific Forms.

1. Collection of good designs from Graphic Design Literature.
 - Books
 - Magazines
 - Papers
 - Journals
2. Collection of what consumers (end users) consider good design
 - Example: from a supermarket shelf
3. Collection of award winning/ good designs from designers
 - Example: from a graphic communication exhibition.

TRIZ to Graphic Design:

Steps taken to Translate TRIZ Principles to Graphic Design Specific Forms.

TRIZ effects translated to Graphic Design

Genetic Algorithms A2GIS Version 6.6_GA (B)
Translation of TRIZ Principles to Image Transformation Effects.
(The parameters of these mutation functions are Genes in the GA structure of A2GIS in (discussed in Phase-II)).
Applied to the L&H2B Component Name's Base

Effect/Transformer Name (B)	Translated Effect(s)	TRIZ Principle (Sub-Principle)	Description	Source(s) of inspiration: idea.	Applied to the Graphic Element (Basic Forms)
TRIZ:	<ul style="list-style-type: none"> Introducing details of Lines effects. Creating a Texture with Lines. Micro-chronically variations of Colors. Repeating the area two. Repeating the diagonal arrows. Changing the color of Colors. <p>(Farhat 2012)</p>	Principle 1: Nested (A) Principle 4: Anti-Weight (A) Principle 21: Parameter Changes (B) Principle 25: Copying (B) Principle 33: Color changes(A)	The line, dots and photo element of text component is manipulated to produce a Texture .	 <ul style="list-style-type: none"> (Sharma 2011) (Farhat 2012) 	<ul style="list-style-type: none"> Lines Colors Texture Planes Shapes Spines <p>Applied to the anatomy of Type: 1. Cross Bars 2. Diagonal Stroke (Carter 2002)</p>
TRIZ:	<ul style="list-style-type: none"> Dividing a Plane in to different Planes. Creating angles in to a rectangular plane shape. Dividing along lines. Dividing the lines. Dividing the Color line. Dividing the area. 	Principle: Segmentation(A,B,C) Principle: Segmentation(A) Principle: Segmentation(A) Principle: Segmentation(A)	The planes of the Face component are divided into x and y axis. Furthermore, the end of planes of the Face Component is cut at an angle rather than at right angle.	 <ul style="list-style-type: none"> (Sharma 2011) 	<ul style="list-style-type: none"> Planes <p>Applied to the anatomy of Type: 1. Stem 2. Cross Bar 3. Arm 4. Bracket (Sharma) (Carter 2002)</p>
TRIZ:	<ul style="list-style-type: none"> A variety of arrows or divides effects on the area Line of the Face Component. Developing Colors Manipulation scheme to be followed. 	Principle: Taking Out (A) Principle: Copying (A,B) Principle 1: Change the color of an	The line (endings) of Face component has been copied and manipulated separately.		<ul style="list-style-type: none"> Lines Planes

Computer Aided Innovation: Overview

- Computer Aided Design is different from Computer Aided Innovation.
- History of computer applications consists of tools like CAD, CAM and CAx series tools.
- The future potential of computer tools lies in the application of computer tools to aid innovation.
- This research hence attempts to build a CAI tool to help Graphic Designers.

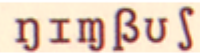
Slides from FuTRIZ Presentation, France (2013)

TRIZ to Graphic Design:

Steps taken to Translate TRIZ Principles to Graphic Design Specific Forms.

4. Analysing what design elements are manipulated to achieve these designs (in steps step 1-3).

- Example: a line in letter n is manipulated to achieve a good design.



5. Analysing font parts (anatomy of type), which have been manipulated to achieve good designs (in steps step 1-3).

-- Example: tail of y is manipulated

**TRIZ to Graphic Design:**

Steps taken to Translate TRIZ Principles to Graphic Design Specific Forms.

6. Questionnaire

- Graphic Designers define basic elements of a design
(Example: line, colour, shape, etc.)
- Graphic Designers translate TRIZ Principle application to the elements defined.
(Example: Principle 17 applied to a line may be called a raised or screen line).

7. To summarize all the steps; TRIZ Principles are mapped to manipulations of different elements of a design.

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Genetic Algorithms: Overview and Relevance


- “Genetic Algorithms are good at taking large, potentially huge search spaces and navigating them, looking for optimal combinations of things, solutions you might not otherwise find in a lifetime.”
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- Graphic Design solution innovation has a huge search space (example a line can be bent in different angles and that combined with varied backgrounds results in millions of solution subsets). Hence it is a perfect candidate for Genetic Algorithm.

Genetic Algorithms: AEGIS

- Accelerated Evolutionary Graphic Interface System.
- Latest version implemented using GA's
 - Crossover
 - Mutation
- TRIZ is applied through GA's to Graphic Design, in this software.
- TRIZ Principles are coded as chromosomes.

Slides from FuTRIZ Presentation, France (2013)



Genetic Algorithms: Structure Implemented

Name of process/ element type	Equivalent in ABS_6_6_GA	Sample
Gene	Function/Method Parameters in cR.net	In the method Segmentation (00111111, 00111111, 1 and 000011 are the genes.
Chromosome	Function/ Method	The method Segmentation (001111, 001111, 000011, ...) altogether is called a chromosome.
Gene controlled property	The size, shape and degree of different mutations in ABS	Curvature of an alphabet.
Allele	Different colours, sizes, shapes of the gene controlled property	The gradient colour of base. 
Locus	The point where the parameters of a function end.	In the method above, the "" represents a locus separated point as it marks the end of one gene and start of another.

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Genetic Algorithms: Structure Implemented

Name of process/ element type	Equivalent in ABS_6_6_GA	Sample
Phenotype/individual	The image	One of the images in generated generation. 
Population	Group of all individuals (image) generated.	Images generated in each iteration (R). 
Genome	Collection of all chromosomes for an individual (image).	Summation of all methods and their parameters for an image generated at point 3 of the 3x3 grid of ABS.

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Slides from FuTRIZ Presentation, France (2013)

AEGIS: Overview

- Seven versions developed so far.
- Mathematica and c#.net technology based.
- The last versions (6.6 GA and 7.0) use GA's
- Iteratively being improved after feedback from Graphic Designers.
- Some tools based on 3x3 grid are pic breeder.
- Pic breeder generates random generations.
- AEGIS generates TRIZ guided generations.

**AEGIS: Software Requirement Specifications.**

- Functionality
 - To be able to mutate images
 - Iterative mutations based interface
- Outputs
 - In the form of finalized design (picture formats)
 - Intermediate images used and generated (for research and future use)
- Inputs
 - Initial sketches or seed image(s)
 - User preferences

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AEGIS: Software Requirement Specifications.

- Performance
 - It will be designer's who attempt to make AEGIS's performance better as compared to commonly used graphic design tools like Adobe PS in certain aspects, such as speed, choice of mutations, etc.
- Design constraints
 - Most of the design patterns, algorithms should be guided by TRIZ Principles
 - Manual interpretation of users should be kept to minimum in case of guiding the design
- External interfaces
 - It may be later used as a plug-in or a connection to other tools
 - It can take outputs from other tools like handwriting alphabet generation based tool.
 - (The above SRS was valid at the beginning of AEGIS project and has been refined and more details added from time to time)

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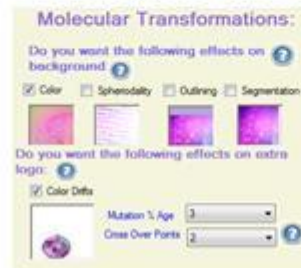
AEGIS: Flow of software use (Steps followed to generate a design).

E. Designer uploads

- Background
- Logo
- Extra Logo



F. Designer selects the TRIZ Chromosomes to be applied to the background and extra logo.



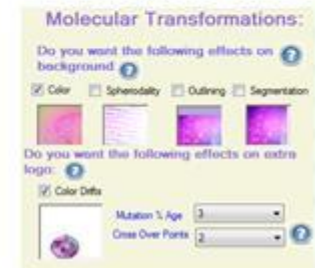
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Feedback: From Designers.

- The software is fast in producing the design ideas for quick idea generation.
- Potential drawback is it may cost jobs (doing the work of a designer) !
- Designers find it useful for brainstorming ideas.
- Visual aid for quick idea generation.
- Works well for designers in initial concept creation.

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TRIZ Future Conference 2013, Paris, France: 29th-31st Oct 2013

Feedback: Conclusion and On-going Work.

- Positive feedback from designers.
- Currently the interface is being improved.
- The software is being used by over 300 engineers, scientists, graphic designers and other users to make the software 'learn' successful chromosomes specific to different expert level and the different specialisms of users.
- Many further chromosomes have been defined to embed more TRIZ Principles through GA's.

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Applying TRIZ to Graphic Design using Genetic Algorithms – An update

1st November 2013

Mir Abubakr Shahdad &
Paul Filmore

Contents

- Introduction
- TRIZ Overview
- Research Objectives
- Graphic Design Process
- TRIZ Application to Graphic Design
- Computer Aided Innovation
- Genetic Algorithms
- AEGIS
 - Software Requirement Specifications
 - Forms
 - Components
 - Functionality
- Feedback
- Current Conclusion
- Ongoing Work and Research

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Slides from UK TRIZ Forum Presentation, UK (2013, #5)

Research Objectives: General

- TRIZ is a problem-solving, analysis and forecasting tool derived from the study of patterns of invention in the global patent literature.
- Is it possible to 100% automate innovation using TRIZ?
 - If not, then how much?
- Can the DNA of Innovation be captured (using TRIZ)?
 - What percentage and how effectively?

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Research Objectives: Particular

- Specifically, can a tool be developed to help graphic designers innovate?
- Can TRIZ Principles be used to guide this tool and help in step-changes.
- If yes then how much and at which stage and can this process be automated?

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Graphic Design Process: Stages

1. Briefing
 - Discussion between designer and client
 - Analysis of the design requirement
2. Design
 - Designer reviews standards
 - Details the background of requirement of design
3. Artwork
 - Designer prepares the artwork files
 - Feedback is noted and changes implemented
4. Production
 - Artwork forwarded to commercial printer

Graphic Design Process: Scope for Innovation

1. Briefing
 - Can there be a tool to help designers quickly generate samples of different ideas (design previews) to client?
2. Design
 - Can designer feed requirement to a system which generates TRIZ triggered design patterns?
3. Artwork
 - Can there be a tool to help designer generate different TRIZ triggered previews of same design?
4. Production
 - This stage has not been touched by our research.

Slides from UK TRIZ Forum Presentation, UK (2013, #5)

TRIZ to Graphic Design:

Steps taken to Translate TRIZ Principles to Graphic Design Specific Forms:

1. Collection of good designs from Graphic Design Literature.
 - Books
 - Magazines
 - Papers
 - Journals
2. Collection of what consumers (end users) consider good design
 - Example: from a supermarket shelf
3. Collection of award winning/ good designs from designers
 - Example: from a graphic communication exhibition.

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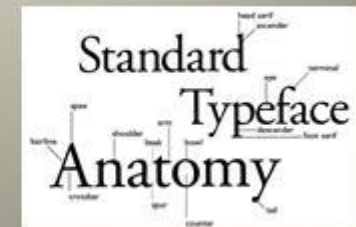
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Genetic Algorithms: Structure Implemented

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Genetic Algorithms: Structure Implemented

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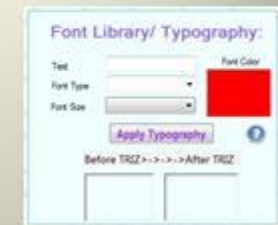
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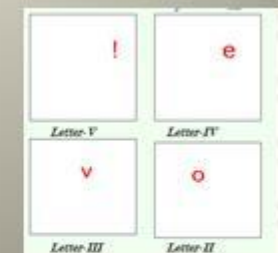
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 - (The above SRS was valid at the beginning of AEGIS project and has been refined and more details added from time to time)

AEGIS: Flow of software use (Steps followed to generate a design).

A. Designer inputs a font specification.



B. The corresponding font letters are generated.



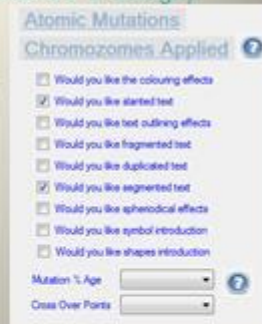
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AEGIS: Flow of software use (Steps followed to generate a design).

C. Designer selects the TRIZ Chromosomes To be applied to the font letters.

D. The corresponding grid is generated and the designer can carry on through different generations.

- Three parents carry on to next generation.
- Fitness function (selection by Designer).



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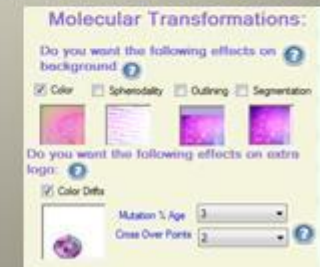
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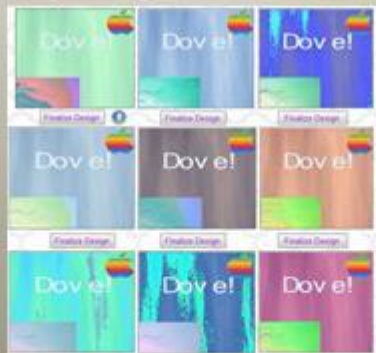
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AEGIS: Flow of software use (Steps followed to generate a design).

G. The solution grid (generation) is displayed

H. Designer can continue through different generations unless a satisfactory design is encountered.



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AEGIS: Flow of software use (Steps followed to generate a design).

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AEGIS: Software learns from users.

- During the generation of font and the complete design generations, the user can select the chromosomes of successful designs made by previous users.
- Hence the software learns from user experiences.



Feedback: From Designers.

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- Designers find it useful for brainstorming ideas.
- Visual aid for quick idea generation.
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Slides from UK TRIZ Forum Presentation, UK (2013, #5)

Feedback: Conclusion

- Positive feedback from design
- Currently the interface is being
- The software is being used by scientists, graphic designers, software 'learn' successful at different expert level and the
- Many further chromosomes for more TRIZ Principles through

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Thank you



AEGIS

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*School of Computing & Mathematics, University
of Plymouth, UK.*

Email: abubakr.shahdad@plymouth.ac.uk.

Email: pfilmore@plymouth.ac.uk.

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"Applying TRIZ to Graphic Design
presented at the The 2013 Joint
Systematic Innovation & IFIP
Tainan, Taiwan.

TRIZ: COMPUTER AIDED
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Shahdad, R. (2013) "A review of TRIZ
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"Applying TRIZ to Graphic Design using
TRIZ2013, Paris 28-31st October 2013,

Thank you.
End of Thesis -December 2014 Version
of
Engineering Innovation (TRIZ Based
Computer Aided Innovation)
by
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