

Innovation in Conceptual Age (Case of Five Companies in Avionics Industry of Iran)

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Abstract

Background: Human being has passed different technological ages so far, from agriculture age to industry age and to information age. Now a new paradigm is developing. This new age is named Conceptual Age. In this new age you should do the job artificially and differently. This new age is recognized by several indexes which are named Senses of Conceptual Age. **Aim:** One of the most important issues of Conceptual Age is technological innovation. It is the main engine of economic progress. In this article we have discussed about Conceptual Age effects on technological innovation in avionic industry of IRAN. We have promoted a framework which connects innovation and Conceptual age features. **Methods:** by studying in innovation literature a proposed model was produced which is the combination of Stage-Gate model and Conceptual Age Senses, then by interviewing it was accurred, then questionnaires helped us to determine which senses of the New Age is important in different stages of innovation, Delphi Technique at the end used for confirmation of final model. **Findings:** A model which shows the important factors in any stages of innovation and the main Sense of New Coming Age in any stages of innovation

Keywords: Technological Innovation, Conceptual Age, Stage-Gate, New Coming Age

1. Introduction

Now we live in a new age which is more complicated and varies more than ever (1). One of the most important turning point in human technological life is agriculture revolution, before that time the human lived in hunting communities, almost seven thousand years BC (2). They have started to cultivate plants and it was the reason for starting the agriculture age. With the expansion of communication between societies and growing the concept of trade and increase in transportation, the separated economic units joined to each other and made bigger units. This growth is driven by the expansion of agriculture (3) Over production of agriculture sector over time caused division of labor, rising prosperity and urban development (4).

The second technological evolution is industrialization which means using machines instead of manpower (5). Industrialization has begun in Mid-eighteenth century and during less than a century caused many innovations in textile industry, advances in mass production, coal mining and using steam power etc.(6). Next phase of industrialization occurred in the last years of the nineteenth century. The features of this period as follows: expansion in automotive and electrical industry (7). The next phase of industrialization occurred coinciding with World War II in this period aluminum industry (8).then new technologies emerged, such as radio and television and electronics industries grew at a faster pace and thereby provide context for the information age (9). In information age, an industrialized society can only be seen not only in its industrial activities but also most people work in a spirit of intellectual and high performance (10).

Achieve beyond the routines and the quest for meaning and purpose of the life. In information age we emphasized on thinking as computers but in conceptual age artistic thinking is considered, the age after information age is called Conceptual age (11).

Avionics is one of the most important segments of aviation industry, it means Aviation plus Electronics which is contains parts as Radars, Communication systems, Sensors, Control systems, Automation Systems and etc. (12). This is complicated industry so phase to phase model of innovation is suitable for Avionics (13).

Innovation can make new opportunities but unfortunately, when companies are faced with the challenge of reducing costs they reduce innovation budget (14). When many jobs have been outsourced to Asian countries the advanced economies should be innovative to remain in competition (15). How is innovation in the conceptual age? We know the main engine of development is innovation (16). The main objective of this research is to design a model to show the relationship between technological innovation and conceptual. There is a Stage-Gate modified model (13) which is the proposed innovation model and a seven senses Conceptual Age model (11) which is

proposed as Conceptual Age model. We have declared that which sense is more considered in which stage of innovation by creating a new model which is combination of these two.

For this purpose, a proposed model is designed by combination of two models of innovation and conceptual age. Firstly, the innovation part of model was enriched by doing interviews in Avionic industry companies. Then relation of each senses of Conceptual Age and innovation stages are asked by questioner. At last a model showed the result.

2.1 Conceptual Age

Today we have entered to a New Coming Age which is named Conceptual Age (11). The entrance to the age was sensed when three main features appeared: first - Abundance which means full competitiveness of market, second- Asia which means we can outsource many productions to other countries for saving money, third –Automation which means many jobs could be done by machines and computers with no need to human resource (17). Following table somehow describes the historical trend of technological ages.

Table 1 technological ages (18)

	Agricultural age	Industrial age	Information age	Conceptual age
period	Up to 1800	1800-1950	1950-2010	2010 to now
Most workers	Farmers	Workers	Knowledge workers	Creatives
partnership	People- Land	People- Machine	People- People	People-People
Tools	Traditional tools	Machines	Information tool	Conceptual tool

The last few decades have belonged to a certain kind of person with a certain kind of mind — computer programmers who could crank code, lawyers who could craft contracts, MBAs who could crunch numbers. But the future belongs to a very different kind of person with a very different kind of mind -creators and empathizers, pattern recognizers, and meaning makers (19). These people -artists, inventors, designers, storytellers, caregivers, consolors, big-picture thinkers - will now reap society’s richest rewards and share its greatest joys (11). There is a seismic — though as yet undetected — shift now under way in much of the advanced world. We are moving from an economy and a society built on the logical, linear computer-like capabilities of the Information Age to an economy and a society built on the inventive, empathic, big-picture capabilities of what’s rising in its place, the Conceptual Age (20).

There are six essential aptitudes— “the six senses” on which professional success and personal satisfaction increasingly will depend: Design, Story, Symphony, Empathy, Play and Meaning (11). These are fundamentally human abilities that everyone can master. A change of such magnitude is complex. For nearly a century, Western society in general, and American society in particular, has been dominated by a form of thinking and an approach to life that is narrowly reductive and deeply analytical. Ours has been the age of the “knowledge worker,” the well-educated manipulator of information and deployed of expertise (21). But that is changing. Thanks to an array of forces — material abundance that is

deepening our nonmaterial yearnings, globalization that is shipping white-collar work overseas, and powerful technologies that are eliminating certain kinds of work altogether — we are entering a new age(22).

It is an age animated by a different form of thinking and a new approach to life — one that prizes “high concept” and “high touch” aptitudes (11). High concept involves the capacity to detect patterns and opportunities, to create artistic and emotional beauty, to craft a satisfying narrative, and to combine seemingly unrelated ideas into something new. High touch involves the ability to empathize with others, to understand the subtleties of human interaction, to find joy in one’s self and to elicit it in others, and to stretch beyond the quotidian in pursuit of purpose and meaning (23).

There’s something that encapsulates the change — and its right inside your head. Our brains are divided into two hemispheres (24). The left hemisphere is sequential, logical and analytical. The right hemisphere is nonlinear, intuitive and holistic. We enlist both halves of our brains for even the simplest tasks (25). But the well-established differences between the two hemispheres of the brain yield a powerful metaphor for interpreting our present and guiding our future (11). Today, the defining skills of the previous era — the “left brain” capabilities that powered the Information Age — are necessary but no longer sufficient. And the capabilities we once disdained or thought frivolous — the “right brain” qualities of inventiveness, empathy, joyfulness and meaning — increasingly will determine who flourishes and

who flounders (26). For individuals, families and organizations, professional success and personal fulfillment now require a whole new mind (2).

Figure 1 Conceptual Age senses (11)



As Pink has told(11) : To survive in this age, individuals and organizations must examine what they are doing to earn a living and ask themselves three questions:

1. Can someone overseas do it cheaper?
2. Can a computer do it faster?
3. Is what I am offering in demand in an age of abundance?

These are three main question of this age, then six senses are under consideration. In the Conceptual Age, we will need to complement our L-Directed reasoning by mastering six essential R-Directed aptitudes. Together these six high-concept, high-touch senses can help develop the whole new mind this era demands:

1. Not just function but also DESIGN. Today it's economically crucial and personally rewarding to create something that is beautiful, whimsical, or emotionally engaging.

2. Not just argument but also STORY. The essence of persuasion, communication and self-understanding has become the ability also to fashion a compelling narrative.

3. Not just focus but also SYMPHONY. What's in greatest demand today isn't analysis but synthesis — seeing the big picture and, crossing boundaries, being able to combine disparate pieces into an arresting new whole.

4. Not just logic but also EMPATHY. What will distinguish those who thrive will be their ability to understand what makes their fellow woman and man tick, to forge relationships, and to care for others.

5. Not just seriousness but also PLAY. Too much sobriety can be bad for your career and worse for your general well-being. In the Conceptual Age, we all need to play.

6. Not just accumulation but also MEANING. A world of material plenty has freed us to pursue more significant desires: purpose, transcendence, and spiritual fulfillment.

2.2 Technologic Innovation

Innovation can be defined in two main categories: firstly macro innovation in the level of countries, secondly micro innovation in the level of companies or projects (27). there is no accepted specified definition for innovation and researchers in each field define it in a specific way, for example economists believes that innovation occurs in companies they produce some product for the first time and gain profit and they say other companies are imitators (28). But management scientists believe that creation a new vision and understanding of phenomena is innovation (29).

According to the Oxford management dictionary innovation is any new approach in design, production or marketing if innovator gives an advantage more than other competitors (30). Using new knowledge for a new product or service (31).

The definitions have been tried to be explained the difference between invention and innovation. Invention is the product of research but innovation occurs when invention ends in profit (32). Innovation integrate an idea with company and cause to change strategies and plans and make a new organization (28). Innovation occurs in both product and process, it contains Design - Development - select - implementation and dissemination (33).

Schumpeter defined innovation: -Introduce new product- change in production methods – enter to a new market –using new sources – using new marketing methods (34).

Innovation should be new, new for company or new for the market (35). So we can divide innovation in to: new product for the current market, new production line, production line development, product improvement, product replacement and cost reduction (36). In developing

countries most innovations are new for company and not new for market (35).

In Iran most of innovations are new for company and in this research we also mean this kind of innovation (27).

There are some models in innovation literature, we can divide them into three categories: linear -Interactive –Integrated. Linear models say

that innovation levels come after each other from research to commercialization and marketing and ends to publication. In interactive models innovation occurs in levels with feedback loops and integration models believe that there is cooperation with different parts and levels of innovation (37).

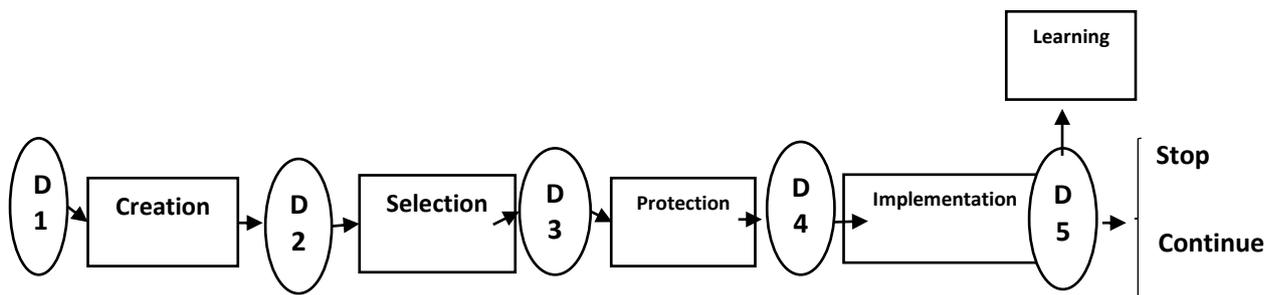
Table 2 Technology Innovation Models (38)

GENERATION	TYPE OF MODEL	CHARACTERISTICS OF MODEL
First	Technology push	Even a simple linear process, emphasis on research and development
Second	Market pull	Even a simple linear process, focusing on the market, the market source for ideas, research and development, R & D reacts role.
Third	Combined model	Steady, but has feedback loops, Push or Pull or a combination of Push/Pull, greater balance between the market and research and development, emphasis on the integration of markets / R & D
Fourth	Integrated model	Parallel development integrated development team, a strong relationship with suppliers, interaction with customers, emphasizing the integration of R & D and design Produce to achieve the ability to build, horizontal cooperation.
fifth	Integrated systems and network model	Fully integrated parallel development of expert systems and simulation models in research and development, strong relationship with customer demand, strategic integration with key suppliers, links horizon, the establishment of procedures for joint research, joint marketing setting, emphasis on adaptability and speed in development, emphasis on quality and other factors without Price

In the past, innovation was studied in a linear way but it was accused to oversimplification so other models were created (39). So many models were created by many Scientists e.g. Cooper, 1990(40); Gobeli and Brown (41), 1993; Goffin (28) and Pfeiffer, 1999; Tidd, Bessant and Pavitt (34), 2005; Narvekar and Jain, 2006(42); Chandra and Neelankavil, 2008(30).

The conclusion of these researches was that innovation has five main steps: Search, selection, implementation, learning. Based on this Cooper proposed Stage-Gate model (36).

Figure 2 Stage-Gate model (36)



Stage-Gate models says that in certain point we should think about continuing or stop the project. These cause saving resources. And so this model is the most suitable for Avionic industry as a complicated industry(13).

Stage-Gate is the basis of this research, each level of innovation is shown by a square and each decision point is shown by a circle. In each gate we decide to continue or stop the project. By

considering stages and add some new function to it we can create a new model. So in this research we want to add conceptual age index to each Stage. We will create a new model by adding index of conceptual age to stages and in gate we will decide and also do corrective action to keep project in Paradigm of conceptual age.

Most of innovations in developing countries, innovations are just new for the company

and not for the universe (43). In recent years' countries such as India and China entered to the innovation market, but most of the innovations in Asian countries are left-minded. Iran also is one of the historical Asian country.

Research Background

Alan Greenspan, former chairman of the Federal Reserve Board, recognized the role of conceptual output as early as 1997 in a speech at the University of Connecticut when he said "The growth of the conceptual component of output has brought with it accelerating demands for workers who are equipped not simply with technical know-how, but with the ability to create, analyze, and transform information and to interact effectively with others(17). By 2004, he had developed his views on the topic, referring to reductions in manufacturing in the United States, outsourcing to India and China, excess of supply and the global marketplace, all leading to the increasing conceptualization of economic output (20).

In his book *A Whole New Mind*, Daniel H. Pink explains how the economy is now moving from the information age to the conceptual age. He describes how abundance (over-supply), Asia (outsourcing) and automation contribute to the need for business to concentrate on cognitive or creative assets such as design, storytelling, teamwork, empathy, play and meaning. He bases his approach on brain functions explaining how qualities dependent on the left hemisphere of the brain (logic, knowledge) now need to be complemented by those associated with right-brained processes (intuition and creative thinking)(11).

Other contributors to our understanding of the conceptual economy include Tom Friedman who describes the opportunities of globalization in his book *The World is Flat*. He emphasizes the importance of the internet and personal computers for communications and software sharing across the globe. This explains how American companies are able to outsource a substantial portion of their business to India and China with no disruptions for the customer (44).

Tom Kelley is also a key player in the field, both as general manager of IDEO, a highly successful design and innovation company, and the author of two widely acclaimed books: *The Art of Innovation*, highlighting the importance of brainstorming and teamwork in product creation; and *The Ten Faces of Innovation*, explaining the

role of assets such as empathy, storytelling, individual experiences and stimulating work environments in fostering creative ideas(45).

The key steps behind the conceptual economy fall into the following categories (11):

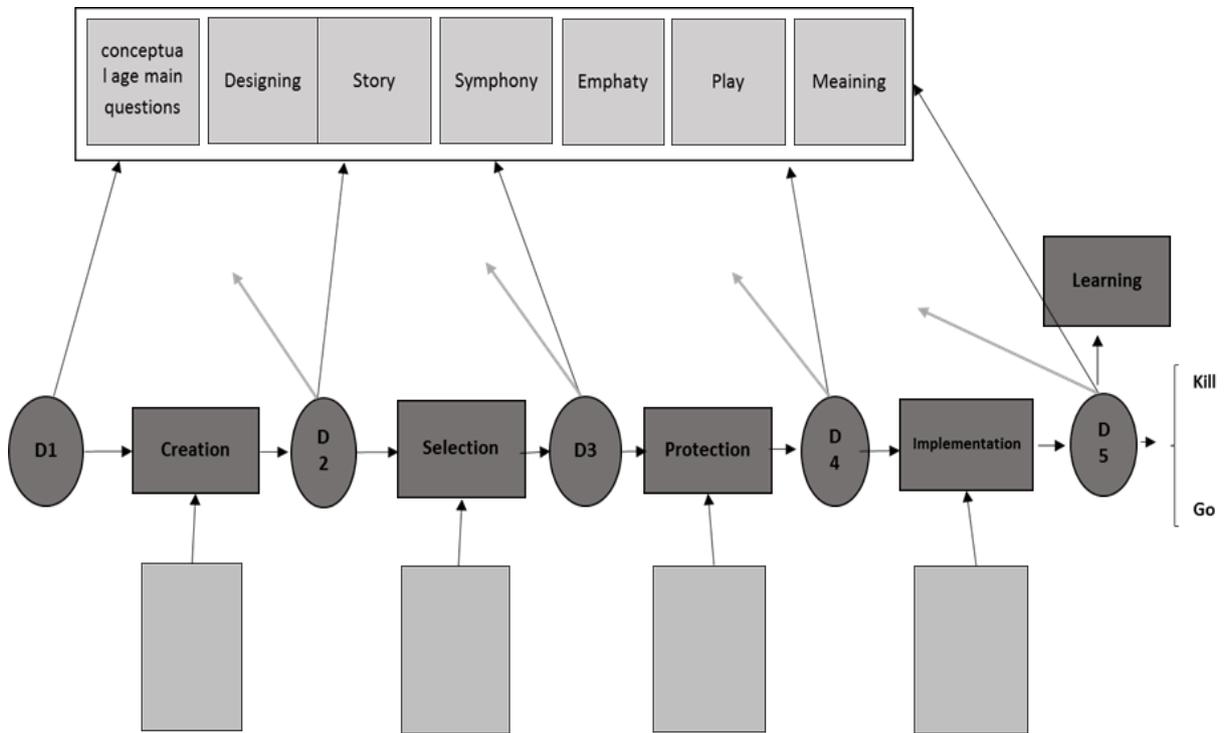
The ability to have an overall view rather than the individual components. Systematic thinking and doing activities such as machine changed by understanding the feelings and pay attention to the beauty and communion with others and the ability to think several issues at the same time and attention to the real meaning of things while enjoying the job. In conceptual age three main questions are been asked before starting any production or activity: first- can we outsource the job to others by better quality and price? Second- can computers and machines do the job better than us? Third- in abundance age despite high competition, what I want to do is needed or not?

Conceptual age also includes six senses: first. Not just function but also DESIGN. Today it's economically crucial and personally rewarding to create something that is beautiful, whimsical, or emotionally engaging second. Not just argument but also STORY. The essence of persuasion, communication and self-understanding has become the ability also to fashion a compelling narrative third. Not just focus but also SYMPHONY. What's in greatest demand today isn't analysis but synthesis — seeing the big picture and, crossing boundaries, being able to combine disparate pieces into an arresting new whole forth Not just logic but also EMPATHY. What will distinguish those who thrive will be their ability to understand what makes their fellow woman and man tick, to forge relationships, and to care for others fifth. Not just seriousness but also PLAY. Too much sobriety can be bad for your career and worse for your general well-being. In the Conceptual Age, we all need to play sixth. Not just accumulation but also MEANING. A world of material plenty has freed us to pursue more significant desires: purpose, transcendence, and spiritual fulfillment.

4. The proposed model

As said before by combining Stage-Gate model and conceptual age we are eager to make a new model. So combining these two is shown below:

Figure 3 Proposed Model



This model is made by mixing conceptual age and Stage gate model, boxes will be filled by essential information needed for making decision in each gate.

5. Methodology

The study uses a combination of inductive and deductive methods. By extracting a model from innovation and conceptual age literature review and then refining the model by interviews. The interviews helped us to determine the factors which should be considered in innovation process in case companies. These factors have been determined by Grounded-theory method within 10 interviews. All available persons were 17 people from five companies. Theoretical sampling method is advised in qualitative surveys (46). It should be considered that most suitable people selected for interview.

Company selection criteria is their Innovativeness; the companies have been chosen for study that:

- Tended to share details with researcher
- The number of people who are active in projects and can be used as an interviewee, is an amount that does not interfere with the validity and reliability of the study.
- Innovative projects have been done in the company

Have experienced people in management of technology

Considering above criteria and by cooperation of Iranian Aviation Technology Development Headquarter –IATDH-some companies have been chosen as below:

Table 3 cased companies

Nom.	Company name	field	Number of innovative projects	Number of active people
Case 1	Beker Part	Avionics	1	8
Case 2	Alagam Afarin	Avionics	1	8
Case 3	Mahad Sanat	Avionics	1	8
Case 4	Samaneh Sanat	Avionics	1	8

Dideh Pardaz Saba	Avionics	1	8
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After doing interviews about factors which they consider during innovation stage. The factors made from codes which are mentioned by experts. Then codes were grouped and shown in this article. Then by Chi-square technique the goodness of fit of data were measured. In second phase 40 expert in field of management of technology were asked by questionnaire if each senses of Conceptual Age is related to each phases of innovation process or not. The result analyzed by Binomial test.

So the model of study was created then this model was tested by six people via Delphi technique and approved.

6. Analysis Results

As discussed above after literature review, people in charge in case studies were interviewed to refine the model. Items raised in this interviews by grounded theory and then were written by system prototypes to reach to the factors which are effective at every stage of our innovation model.

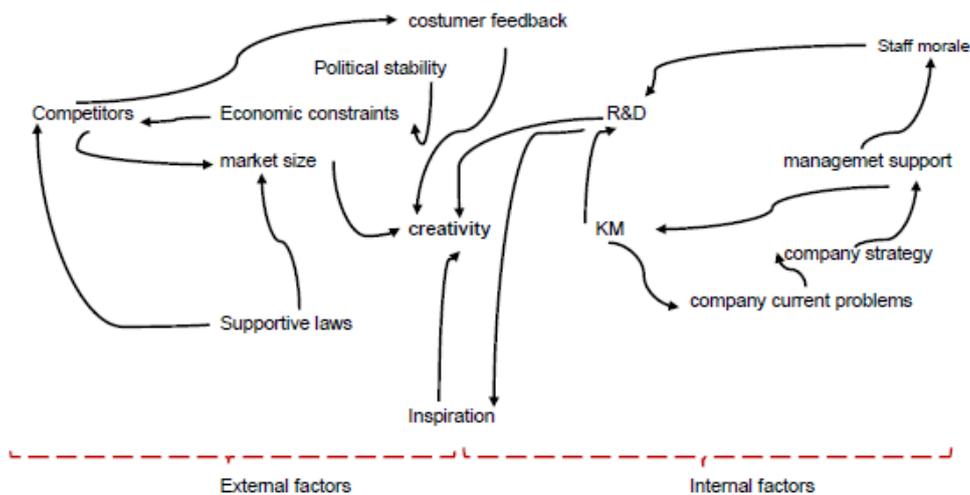
6.1 creation stage in innovation model

After summarizing interviews, following diagram was obtained by systematic thinking prototype. In this method, each vector represents the primary factor impact on the factor which is on the end of vector. The factors and impacts are extracted from interview

Figure 4 Effective factors on creation

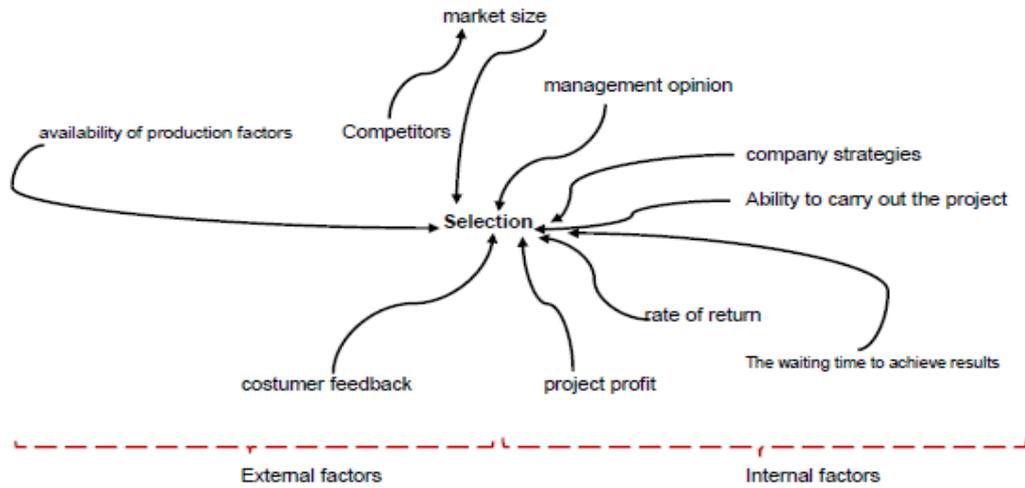
6.2 selection stage in innovation model

After summarizing interviews, following diagram was obtained by systematic thinking prototype



6.3 Protection stage in innovation model

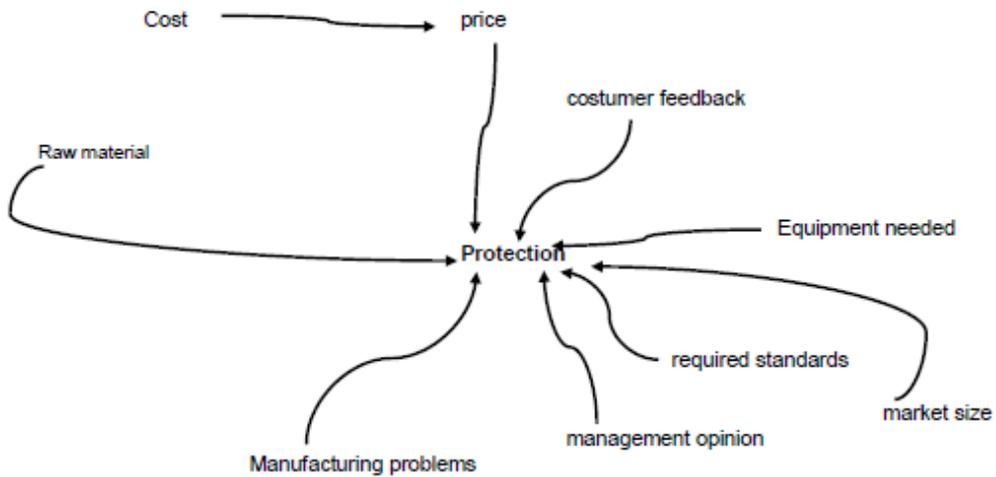
After summarizing interviews, following diagram was obtained by systematic thinking prototype.



6.4 Implementation stage in innovation model

After summarizing interviews, following diagram was obtained by systematic thinking prototype.

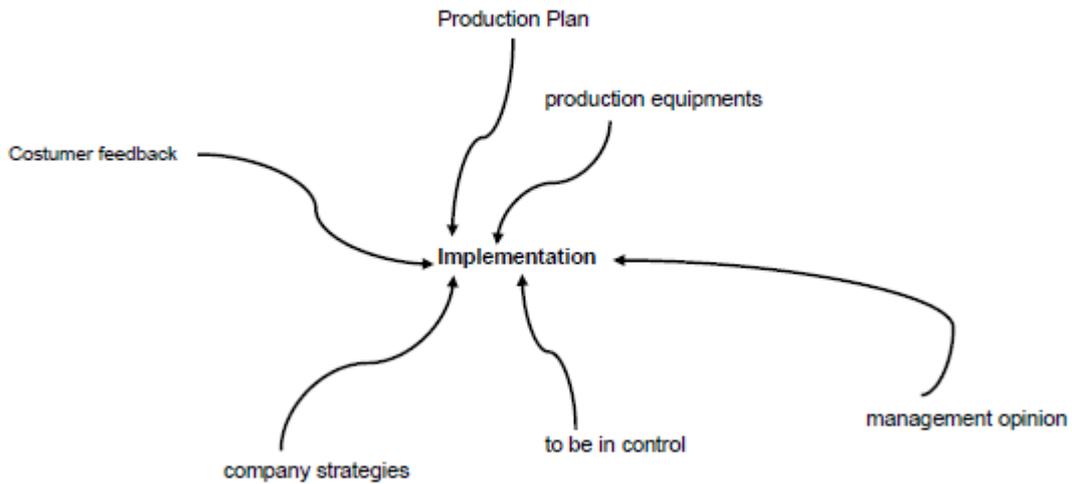
Figure 5 Effective factors on selection



6.5 Learning stage in innovation model

As previously mentioned, the learning capacity of a company has a direct impact on innovative performance. In most interviews, the importance of knowledge management and document noted was stressed. Companies to implement ISO standard will have to record their official information documents, this is despite the fact that people believe, official data recording alone, would not be cause learning.

Figure 6 Effective factors on implementation



6.6 asymptotically of gathered information

a chi-squared test is a test in which this is asymptotically true, meaning that the sampling distribution (if the null hypothesis is true) can be made to approximate a chi-squared distribution as closely as desired by making the sample size large enough. The chi-squared test is used to determine whether there is a significant difference between the expected frequencies and the observed frequencies in one or more categories.

Table 4 chi square test result

asymptotically by chi square test						
stage	case 1	case 2	case 3	case 4	case 5	Total
Creativity	0.96	0.86	0.98	0.84	0.98	0.99
Selection	0.99	0.94	0.97	0.97	0.97	0.99
protection	0.99	0.99	0.99	0.88	0.84	0.99
Implementation	0.93	0.99	0.96	0.89	0.78	0.99

6.7 Conceptual Age senses impacts on different stages of innovation

In this phase of the research a questionnaire developed to assess the impact of each of the six senses of conceptual age in addition to the age main questions. For this purpose, each senses were divided into three separate indicators to better understand of respondents.

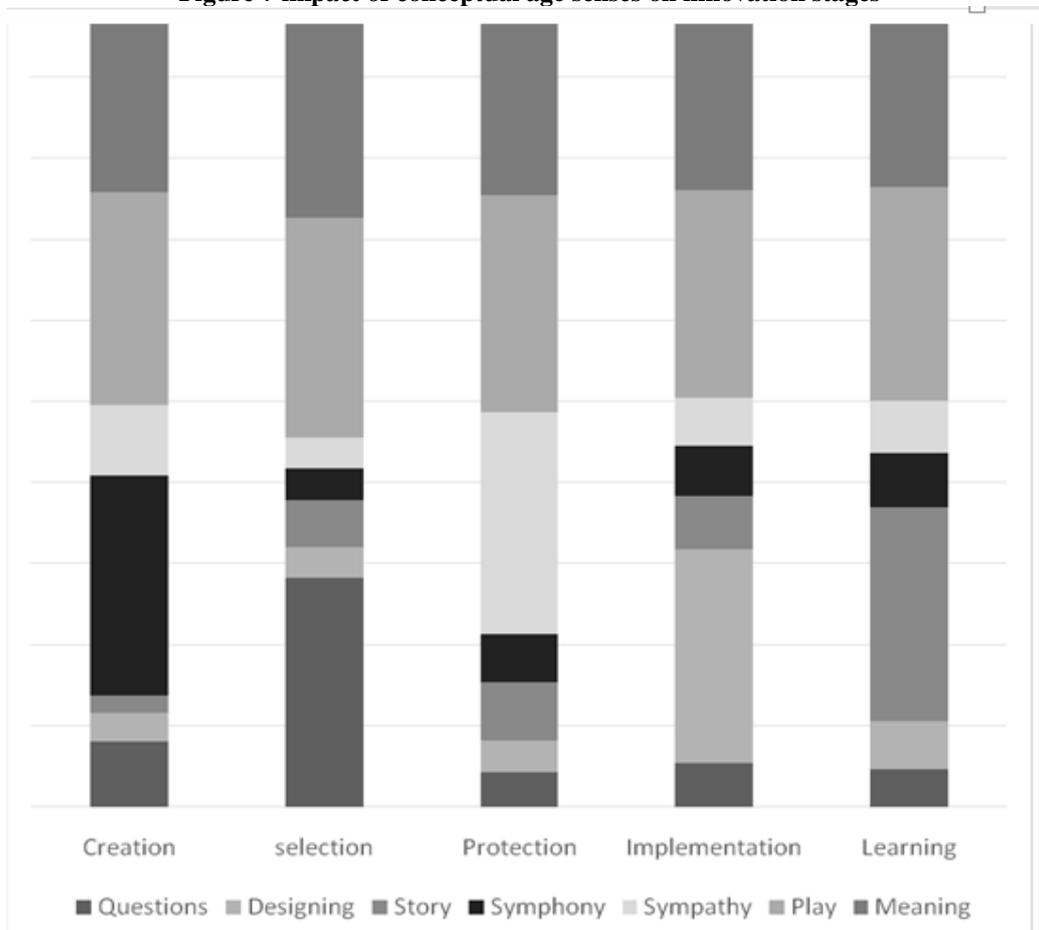
Table 5 detailed characteristics of Conceptual Age (47)

Conceptual Age	Main questions of Conceptual Age	Outsourcing Automation Abundance
	Design	Artistic sensibility Originality Temptation
	Story	Foresee Destiny Knowledge Management
	Sympathy	Big picture Simple Thinking Invention
	Empathy	Pay attention

		To realize Care
	Play	Enjoy Well-being Teamwork
	Meaning	Satisfaction Social value To advance

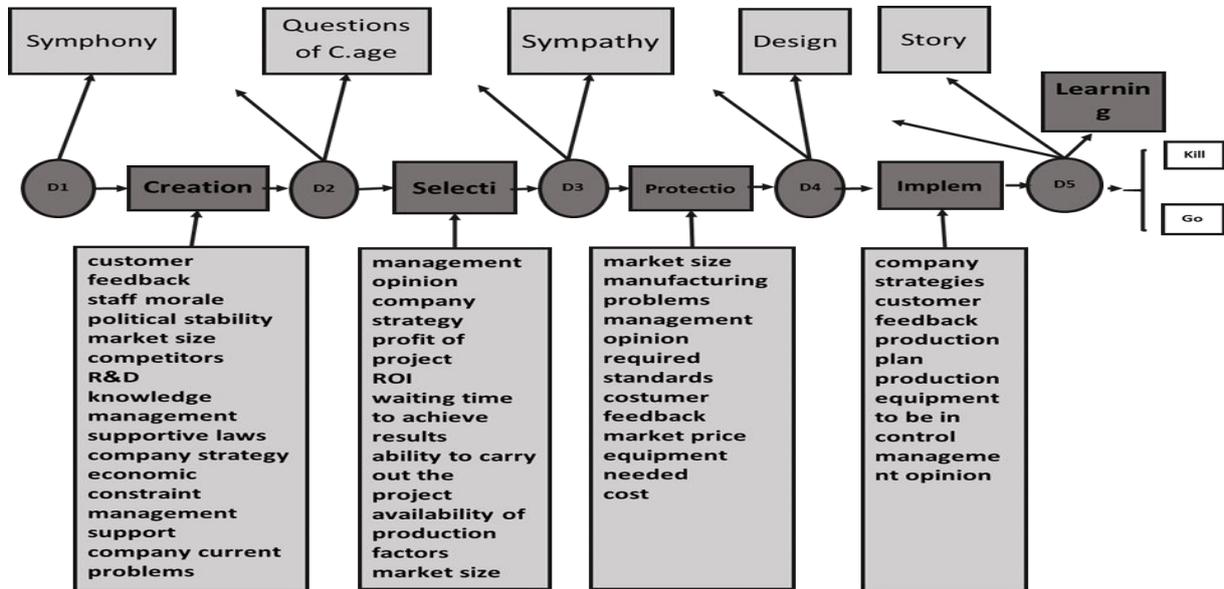
After collecting the questionnaires and review them the impact of each senses in the process of technological innovation was explained as follows. Most impact in creation stage is from symphony, in selection stage is from questions, in protection stage is from sympathy, in implementation stage is from designing and in learning stage is from story. Play and meaning almost have high impact in all stages.

Figure 7 impact of conceptual age senses on innovation stages



The results obtained in this step was determined by the binomial test so it was confirmed that senses of Conceptual age impact on the innovation process stages, the binomial test is a test of binomially distributed hypotheses. It can also be used to test hypotheses about the median of a population. In this latter function, it is a nonparametric analog of the one sample t-test and may come in handy when the population of interest is not normally distributed and the sample size is small (48). According to research the final version of the model can be drawn as follows:

Figure 8 Final Model of Study



Of course above model was verified by experts. So after drawing primary model it was discussed by respondents via two rounded Delphi. The Delphi technique is a widely used and accepted method for gathering data from respondents within their domain of expertise (48). The technique is designed as a group communication process which aims to achieve a convergence of opinion on a specific real-world issue, several rounds of questionnaires are sent out, and the anonymous responses are aggregated and shared with the group after each round. The experts are allowed to adjust their answers in subsequent rounds. Since multiple rounds of questions are asked and the panel is told what the group thinks as a whole, the Delphi method seeks to reach the correct response through consensus (48).

7. Discussion and Conclusion

This article aimed to explain the impact of Conceptual Age Senses on Technological Innovation process. Stage-Gate model was the base of study as previous researchers told it is the best for Avionics industry as our case, the innovation factors in each stages was identified by interviews in first phase of study. Then impact of each Conceptual Age sense on innovation stages was asked by questionnaire. The result was being tested by binomial test. The final model generated after Delphi technique has taken and confirmed the result.

Final model showed that while Creating a product is in progress the main sense which is important is Symphony, in the Selection Stage the Questions of Conceptual Age are asked and in the Protection stage the Sympathy is mentioned, while Implementing the Design sense and in Learning the Story senses are more important.

By consideration of the effect of Conceptual Age senses in Innovation of Technology, paying more attention to the age changes in managing the innovation projects will cause to improve innovation success.

Off course this study was toke place in Avionics industry, so doing same study in other industries and in other countries especially advanced countries may to help consolidate the results.

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