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# The Application of Compensatory Model in Cognitive Strategies of Designers

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**Abstract:** Content Analysis as a research technique for the objective, systematic and quantitative description of manifest content of communications. Content analysis is a research tool focused on the actual content and internal features of media. It is used to determine the presence of certain words, concepts, themes, phrases, characters, or sentences within texts or sets of texts and to quantify this presence in an objective manner. Texts can be defined broadly as interviews, discussions, speeches, conversations, informal conversation, or really any occurrence of communicative language. To conduct a content analysis on a text, the text is coded or broken down, into manageable categories on a variety of levels-word, word sense, phrase, sentence, or theme--and then examined using one of content analysis' basic methods: conceptual analysis or relational analysis. In this paper, the author is trying to approach the Shannon's Entropy, which is derived from information theory to analyze field data, to determine the strategy development. If the content analysis technique is the preparation, organization of message and data processing, method presented. in this paper (Shannon's Entropy) will be in the third step. Data processing methods in content analyzing totally is non-compensatory basis and interpreted based on the frequency of each category. These methods have problems of mathematical and theoretical dilemmas that limit their application and the type of information obtained doesn't have, while to overcome this shortcoming, the compensation models less used in the area of ??data analysis in content analysis methods have been considered. In this paper one of the main methods in the field of system engineering, have been studied and thereby a new approach to develop the content analysis technique expanded. Main part of essay express the Shannon's Entropy in content analysis, has been allocated the strategies and methods compared with current methods of data analysis. The results validate of the new method compared with current methods of data processing and data obtained from the studies of thirteen architecture students protocol for the development of expertise model for identification of four different design strategies: "Problem driven strategy"; "Solution driven strategy"; "Information driven strategy"; "Knowledge driven strategy" are analyzed and compared.

**Key words:** Content analysis · Shannon's Entropy · Systematic theory · Design strategy · Design process · Protocol studies · Compensatory model

## INTRODUCTION

A researcher attempts to answer a number of problems or studies verifying and accuracy one or more research hypotheses. In the methodologies, there are different strategies (approaches) and techniques to achieve this purpose. One of the approaches that have been developed seriously in recent decades is "content analysis" method. A researcher through studying the interview and written or verbal data tries to achieve the research hypothesis evaluating.

Content analysis is an approach to help those who are trying to interviews, counseling, test types, speech, intuitive gesture, or any other element that may help in understanding the individual, to acquire information that is based on assumption and the research question. Content analysis is a Technique that is used in all fields of research and has been used by researchers nowadays [1].

This study shows that content analysis is a process of gathering information, in which content can be transformed into information that can be summarized and

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compared. Accordingly, two questions: whether the method of content analysis should be quantitative? And or it should be restricte the obvious content of design protocols or would be involve hidden aspects? are examined. Finally, the protocol data and the expertise model of the product design process were used to identify four different cognitive strategies employed by the designers: problem, solution, information and knowledge driven design strategies of thirteen architecture students in two traditional and Shannon's Entropy methods will be analysis and compare [2].

## MATERIALS AND METHODS

In addition, in the content analysis, objectivity, system integration and universality are the main features; also in this regard there is general agreement, Quantity and quality of content analysis have involved more significant discussed in recent literature [3]. Quantity condition, often by those who make this technology more scientific methods of analysis other documents and also by those who are most critical to its position have been considered a necessary measure. A recent perspective is intended to prove that there is not a clear reason for applying the content analysis, unless the person seeking the answer to that question is quantitative. However, about the meaning of the quantity, so that the content analysis method is used, there is a significant difference [4]. limited definition in content analysis is assessment with frequency of symbols or categories [5]. The purpose of content analysis, classifying content of design protocols in numerical phrases which the words more or less emotional judgments are more accurate [6]. Other restrictive definitions are even fewer and include those findings in which such words less or increasingly are described [7].

During the content analysis several stages occur. For instance we can mention three following main phases: the phase of before analysis (preparation and organization); studying materials (design protocols) and process the results. This article will focus on analyzing the content of the third stage, means that the process will be gain from data collection design protocols. After coding protocols and their categorization, the information obtained should be analyzed. Nowadays, many techniques in this regard are presented based on the percentage frequency of category. These kinds of techniques have mathematical problems in which the results will have low reliability [8].

This research is trying to use a new method and system for processing data from the topic of the content analysis is known Shannon's Entropy, according this method, data analysis will be very reliable. The paper presents the entropy algorithm, the results are compared with the current method of data processing results then the results and suggestions about the validity and reliability of this method and its use in determining how to design strategies will be presented.

Entropy represents the uncertainty value of the content in designing protocol. In other words, the entropy in the theory of information is an index for the measurement uncertainty value which is expressed by a probability distribution.This uncertainty can be written as follows [4]. K is a positive index that Entropy value between 0 and 1 is obtained. The following matematical relationship to examine the content m response in n categories of the message.

$$E = -k\sum_{i=1}^{m}[p_i L_n P_i]$$

**Research Project:** Empirical studies based on protocol-based studies of thirteen undergraduate architecture student's in third semester. The workshop designed by the combination three of Tehran University, which seeks to develop a conceptual design for temporary architecture exhibition. This problem includes aspects of statics, lack of damage to the land (site of exhibition), (genetically) to be Iranian, simple and easy setup. The experiment were conducted as think-aloud protocol studies [9]. The designers (each working alone) were requested to think aloud as they were solving the design problem and the design session was preceded by a short training exercise, to help them become accustomed to thinking aloud. The design breif was then given to the designer. The time allotted was 2 week in the class-work activities. The sessions were recorded by two high-level video cameras in the corners of the class; one pointing down at the designer to capture sketching and drawing behaviour and one to take a general picturte.

**An Expertise Model of the Product Design Process:** In order to study the cognitive strategies employed by the designers, a conceptual model of the product design process was developed [4]. This model was based on empirical data derived from the protocol studies, analysed with the aid of the CommonKADS conceptual modelling language [10]. Common KADS offers a methodology for

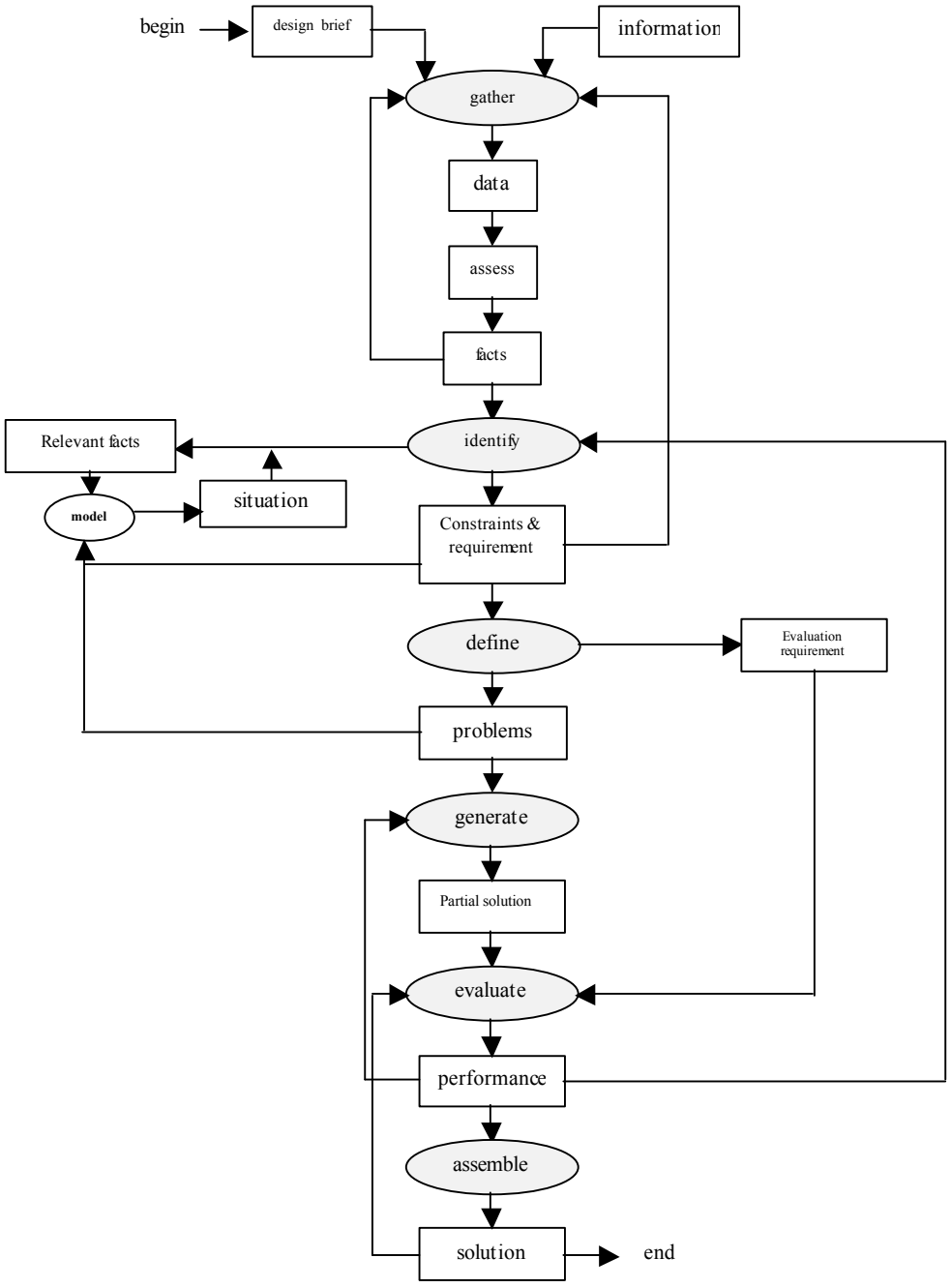


Fig. 1: The derived expertise model of product design (Cross, 2006, 532)

1. Gather data
2. Assess value and validity of data
3. Identify constraints and requirements
4. Model behaviour and environment
5. Define problems and possibilities
6. Generate partial solutions
7. Evaluate solutions
8. Assemble a coherent solution

Table 1: Percentages of the statements per task in verbal protocols of the 13 students

| Gategortv Students | Gather X1 | Assess X2 | Identify X3 | Model X4 | Define X5 | Generate X6 | Evaluate X7 | Assemble X8 | Strategy type |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 19 | 2 | 21 | 0 | 3 | 28 | 13 | 8 | P |
| 2 | 32 | 4 | 26 | 2 | 4 | 17 | 1 | 2 | K |
| 3 | 13 | 2 | 19 | 3 | 0 | 28 | 8 | 12 | I |
| 4 | 15 | 4 | 22 | 4 | 0 | 30 | 2 | 15 | P |
| 5 | 17 | 3 | 20 | 0 | 2 | 24 | 11 | 5 | I |
| 6 | 42 | 5 | 30 | 3 | 2 | 15 | 2 | 3 | K |
| 7 | 6 | 1 | 17 | 15 | 4 | 31 | 2 | 4 | K |
| 8 | 21 | 3 | 25 | 0 | 2 | 30 | 14 | 6 | K |
| 9 | 25 | 2 | 10 | 18 | 1 | 19 | 0 | 5 | I |
| 10 | 12 | 2 | 14 | 1 | 3 | 26 | 1 | 1 | S |
| 11 | 29 | 5 | 21 | 2 | 1 | 12 | 4 | 3 | I |
| 12 | 8 | 2 | 14 | 17 | 2 | 29 | 1 | 3 | K |
| 13 | 5 | 4 | 18 | 5 | 1 | 22 | 2 | 2 | S |
| Sum | 244 | 39 | 257 | 70 | 25 | 285 | 61 | 69 | |

Table 2: Percentages of the statements per task in verbal protocols of 8 category by problem driven.

| Students | Gather X1 | Assess X2 | Identify X3 | Model X4 | Define X5 | Generate X6 | Evaluate X7 | Assemble X8 | Strategy type |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 19 | 2 | 21 | 0 | 3 | 28 | 13 | 8 | P |
| 4 | 15 | 4 | 22 | 4 | 0 | 30 | 2 | 15 | P |

Table 3: Percentages of the statements per task in verbal protocols of 8 category by Solution driven.

| Students | Gather X1 | Assess X2 | Identify X3 | Model X4 | Define X5 | Generate X6 | Evaluate X7 | Assemble X8 | Strategy type |
|---|---|---|---|---|---|---|---|---|---|
| 10 | 12 | 2 | 14 | 1 | 3 | 26 | 1 | 1 | S |
| 13 | 5 | 4 | 18 | 5 | 1 | 22 | 2 | 2 | S |

Table 4: Percentages of the statements per task in verbal protocols of 8 category by information driven

| Students | Gather X1 | Assess X2 | Identify X3 | Model X4 | Define X5 | Generate X6 | Evaluate X7 | Assemble X8 | Strategy type |
|---|---|---|---|---|---|---|---|---|---|
| 3 | 13 | 2 | 19 | 3 | 0 | 28 | 8 | 12 | I |
| 5 | 17 | 3 | 20 | 0 | 2 | 24 | 11 | 5 | I |
| 9 | 25 | 2 | 10 | 18 | 1 | 19 | 0 | 5 | I |
| 11 | 29 | 5 | 21 | 2 | 1 | 12 | 4 | 3 | I |

Table 5: Percentages of the statements per task in verbal protocols of 8 category by Knowledge driven.

| Students | Gather X1 | Assess X2 | Identify X3 | Model X4 | Define X5 | Generate X6 | Evaluate X7 | Assemble X8 | Strategy type |
|---|---|---|---|---|---|---|---|---|---|
| 2 | 32 | 4 | 26 | 2 | 4 | 17 | 1 | 2 | K |
| 6 | 42 | 5 | 30 | 3 | 2 | 15 | 2 | 3 | K |
| 7 | 6 | 1 | 17 | 15 | 4 | 31 | 2 | 4 | K |
| 8 | 21 | 3 | 25 | 0 | 2 | 30 | 14 | 6 | K |
| 12 | 8 | 2 | 14 | 17 | 2 | 29 | 1 | 3 | K |

constructing knowledge based systems, which can also be used as a cognitive modelling tool. An expertise model was developed; a model of the problem solving behaviour of an agent in terms of knowledge that is being applied in carrying out a certain task. An expertise model consists of application knowledge and problem solving knowledge. Application knowledge consists of task knowledge, inference knowledge and domain knowledge. These are the primary epistemological categories in CommonKADS.

Problem solving knowledge consists of problem solving methods and strategic knowledge. The expertise model shown in Figure 1 was developed. It comprises the following tasks or activities:

Model is not dissimilar to other models of the engineering product design process [11]. A significant additional feature in this model is the model task, which was identified from the designers' protocols. In the model task, a designer forms a mental image (sometimes using sketches to aid this) of the object to be designed, within its environment of use. Thus, some implicit constraints and/or requirements might be derived in this way [12].

In Table 1 the percentages of frequencies of coded protocol statements per activity of the thirteen students are shown. The amount of statements made within each category is an indicator of the amount of time and attention a designer gave to each activity.

The frequencies data indicate some basic differences in the design strategies used by the designers.

**Step 1:** based on the data table, the frequency of matrix Table 1 have been normalized to be between 0 and 1, To calculate the weights the followings are used (Salehi Sadaghiani, 2002, 153).

$$\sum_{}^{m} F_{ij}$$

$$P_{ij} = \frac{i=1}{F_{ij}} (i = 1,2,...,m;\ j = 1,2,...,n)$$

**Step 2:** Certainty Value Calculation

$$E = -\sum_{i=1}^{m} [p_{ij} L_n P_{ij}]\ (j =,1,2,...n) \qquad K = \frac{1}{L_n m}$$

Equation 2:

**Step 3:** Determining Significance Degree

Equation 3:

$$W_j = \frac{E_j}{j=1} (j =,1,2,...,n)$$

$$\sum_{n} E_j$$

Table 6: The normalized Percentages of the statements per task in verbal protocols of the 13 students

| Category students | Gather X1 | Assess X2 | Identify X3 | Model X4 | Define X5 | Generate X6 | Evaluate X7 | Assemble X8 | Strategy type |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.078 | 0.051 | 0.08 | 0 | 0.12 | 0.098 | 0.213 | 0.116 | P |
| 2 | 0.13 | 0.102 | 0.10 | 0.028 | 0.16 | 0.06 | 0.016 | 0.029 | K |
| 3 | 0.05 | 0.051 | 0.07 | 0.043 | 0 | 0.1 | 0.131 | 0.173 | I |
| 4 | 0.06 | 0.102 | 0.085 | 0.057 | 0 | 0.105 | 0.033 | 0.217 | P |
| 5 | 0.07 | 0.077 | 0.078 | 0 | 0.08 | 0.084 | 0.180 | 0.072 | I |
| 6 | 0.17 | 0.128 | 0.12 | 0.043 | 0.08 | 0.05 | 0.033 | 0.043 | K |
| 7 | 0.02 | 0.026 | 0.066 | 0.214 | 0.16 | 0.1 | 0.033 | 0.058 | K |
| 8 | 0.086 | 0.077 | 0.097 | 0 | 0.08 | 0.1 | 0.23 | 0.087 | K |
| 9 | 0.1 | 0.051 | 0.039 | 0.257 | 0.04 | 0.06 | 0 | 0.072 | I |
| 10 | 0.05 | 0.051 | 0.054 | 0.014 | 0.12 | 0.09 | 0.016 | 0.014 | S |
| 11 | 0.12 | 0.128 | 0.08 | 0.028 | 0.04 | 0.04 | 0.065 | 0.043 | I |
| 12 | 0.03 | 0.051 | 0.054 | 0.243 | 0.08 | 0.1 | 0.016 | 0.043 | K |
| 13 | 0.02 | 0.102 | 0.07 | 0.071 | 0.04 | 0.077 | 0.033 | 0.029 | S |
| Sum | 244 | 39 | 271 | 70 | 25 | 285 | 61 | 69 | |

Table 7: The normalized Percentages of the statements per task in verbal protocols of 8 category Knowledge driven

| Category students | Gather X1 | Assess X2 | Identify X3 | Model X4 | Define X5 | Generate X6 | Evaluate X7 | Assemble X8 | Strategy type |
|---|---|---|---|---|---|---|---|---|---|
| 3 | 0.154 | 0.16 | 0.27 | 0.13 | 0 | 0.337 | 0.347 | 0.48 | I |
| 5 | 0.20 | 0.25 | 0.285 | 0 | 0.5 | 0.289 | 0.478 | 0.2 | I |
| 9 | 0.297 | 0.16 | 0.142 | 0.782 | 0.25 | 0.228 | 0 | 0.2 | I |
| 11 | 0.345 | 0.416 | 0.3 | 0.869 | 0.25 | 0.144 | 0.17 | 0.12 | I |

Table 8: The normalized Percentages of the statements per task in verbal protocols of 8 category Solution driven

| Category students | Gather X1 | Assess X2 | Identify X3 | Model X4 | Define X5 | Generate X6 | Evaluate X7 | Assemble X8 | Strategy type |
|---|---|---|---|---|---|---|---|---|---|
| 13 | 0.7 | 0.33 | 0.636 | 0.166 | 0.75 | 0.54 | 0.33 | 0.33 | s |
| 10 | 0.29 | 0.66 | 0.818 | 0.83 | 0.25 | 0.458 | 0.66 | 0.66 | s |

Table 9: The normalized Percentages of the statements per task in verbal protocols of 8 category Problem driven

| Category students | Gather X1 | Assess X2 | Identify X3 | Model X4 | Define X5 | Generate X6 | Evaluate X7 | Assemble X8 | Strategy type |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.55 | 0.33 | 0.49 | 0 | 1 | 0.420 | 0.87 | 0.35 | P |
| 4 | 0.44 | 0.67 | 0.51 | 1 | 0 | 0.52 | 0.13 | 0.65 | p |

Table 10: The normalized Percentages of the statements per task in verbal protocols of 8 category Knowledge driven

| Category students | Gather X1 | Assess X2 | Identify X3 | Model X4 | Define X5 | Generate X6 | Evaluate X7 | Assemble X8 | Strategy type |
|---|---|---|---|---|---|---|---|---|---|
| 2 | 0.29 | 0.26 | 0.23 | 0.054 | 0.286 | 0.139 | 0.05 | 0.105 | K |
| 6 | 0.385 | 0.33 | 0.267 | 0.08 | 0.143 | 0123 | 0.1 | 0.158 | K |
| 7 | 0.055 | 0.066 | 0.151 | 0.459 | 0.286 | 0.254 | 0.1 | 0.21 | K |
| 8 | 0.19 | 0.2 | 0.22 | 0.676 | 0.143 | 0.246 | 0.7 | 0.316 | K |
| 12 | 0.073 | 0.13 | 0.125 | 0.378 | 0.143 | 0.238 | 0.05 | 0.158 | K |

Table 11: Comparison of the results content analysis in determining of Information driven design strategy-Frequency and Shannon's Entropy method

| Design Strategy I | Identify X3 | Gather X1 | Assemble X8 | Define X5 | Evaluate X7 | Generate X6 | Assess X2 | Model X4 |
|---|---|---|---|---|---|---|---|---|
| Frequency | 70 | 84 | 25 | 4 | 23 | 83 | 12 | 23 |
| Shannon's Entropy | 0.59 | 0.585 | 0.54 | 0.45 | 0.44 | 0.438 | 0.437 | 0.247 |

Table 12: Comparison of the results content analysis in determining of Solution driven design strategy-Frequency and Shannon's Entropy method

| S Design Strategy | Generate X6 | Evaluate X7 | Assemble X8 | Assess X2 | Gather X1 | Define X5 | Model X4 | Identify X3 |
|---|---|---|---|---|---|---|---|---|
| Frequency | 48 | 3 | 3 | 6 | 17 | 4 | 6 | 32 |
| Shannon's Entropy | 0.299 | 0.28 | 0.28 | 0.279 | 0.264 | 0.243 | 0.2 | 0.195 |

Table 13: Comparison of the results content analysis in determining of Problem driven design strategy-Frequency and Shannon's Entropy method

| Dsesign Strategy p | Identify X3 | Gather X1 | Generate X6 | Assemble X8 | Assess X2 | Evaluate X7 | Model X4 | Define X5 |
|---|---|---|---|---|---|---|---|---|
| Frequency | 43 | 34 | 58 | 23 | 6 | 15 | 4 | 3 |
| Shannon's Entropy | 0.299 | 0.297 | 0.291 | 0.28 | 0.278 | 0.165 | 0 | 0 |

Table 14: Comparison of the results content analysis in determining of Knowledge driven design strategy-Frequency and Shannon's Entropy method

| Design Strategy k | Identify X3 | Model X4 | Generate X6 | Gather X1 | Assess X2 | Evaluate X7 | Define X5 | Assemble X8 |
|---|---|---|---|---|---|---|---|---|
| Frequency | 112 | 37 | 122 | 109 | 15 | 20 | 14 | 18 |
| Shannon's Entropy | 0.989 | 0.702 | 0.679 | 0.676 | 0.675 | 0.63 | 0.554 | 0.539 |

Using values of Table (1) the weight of information and significance degree of each category is achieved by using Shannon's Entropy in the following tables.

**The Derived Cognitive Strategies:** The rationale for the categorization of strategies is based on the main activity generators of the design process, which are the problem, gathered information, generated solution ideas and prior knowledge. The choice of the generator will depend on the particular situation in the design process and the general preference (perhaps the cognitive style) of the particular designer. Here it is suggested that differences between design processes and their outcomes are the consequence of the application of strategic knowledge. Strategic knowledge is knowledge of design strategies and how to apply them. In the following descriptions, derived from the protocol studies, the influences of different strategies on the design process and their likely effects on the outcome of the design process are assessed. On the basis of the data analysis and on the evidence of the designers' behavior from the verbal protocols, we identified the following four design strategies.

**Problem Driven Design:** The designer focuses closely on the problem at hand and only uses information and knowledge that is strictly needed to solve the problem. The emphasis lies on defining the problem and finding a solution as soon as possible.

**Solution Driven Design:** The designer focuses on generating solutions and only gathers information that is needed to further develop a solution. The emphasis lies on generating solutions and little time is spent on defining the problem, which may be reframed to suit an emerging solution.

**Information Driven Design:** The designer focuses on gathering information from external sources and develops a solution on the basis of this information.

**Knowledge Driven Design:** The designer focuses on using prior, structured, personal knowledge and develops a solution on the basis of this knowledge. Only minimal necessary information from external sources is gathered [12].

Table 15: Comparison of the Information driven design strategy in Frequency and Shannon's Entropy method

| "I" Design Strategy | Frequency method | Shannon's Entropy method |
|---|---|---|
| | Gather | Identify |
| | Generate | Gather |
| | Identify | Assemble |

Table 16: Comparison of the Solution driven design strategy in Frequency and Shannon's Entropy method

| "S" Design Strategy | Frequency method | Shannon's Entropy method |
|---|---|---|
| | Generate | Generate |
| | Identify | Evaluate |
| | Gather | Assemble |

Table 17: Comparison of the Solution driven design strategy in Frequency and Shannon's Entropy method

| "P" Design Strategy | Frequency method | Shannon's Entropy method |
|---|---|---|
| | Generate | Identify |
| | Identify | Gather |
| | Gather | Generate |

Table 18: Comparison of the Solution driven design strategy in Frequency and Shannon's Entropy method

| "K" Design Strategy | Frequency method | Shannon's Entropy method |
|---|---|---|
| | Generate | Identify |
| | Identify | Model |
| | Gather | Generate |

**Finding Research:** We can use the empirical data from the protocol studies to categorize each designer according to the design strategies they appeared to operate. The designers' protocol statements were encoded according to the eight categories of tasks or activities identified in the expertise model. In Table 1 the percentages of frequencies of coded protocol statements per activity of the thirteen students are shown.

The amount of statements made within each category is an indicator of the amount of time and attention a designer gave to each activity. The frequencies data indicate some basic differences in the design strategies used by the designers. For example, Designers 1, 4 have relatively higher percentages of statements in the categories of identifying constraints and data gathering than they do in other categories (except generate). We identify their strategy as 'problem driven'. A variant of this appears with Designer 3,5,9,11 who has a very high frequency in data gathering, solution generating and identify; we identify this strategy as 'information driven'. Designers 10,13 have high frequencies in generating and evaluating can be categorized as using a 'solution driven' strategy, whereas Designers 2,6,7,8,12 have a high frequency of modeling activity (i.e. utilizing prior knowledge) and can be categorized as using a 'knowledge driven' strategy. On the basis of the data analysis and on the evidence of the designers' behavior from the verbal protocols, we identified the following four design strategies. For almost all designers, the most frequent activities are those of gather data, identify constraints and requirements and generate partial solutions.

Differences between solution driven and problem driven strategies can also be verified numerically. A solution driven versus problem driven index (S/P index) can be generated for each designer by computing the ratio of generate activities to the mean of gather and identify activities. The S/P indices are 2.0, 1.9 for designers 10, 13 respectively (solution driven designers) and 1.4, 1.5 for designers 1, 4 respectively (problem driven designers).

## CONCLUSION

Individual differences between designers were clear in most of the data relating to both design process and solution outcomes, even though they were performing the same task under the same conditions. Nevertheless, some commonalities of approach did emerge in the types of cognitive strategies the designers employed, enabling them to be classified into the four types of design strategies: problem driven, solution driven, information driven and knowledge driven. The data suggest that most designers employ either a problem driven or a solution driven design strategy, with each of these strategies being equally prevalent. Contrary to expectations, solution driven design did not feature clearly as the dominant strategy. However, the 'generate' activity was

the most frequently occurring single activity, thus tending to confirm the solution focused nature of design thinking. In the derived expertise model, a strictly sequential process of activities was not evident. The data show a complex structure where activities alternate. There was an overall sequencing of activities in the process, but also iteration. Iterations within the analysis stage mainly account for this observation, with many iterations occurring between data gathering and identification of requirements. There was also a secondary iteration loop in the synthesize evaluation stages. Both the problem driven and the solution driven strategies used less iteration than the variants of information driven and knowledge driven strategies. Tables 16 to 20, the uncertainty value and significance degree based on traditional and compensational methods (Shannon's Entropy) have been used.

Now the question is that, which results from the above methods for determining the validity of the strategy is designed. Therefore it is necessary to review the results from two perspectives:

- The validity of mathematics: Two various methods of processing information from a content analysis of the methods derived from a model known as "model compensating " and other categories derived from another model known as non-compensatory models. Non-compensatory models include procedures are among the categories in which the exchange is not encrypted .So every issue raised in this alone and comparisons are also separated. The current method of content analyzing is a non-compensating model. The frequency of each category in this method is analysis and exchange among the categories of respondents is not significant.

Compensating model consists of methods which permit the exchange between the indices is allowed, Means a minor change in a category can be compensate by opposite change in other categories. Shannon's Entropy method is a type of compensating. In the other hand both respondents and categories of analysis data processing are considered. [7] Using compensation method in the analysis of data from design protocols is more useful and involves more accuracy of math. These methods according to their interactive nature could provide as well as more information interpretation on design protocols. Mathematical reasons show that the results of Shannon's Entropy are more reliable than the current method abundance analysis.

- The validity of structure is represented as a means of measuring that the analysis and measuring method how could measure a structure or category which has a theoretical basis. Using mathematical method is better and more accurate in data analysis and the theoretical hierarchy of design categories confirmation that the new provided approach as Shannon's Entropy method will be an appropriate method for analyzing the design protocols. So if we suppose the validity of structure as a criterion for evaluating the obtained results, we can claim that the order of obtained results for design strategy is classified according to Shannon's Entropy.

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**Appendix:**

- Various methods could be used when indices weight identification is required. One of these methods is the Shannon's entropy. This method was first proposed by Shannon in 1948. Entropy is a general concept in physical, social and information theories. Entropy represents the uncertainty in a proposition. In information theory, entropy is a criterion for the uncertainty expressed by a discrete distribution so that this uncertainty in cases which distribution is broader is more than cases with narrow peaked distributions. [4] Beasley J. (1990). "Comparing University Departments", Omega-International Journal, Vol. 18, PP 171-18.