Interaction design of grip form of manually handled tools and Organic constructing

In view of Zdeněk Kovář approach

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Abstract :

The paper cast light on the sculptor and industrial designer Zdeněk Kovář approach who acquired a considerable experience in the field of design. The paper illustrates the outcome of a workshop carried out with the help of a group of Sculpture and Industrial Design students. After viewing Zdeněk Kovář approach followed by a discussion on how to utilize this approach in analysis and work designs of some products handles. The organic characteristics, taking into account usability position, This seemed to help to detect the relationship between the nature of the organic form and design of the grip

The statement of the problem can be summarized in " to what extent organic form of grip handle increases interactivity and usability of design of manually handled products?

The search based on that the form is represented in an organic form which is proportional with the user nature, helps in providing the product in an easy to use form on the physiological and psychological side too, which increases the interaction with the product during achieving the function especially in the products with which the user deals directly (through controlling the handle). Hence, we must concentrate on the grip design of the product and . Therefore, the aim of the research shows Interaction design of grip form of manually handled tools and Organic constructing in designing the products which are used directly (with handle) to achieve the element of rest during the usage through the sculptor designer Zednek Kovar methodology. The researchers used the analytical and inferential analysis to reach the results.

Keywords:

Form - User -Comfortable -Organic construction -interactive relationship - grip - sense of touch-

Introduction:

There will always be a need for well-designed hand tools and hand operated controls despite newer technology. Good handle design is important at work and in all kinds of daily activities for items that are efficient to use, safe, and attractive to buy.

Anything that can pick up by the human hand or which the body comes in contact with is in some sense a handle. All these need some of the same features, whether it is a door or a door-handle pushed open by the body, or any of a hundred thousand other items.

Humans still communicate with machines or tools by Applying their hands or fingers to controls or keys of some kind.

Even in the most advanced workplace, there are still many times each day when items have to be picked up and shifted, or handled in some other way. Too often the contact between hand and equipment is awkward, inaccurate, or unsafe. Bulky items like refrigerators and heavy office equipment still have to be gripped or pushed by human hand. The innards of a washing machine, or a motor engine, must have space in and around them for hands (and lines of illumination and sight) as well as tools.

Objectives:

The relationship between the design and construction of organic grips in the design of products with handle element to achieve positive interaction while achieving functionality through shedding light on the approach of Zdeněk Kovář, to identify a method of benefiting from the human body member form in the development of usability considerations in the

design of manually handled products. The investigators assume that whenever the form organically fits the human nature it would help deliver a product in a form of an easy to use on a physiological and even a psychological basis. This should increase the interaction with the product while achieving the job, especially in products that deal with user directly (tightly Fist)

Methodology:

The investigators have utilized the Inductive approach however, the survey method in the form of a questionnaire was used to get hold of the impression of users and experts on the results of the a workshop.

Types of grips:

For many activities (e.g. lifting, lowering, carrying, pushing, pulling),
The type of GRIP is the interface between the person's hand and the object being handled, and affects the force that is generated on an object.

1. **POWER GRIP**

(The terms grasp, grip, and prehension are interchangeable.)
(The adductor pollicis stabilizes an object against the palm; the hand's position is static.) (Smith, Weiss, & Lehmkuhl, 1995, pp. 216-219; Hertling & Kessler, 1996, pp.259-260)

- cylindrical grip (fist grasp is a small diameter cylindrical grasp)
- spherical grip
- hook grip (MP extended with flattening of transverse arch; the person may or may include the thumb in this grasp)
- Lateral prehension (this can be a power grip if the thumb is adducted, a precision grip if the thumb is abducted).

2. **PRECISION grip**

(Muscles are active that abduct or oppose the thumb; the hand's position is dynamic.)

- palmar prehension (pulp to pulp), includes 'chuck' or tripod grips
- tip-to-tip (with FDP active to maintain DIP flex)
- lateral prehension (pad-to-side; key grip)

3. **crush grip**

is what is most commonly thought of as "grip". It involves a handshake-type grip, where the object being gripped rests firmly against the palm and all fingers. A strong crush grip is useful in bone-crushing handshakes or for breaking objects with pressure.

4. **pinch grip,**

the fingers are on one side of an object, and the thumb is on the other. Typically, an object lifted in a pinch grip does not touch the palm. This is generally considered a weaker grip position. The pinch grip is used when grabbing something like a weight plate or lifting a sheet of plywood by the top edge. Care must be taken to avoid cramping the muscles in the hand.

5. **support grip**

Typically involves holding something, such as the handle of a bucket, for a long time. This type of strength is epitomized by the "Farmer's walk", where the bucket is filled withsand or water, and carried over a long distance. A great deal of muscular endurance is necessary to have a good carrying grip.

Three arches balance stability and mobility in the hand:

In Figure (1) the proximal transverse arch shown in red is rigid, but the other two arches are flexible, and are maintained by activity in the hand's intrinsic muscles.

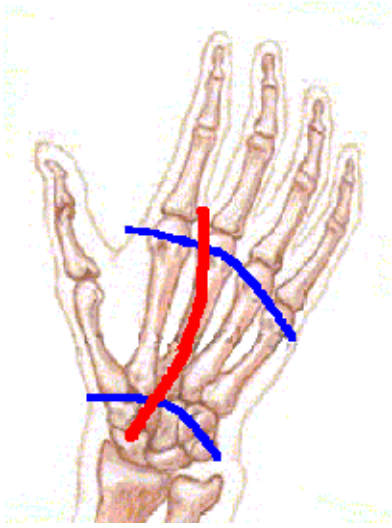


Figure (1): Three arches balance stability and mobility in the hand

1-PROXIMAL TRANSVERSE ARCH

Hertling and Kessler (p. 257) describe this arch as a composite of two arches, the proximal and distal carpal arches.)

- A stable bony arch that forms the posterior border of the carpal tunnel.
- The arch's integrity is maintained by a soft

tissue "strut" formed by the flexor retinaculum or transverse carpal ligament (also called the volar carpal ligament). This ligamentous strut connects the scaphoid and trapezium on the arch's radial side with the hamate on its ulnar side, and forms the anterior border of the carpal tunnel.

2-DISTAL TRANSVERSE ARCH

Hertling and Kessler (p. 257) call this the metacarpal arch, because it is formed by the metacarpal heads; metacarpals 2 and 3 are stable while 4 and 5 are relatively mobile. You can observe the arch's combination of "radial" stability and "ulnar" mobility by loosely closing your fist, then squeezing more tightly, when you will observe movement in the more mobile fourth and fifth metacarpals.

3-LONGITUDINAL ARCH

Observe this arch's behavior as you loosely close your fist. Tighten the Grip and watch the fourth and fifth metacarpals.

Grips design:

The fundamental aspects in the design of knobs, handles, grips and manual controls in among human factors considerations are:

A - form

From the basics of design in the shape of knobs, handles etc. is the use of curved lines, which compensates for the reduction of pressure on the hand or wrist of the user during actual use. The best designs in this area are for handles, that allows the user not to make any rotational movements of the hand or wrist that might cause such pressure.

B - Diameter

In general handles must be of cylindrical or oval section and of a diameter of 30:45 ml (CCOHS, 2005) (The Canadian center for occupational health and safety)
C - Length

A handle should be preferably longer than the length of 100 ml (the optimum could be 120:115 ml). The shorter length may cause unnecessary pressure in the middle of the grip (CCOHS, 2005)

D- Bilateral handles

Bilateral handles are controls that have two-sided gripping such as pliers, tweezers. Preferably, spacing between the two controlling elements should be of 50: 65 ml. In knobs that need much more control and precision, the length of the handle should be between 5:12 ml.

E - Materials of knob

Handles design must include materials and textures that provide the sense of comfort, safety and full control and precision. Edges must be round to commensurate with an organic form. Rubber and plastic materials are no good for their electrical conductivity, They are also prone to slipping during use because of sweat or any other liquids around . For similar reasons, the shiny polished appearance should avoided.

F- Organic construction:
Nature is the source of organic forms. Designer try always to quote from nature but with in a different formulation that correspond to the form of the product being developed.

The authors believes that the organic structure provides certain special features including :

1. Characterized by flowing stream lines .
2. Diversity of rhythm in the movement of the lines .
3. Harmony of the nature of lines and the user during use on physiological and psychological basis .
4. spread out and stretch .
5. Growth in a specific direction .
6. Sometimes depend on a module

These features undoubtedly help the designer to reflect the shapes in a valuable aesthetic that attract users to deal with the product on a level of familiarity and preference. Human nature is attracted by all that stems from nature as a part of which that fully integrates with it. Subsequently, organic shape features can be utilized in the design of simple products with a grip that are used in manual industrial tools such as saws and Screwdriver, and tools that are used in the kitchen, and many others ..

The sense of touch as an interaction by hand in the design of the handles

The sense of touch, also called lactation is a perception resulting from activation of neural receptors, generally in the skin including hair follicles that receives information from the environment surrounding the human body. It also helps three-dimensional sensation. Also we may find that the interaction design of the grip is greatly influenced by the sense of touch, which broadcasts messages to the user resulting from the provisions of the hand on the grip. These messages are responsible for the formation of a rational image of the grip design, which have the shape characterization on psychological and physiological basis.

For example, as shown in Figure (2) hand grip is affected by three important surfaces during gripping of the handle: [11]

1. Contact surface (shown in yellow) , the largest surface area of the hand in contact with the handle.
2. Pressure surface (shown in red), which is the surface of the handle on which pressure occurs.
3. Counter pressure surface (shown in orange), which is the surface of the counter-pressure.

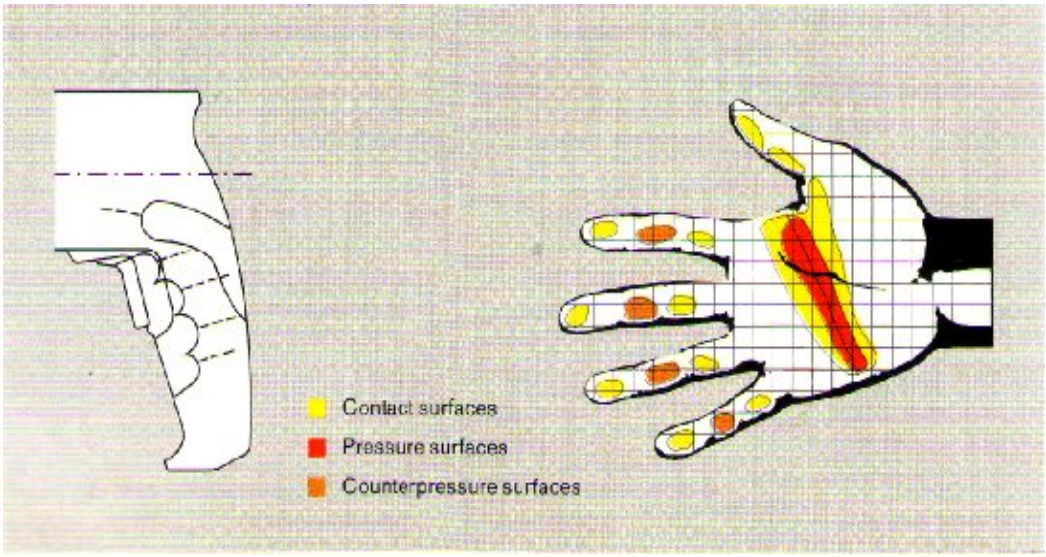


Figure (2) Three surfaces affected by gripping

those surfaces also vary because of difference in the section of the handle whether horizontal cylindrical or round shape or a gradient between them. This affects the distribution of the compressive strength, either parallel or concentrated in a particular direction, as in Figure (3)

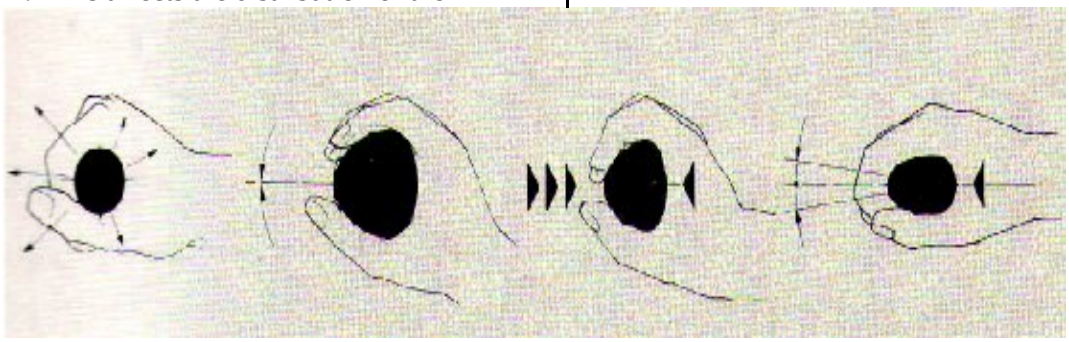


Figure (3) Pressure distribution on the hand fist

Certainly the control of the distribution of these pressure forces on the hand grip formulate linear organic that correspond with the shape of the knob confirms the positive interaction between the organic design of the handle and hand to achieve the best relationship on the physiological and psychological aspects within an integrated design where complete relationship occurs when the user touches the handle of the tool in an interactive relationship to the organic form possession rights during use of the tool

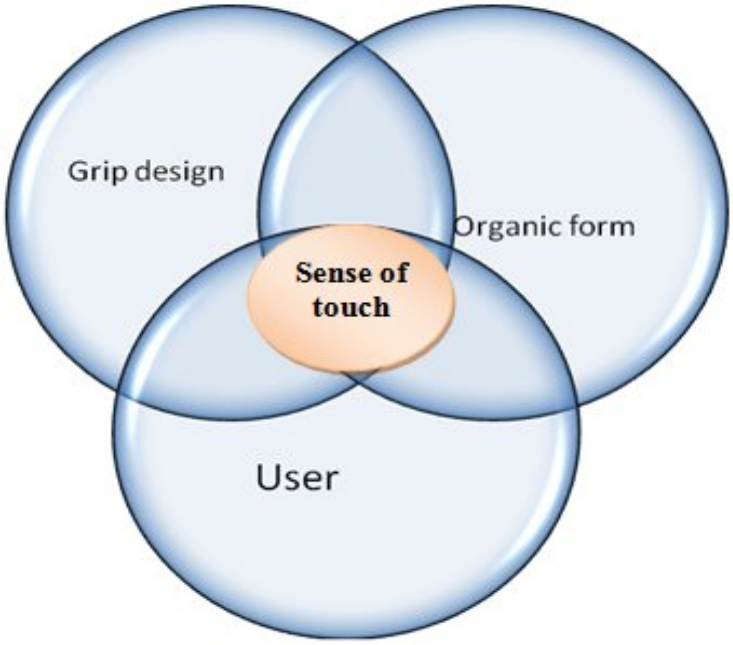


Figure (4) Sense of touch is the center of the interaction relationship between grip of hand tools &Organic constructing and user

Zdeněk Kovář approach:-

Zdeněk Kovář, is a renowned Czech industrial designer born in 1917, and died in 2004. The approach of Kovář in designing controls as close as possible to the human hand. He thought that the grips of a manual tool should conform precisely to the user's hand with all anatomical and physiological features during gripping. [2]

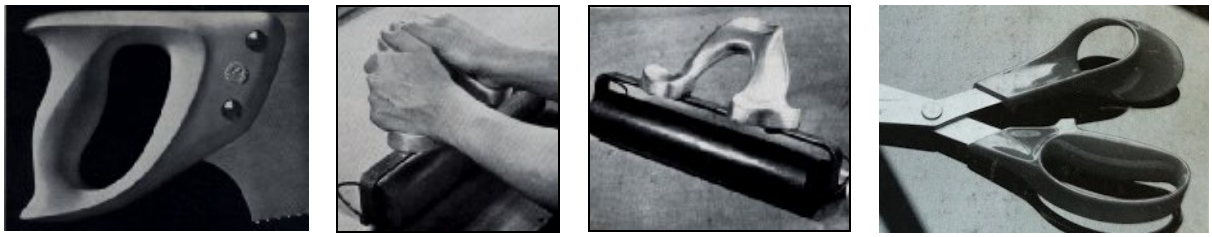


Figure (5) Zdeněk Kovář, works and hand tools design

Designer sculptor " Zdeněk Kovář " With his sense of sculpture has been able beautify many functional tools Throughout the analysis of some of his works Figure (5) it was found that he was concerned with providing hand tools (with a grip) in a functional framework that is consistent with the work performed with the following considerations:

1. design should be proportional to the human body dimensions, in a continuous prolonged use in an industrial process.
2. design should be of an organic linear design formats that fits the human hand structure.
3. The design should be harmonious with the streamline of function and with an integrated process with use.
4. The design should carrying an aesthetic capacity that attracts the user , this positive effect is responsible for its association with his tool during performance of the Job (Improve working conditions by providing a suitable tool for work.

From the background and literature survey, it was found that a positive relationship between the structure of organic form of handles and the approach Zdeněk Kovář. This relationship confirms that the structure of the grip as a design element significantly Interacts with the construction of organic nature which in turn confirms the positive impact on the physiological and psychological of the user.figure (6)

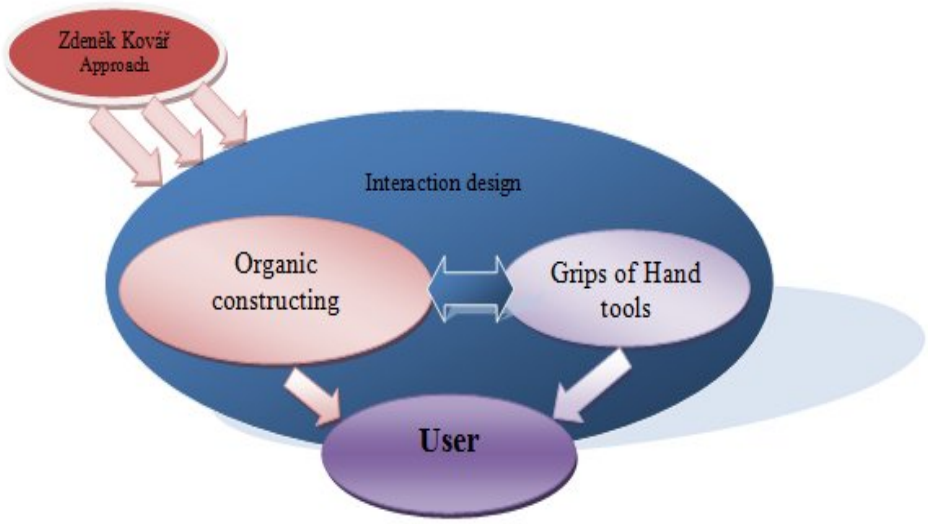


Figure (6) the interaction relationship between Grip designs (interactive usage)

And the organic form

In an attempt to verify the results obtained in the workshop including industrial design, sculpture students and set standards for benefiting from the approach adopted to uncover the relationship between the design of the grip as an interaction and constructive of organic design elements of hand tools with a grip. figures (7) to (13).

Figure (7) shows the workshop on designs of Colany, Karim Rashid and Zdenek Kovar

Figure (8) Mental map (mind board) methodology is used for enhancing creative thinking in tool design

Figure (9) samples of the discussed handles of daily use equipment

Figure (10) Student during design stage of their grips and handles

Figure (11) students guided by two expert designers to ensure that guidelines are observed.

Figure (12). Models of newly designed grips

Figure (13) some of the kitchen tools with handles modified

The research conducted questionnaire, intended to assess the designs provided to measure the suitability of the design of the grip commensurate with the user Looking forward this questionnaire to assess the quality of the designs provided to measure the suitability of the design tool handles and its responsiveness user it has resulted in these designs for a workshop they did researchers in conjunction with some of the students of industrial design and sculpture department and configuration architecture and restoration to uncover the relationship between the design of the grip as an interactive and construction organic design tools with a fist.

The questionnaire adopted the following questions:

1 - Can you handle of the control completely Job?
2 - Do you see that appropriate measurements of the handle you?
3 - Is diameter the handle is right for you?
4 - Do you suffer from any discomfort while using the handle?
5 - Do you see that the handle completely safe during use?
6 - Is the handle commensurate with its mission designed tool?
7 - Do you feel uncomfortable during use when increasing the period of use of the tool?
8 - Did you like the aesthetics of the handle?

Results:

According to the statistical analysis Figure (14) of the questionnaire employed to investigate the relationship between the organic form and grip design usability, it was found out that:

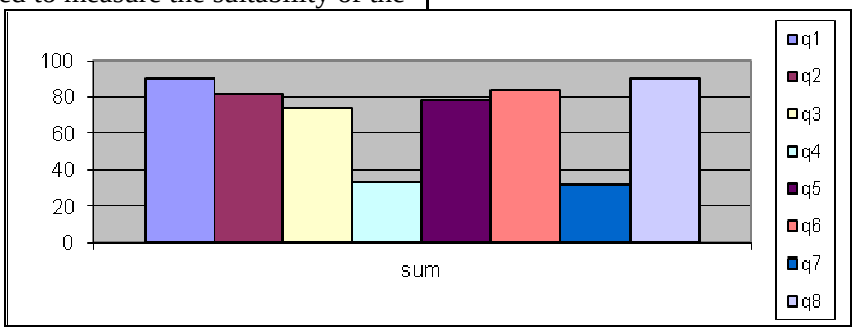


Figure (14) Statistical analysis

1- A positive relationship was found between organic Form and the usability of Grip handled tools.
2- Whenever this relationship is integrated, the rate of correlation between the users with the product increased which results in improving the physiological and psychological sides of the user.
3- Also Students stated that they gained a remarkable experience especially those related to group cooperative work and participatory design activities.
4- Reaching quick and efficient results in design, gave the students major self confidence in the an elevated ability to design.
5- The exchange of experience between industrial design and sculptor students, has enriched the designing process during the stage of introducing the design thoughts for the usage products.

Implementing the new approach the study hypothesis “There are significant differences

between the cognition level of students before and after using the newly introduced approach" . To validate of this hypothesis "T" test has been applied and the following table illustrates this:

Table (1) Significant differences between the mean scores of students basaed on level of interactivity

Total	Mean "M"	Standard Deviation "SD"	Degree of freedom "DF"	T value	Significance level
before	**6.195**	**1.326**	19	**14.174**	0.01
after	**8.437**	**2.528**			

As shown in table (1) the value of "T" is "14.174", a value that is statistically significant at the 0.01 significant level in favor of the post test, where the average scores of students in the after test "8.437", while the average scores of trainees in the application before "6.195 ". This proves the validity of the first hypothesis that students have benefited from approach utilized contained in the newly introduced teaching methodology. This is in agreement with studies of

To validate the second hypothesis stating "There are significant differences between the average scores of students in the level of functionality achieved by each of them before and after using the newly introduced approach in favor of the post test " , "T" test has been carried out. Results are shown on table (2):

Table (2) Significance of the differences between the mean scores of the students related to functionality

Total interactivity test	Mean "M"	Standard Deviation "SD"	Degree of freedom "DF"	T value	Significance level
before	**3.212**	**1.221**	19	**14.015**	0.01
after	**7.634**	**2.710**			

As seen from the table (2) that the value of "T" is equal to "34.015", a value statistically significant at 0.01 level for the post test, where the average scores of trainees in the post "26.554", while the average scores of trainees in the application before "3.212", which shows the benefit of trainees of the skills included in the training program. Thereby achieving the **second** hypothesis, this result agrees with studies that have been used in the training of individuals raising the efficiency of the process. As emphasizes by "Ahmed, 1990" that training aimed at development, technical and behavioral skills which are necessary for individuals to enable them to achieve themselves.

To validate the third hypothesis stating "There are statistically significant differences between the average scores of design appearance before and after applying the new approach in favor of the post application", "T" test has been carried out as shown in table (6)

Table (3) significant differences between the mean scores of the trainees program before and after training

Total " Design appearance performance"	Mean "M"	Standard Deviation "SD"	Degree of freedom "DF"	T value	Significance level
before	7.537	1.628	19	19.639	0.01
after	12.673	3.471			

As seen from the table (3), the "T" value is equal to "19.639" which is statistically significant at 0.01 levels, where the average scores of trainees in the post "12.673" while the average scores of trainees in the application of before "7.537", which indicates to the existence of real differences between the two applications for the post. This means that the training program in this study is successful in achieving the goal of it and

already knew the lines contained in respect of knowledge and skills.

To calculate the effect size the values of t and df. The value of Cohen's d and the effect size correlation, ryl , using the t test value for a between subjects t test and the degrees of freedom. The test employees a free test tool called "Effect Size Calculators"

Where

Cohen's $d = 2t / (df)$

$r_{Y\lambda} = (t^2 / (t^2 + df))$

Cohen's *d is equal to* " 9.01" **effect-size** *r value is "***0.976***"***

The effect magnitude is determined as follows:

0.2 = small effect size, 0.5 = medium effect size, 0.8 = large effect size which means that the effect is significantly large enough to proof the validity of the newly introduced approach,

Conclusion:

The positive relationship found between organic form and the usability of Grip handled tools indicates the success of the introduced approach to establish a sound criteria that could be used in design of grips, handles, and other similar controls.

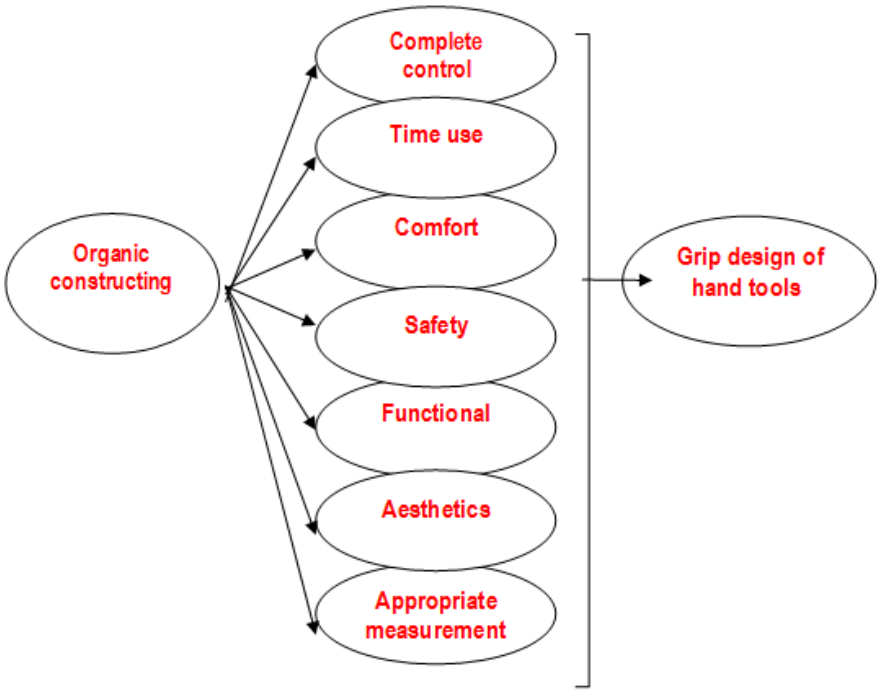
The rate of correlation between users and product that significantly increased should denote an improve of the physiological and psychological consideration of design of the whole product but with a special emphasis on the control elements.

sides of the user.

Students statement of gaining a notable experience especially in the area of cooperative work and participatory design activities. This approach seems to provide them with a quick and efficient methodology of design product elements. Their expression of being acquired an elevated experience can be seen as a reflection of their easy and astonishing achievement.

Discussion:

According to the statistical analysis found most of the factor design for grip design in Organic constructing is achieved in Interaction relationship in framework as:



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