International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES)
Impact Factor: 5.22 (SJIF-2017), e-ISSN: 2455-2585
Volume 4, Issue 7, July-2018

AESTHETIC DESIGN OF FUEL-CUM-DICKEY OPENING KNOB OF A TWO WHEELER

Raghav Mehndiratta[1] ,Jagjit Singh Randhawa[2],Suman kant[3],Vikram puri[4]

[1]*Centre of Excellence in Industrial & Product Design,Punjab Engineering College (Deemed to be University),Chandigarh,India*
[2]*Department of Production & Industrial Engineering,Punjab Engineering College (Deemed to be University),Chandigarh,India*
[3]*Department of Production & Industrial Engineering,Punjab Engineering College (Deemed to be University),Chandigarh,India*
[4]*New Technology,Minda Corporation Limited(Security Division),Noida,India*

Abstract—Automotive Industries is the one of the most developed and changed industries. Nowadays, especially buttons of the two wheelers have changed with significant development. This paper describes and discusses the approach, development aspects, and evaluation phases of a knob of two wheeler. The primary interest in the driver's environment is the relationship between the rider's seat, knob and its location.

Consequently, this paper mainly aims to explore the role of user-centered design criteria's for design phase and the role of ergonomic and human factors for two wheeler knob design . It has a questionnaire based study of brand-specific product design in the automotive sector. The purpose was to explore the product experience of two wheeler knob as perceived by the general public. In the study, respondents were asked to evaluate the proposed designs of two wheeler model knob at the respective dealerships in relation to brand perceptions and this implies that if the aesthetics are not perceived as favourable, neither is the expression of the two wheelers.Furthermore, respondents' assessments of aesthetic appeal and expression are on an average strikingly similar, suggesting that the level of aesthetic appeal correlates with the level of semantic understanding of the design. The general rating of emotional response follows a similar consistent pattern for the studied two wheeler knob .

Keywords—Product Design, Automobile design styling, User Centered Design,Questionnaire, Knob, Two Wheeler

I. INTRODUCTION

Manufacturing companies that operate in a global business environment face challenges and opportunities to develop their business by providing a variety of attractive products to the market in an environment where speed and agility are essential. Companies, in search of satisfying the new expectations of this era's consumer, aspire to be innovative. They try to develop real novel products matching the consumers' real needs and expectations. To achieve this, they utilize certain innovation processes in which design, especially industrial design plays a significant role by creating meaningful products and features for consumers. Beside that companies design their products using user-centered design methods. They concentrate on the user as the main source of innovation. These methods not only apply user information to the innovation process but also stimulate users to be creative and involve in the innovative activity.

The attractiveness of a product depends strongly on how we perceive the product with all our senses in relation to the expected performance of the product. The attractiveness of a product is normally related to its aesthetics. However, this statement is an oversimplification, since the attractiveness of the product is related to how we perceive the product with all our senses in relation to what we expect to get from the product. The products should have something more. Ergonomic, anthropometry,anatomy, human factors engineering can play an important role in the design phase.

In industries, such as the **automotive industry**, ergonomists and functional designers have been working on improving control and display systems in order to minimise and prevent human error that often cause accidents to happen **(Schutte and Eklund 2005; Kim et al. 2011; Ng et al. 2013)**. It has been found that around 75% of all accidents are associated with human errors (**Stanton et al. 2009).** Researchers believe that the ergonomic design of the control interface can also reduce the stress and tiredness of drivers **(Schutte and Eklund 2005).**

Since the ergonomics properties of mechanical knobs are highly important in modern designs, many companies are putting up more effort in designing comfortable and user friendly knobs **(Ha et al. 2009).** For instance, the dial knob of a washing machine is designed according to some design considerations like torque profile, aesthetical appearance, functionality, physical properties and sound effects (Ha et al. 2009). The material used in a knob therefore plays a crucial role, as customers tend to judge the quality of the knob by its appearance and tactile sensation **(You et al. 2006; Ng et al. 2013f**). Researchers have also found that the softness, shininess and surface texture of knobs are factors related with the appearance judgment of customers **(You et al. 2006; Ryu et al. 2003; Tanoue, Ishizaka,and Nagamachi 1997).**Certain ergonomic control knobs are designed with force feedback features to provide torque resistance and physical sensation to the user **(Levin et al. 2000).** The force feedback features are controlled by integrated electrical motors and microprocessors that allow different kinds of tactile sensation to be programmed accordingly (**Levin et al.2000).** Some control knobs are also designed with multiple degrees of freedom, which enable rotary, transverse and linear directional movements (Levin et al. 2000). The rotary movements allow knobs to be rotated about the rotating axis, while the transverse movements (perpendicular to the axis) and the linear movements allow the knobs to be pushed or pulled (Levin et al. 2000). Normally, an index line or mark is indicated on a knob when the position of a rotary control knob is to be discerned **(Kroemer, Kroemer, and Kroemer-Elbert 2001).** The ergonomic design of control knobs has been an emphasis of designers for many years **(Kleiss 2008).** According to researchers, in order to idealise the ergonomic design of a particular knob, the size and shape of the knob are crucial factors to be considered**(Woodson, Tillman, and Tillman 1992; Kleiss 2008; Amaral et al. 2013)**.Studies show that elderly individuals of 65 years and above can only exert a capacity of 75% of the strength and endurance that they were able to exert in their younger years(<30 years old) **(Shaheen and Niemeier 2001; Haigh 1993). Lee and Su(2008**) postulate that the difficulty of the adjustment of control knobs is determined by the size and tolerance of the knob. However, **Kroemer, Kroemer, and Kroemer-Elbert (2001)** opine that if the turning resistance is low and the knob can be easily operated, the size of the knob is inconsequential. On the other hand, if the space is constrained, the knobs are required to be small and with low turning resistance to allow the user to manipulate it easily **(Kroemer, Kroemer, and Kroemer-Elbert 2001**). The function of a knob is often given more attention to rather than the sensory quality of the knob, as designers generally do not consider it to be a critical factor to improve for optimised performance (**Kleiss 2008**). It was found that about 58% of elderly people obtain some form of disability in control and sensation when manipulating knobs **(Shaheen and Niemeier 2001**). A secure sensation is often one of the factors that should be considered, especially in knob designs that emphasise on providing a smooth tactile experience to knob users (**Kleiss 2008).** Beside this, the compatibility of control knobs with display devices is highly important for the reduction in human error and response time**(Chan, Shum, and Poon 2002**). **Kroemer, Kroemer, and Kroemer-Elbert(2001)** suggest that continuous knobs should be considered in machine design if little turning torque and fine adjustments are required.

Kroemer, Kroemer, and Kroemer-Elbert (2001) however explained that the knob position should be set in such a way that it is not affected by vibration or involuntary movements.In reflection of the above mentioned considerations, **Bull(1987**) designed a control knob with a push–pull mechanism, where the control knob was required to be pushed or pulled in order to engage. This prevented inadvertent and accidental adjustments to the device.In summary, the ergonomics considerations incorporated in knob designs are useful based on several aspects. Knobs with sensory feedback capabilities (such as haptic knobs) can aid users to perceive input levels and influence their usability and comfort when manipulating a device. For a functional knob design, the operating degrees of freedom(pushing, pulling and turning) need to be considered so that the knob is of good quality,reliable and user-friendly. The appearance and choice of materials for the knob are also important in order to provide a quality tactile experience for the users. Apart from that, in order to accommodate more precise adjustments, continuous knob design would be preferable.

1.1 Need for Research

To have the best chance of creating and selling an innovative and commercially successful service or product, there is need to have an in-depth understanding of end-users' requirements. End-users are customers or whoever your product or service is aimed at.

User-centered design involves engaging directly with consumers in the early stages of any new product development (NPD) process and keeping them involved throughout. This gives everyone who needs to be involved - such as research, engineering or marketing teams - a clear picture of how their expertise will be called on to benefit the project. Such a unified strategy will reduce the risk of conflicting initiatives wasting your business' time and money.

The ergonomics considerations identified in knob include aesthetic attraction, position, torque requirement and shape-coding.

1.2 Objective

The main objective was to explore the role of user-centred design criteria for design phase and the role of ergonomics and human factors for the fuel-cum-dickey opening knob of a two wheeler for better safety and convenience.

II. METHODOLOGY AND SOFTWARE USED

2.1 Software Used

After analysing the needs and demands of the two wheelers' users using the questionnaire, interviewing different age groups of people and visual analysis of the users of how they operate and what changes can be made to provide the best knob with no better changes required in future, the three dimensional(3D) computer aided design(CAD) of the knob was made, Autodesk Fusion 360 software was used for drawing the model in 3D.

2.2 Methodology

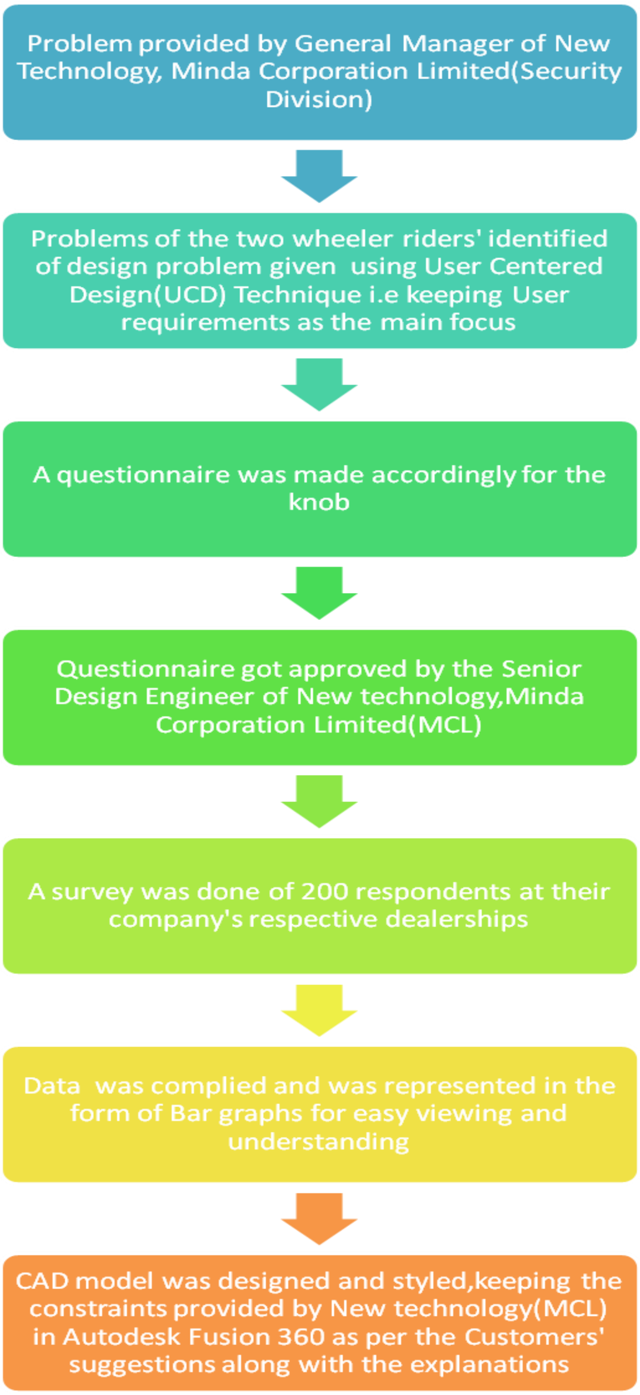
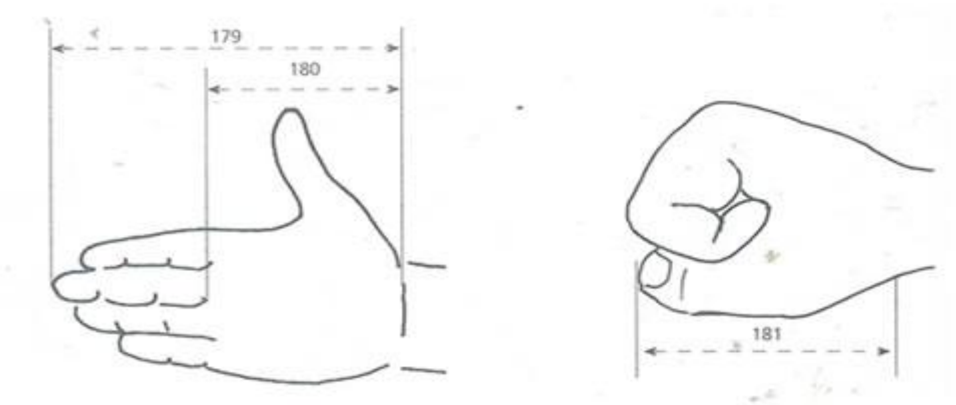


Fig. 1 Methodology

The Datasheet relevant to hand dimensions was used for designing the knob ergonomically



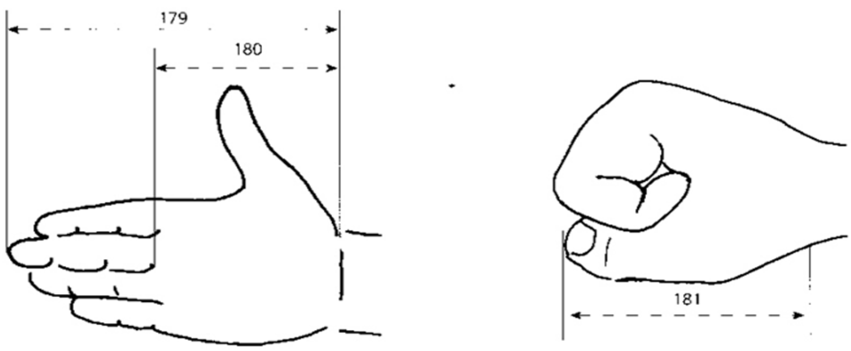
Key to follow the datasheet

The below key structure showing landmarks, definitions and data table structure was used in all the data sheets under different experiment heads

The compiled data(with relevant descriptions of anthropometric terminology and illustrative descriptions with the respective measurement landmarks) are presented herewith as INDIAN ANTHROPOMETRIC DIMENSIONS separately for Males,Females and Combined(males and females both considering a single study)

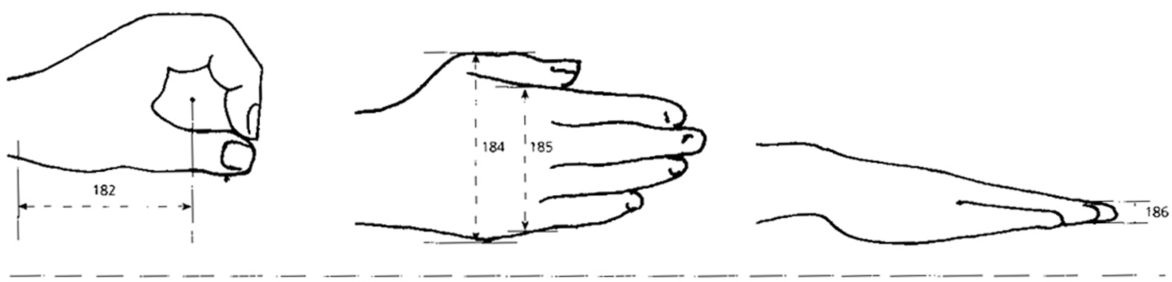
R.No	Parameters	Definition (brief)
Running dimensional reference numbers as illustrations	Names of the dimensions	Continuous running text, starting with explanatory note on the definition of respective dimensional measurements followed by the landmarks specifying the dimensions for the concerned parameters

R.No	Parameters		Min	Percentiles 5th 25th 50th 75th 95th	Max	Mean	±SD	Ratio
Running dimentional reference numbers same as illustrations and definitions	Names of the dimentions	Data for male female combined	Minimum value (1st percentile)	Intermediate percentile values	Maximum value (100th percentile)			The 'ratio' value: respective parameter + stature



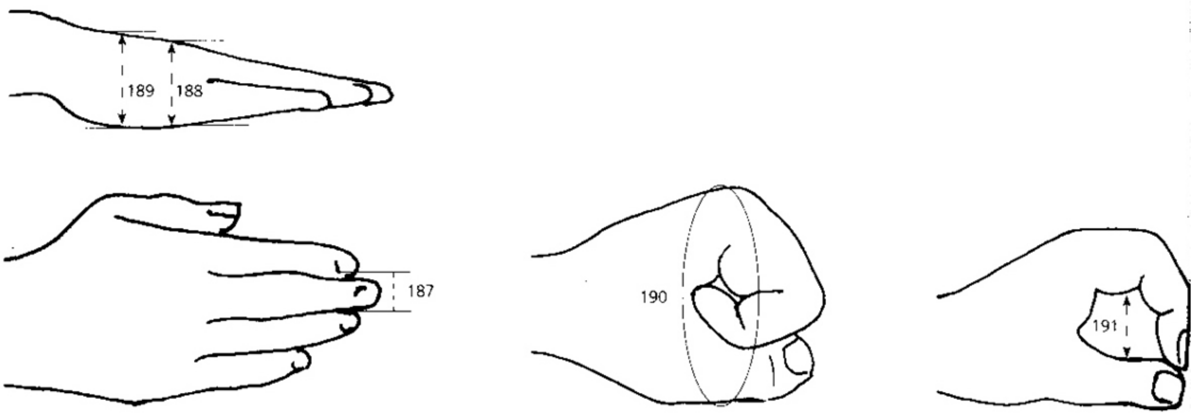
R.No.	Parameters	Definition (brief)
		Hand dimensions
179	**Hand length**	Distance (at palmar surface) from the base of the palm to the tip of the middle finger, when hand is held straight and stiff, with fingers together and extended.
180	**Palm length**	Distance from the base of the palm to the base of the middle finger (at the palmar surface).
181	**Fist length**	Length of the hand grip in the same line of the long axis of the hand from the base of the palm to the tip of the fist, wherever found.

R.No.	Parameters		Min	Percentiles 5th	25th	50th	75th	95th	Max	Mean	±SD	Ratio
179	**Hand length**	Male	119	163	173	180	187	198	229	181	12	0.11
		Female	150	154	160	166	170	181	190	167	8	0.11
		Combined	119	158	168	176	184	197	229	178	12	0.11
180	**Palm length**	Male	86	92	99	103	107	114	176	104	8	0.06
		Female	84	86	91	94	97	103	113	95	5	0.06
		Combined	84	89	96	101	106	114	176	103	8	0.06
181	**Fist length**	Male	73	85	93	99	105	115	127	101	9	0.06
		Female	52	61	87	93	101	106	117	92	13	0.06
		Combined	52	81	92	98	104	115	127	99	11	0.06



R.No.	Parameters	Definition (brief)
182	**Hand grip, length**	Length of the hand grip, from the base of the palm to the centre of the grip, while holding a rod of 30 mm diameter.
183	**Hand grip, breadth**	Maximum breadth of the hand grip, wherever found, perpendicular to the long axis of the hand.
184	**Hand breadth, with thumb**	Maximum breadth across the palm with the thumb at right angle to the long axis of the hand.
185	**Hand breadth, without thumb, at metacarpal**	Maximum breadth across the palm at the distal ends of the metacarpal bones (where the fingers join the palm) of the index and the little finger.
186	**Finger-tip depth**	Maximum distance between the dorsal and the palmar surfaces of the tip of the middle finger.

R.No.	Parameters		Min	Percentiles 5th	25th	50th	75th	95th	Max	Mean	±SD	Ratio
182	**Hand grip length**	Male	36	39	45	50	55	65	95	51	8	0.03
		Female	40	41	46	50	55	63	64	51	7	0.03
		Combined	36	40	45	50	55	64	95	51	8	0.03
183	**Hand grip breadth**	Male	65	82	91	99	104	109	130	98	9	0.06
		Female	51	70	82	86	91	96	104	86	9	0.06
		Combined	51	79	89	96	102	109	130	96	10	0.06
184	**Hand breadth with thumb**	Male	78	86	93	99	104	111	117	99	7	0.06
		Female	75	77	82	86	90	95	100	87	6	0.06
		Combined	75	81	89	95	102	109	117	96	9	0.06
185	**Hand breadth without thumb at metacarpal**	Male	60	72	77	81	85	90	100	82	6	0.05
		Female	60	66	69	71	75	79	92	73	5	0.05
		Combined	60	68	74	79	84	90	100	80	7	0.05
186	**Finger-tip depth**	Male	10	11	12	13	14	15	18	14	1	0.01
		Female	8	8	9	10	11	13	15	11	1	0.01
		Combined	8	10	12	13	14	15	18	14	2	0.01



R.No.	Parameters	Definition (brief)
187	**Finger-tip breadth**	Maximum distance across the lateral surfaces of the tip of the middle finger.
188	**Hand depth at metacarpal**	Maximum thickness between the dorsal and the palmar surfaces of the palm, across the knuckle of the middle finger, where it joins the palm.
189	**Hand depth, at thumb base**	Maximum thickness of the palm, on the fleshy pad at the base of the thumb.
190	**Fist circumference**	Maximum circumference of the fist, wherever found, encompassing the knuckles of the middle finger and the thumb.
191	**Grip inside diameter, maximum**	Maximum inside grip diameter, measured by sliding the hand down a graduated cone until the tips of the thumb and the middle finger remain touched to each other.

Source reference:Chakrabarti,D.,1997:Indian Anthropometric Dimensions for Ergonomic design Practice,NID,Ahmedabad,India

R.No.	Parameters		Min	Percentiles 5th	25th	50th	75th	95th	Max	Mean	±SD	Ratio
187	**Finger-tip breadth**	Male	13	13	14	15	16	17	20	16	1	0.01
		Female	10	11	12	12	13	15	16	13	1	0.01
		Combined	10	12	13	14	15	17	20	15	2	0.01
188	**Hand depth at metacarpal**	Male	15	18	21	24	27	31	39	25	4	0.02
		Female	17	17	20	23	25	29	37	24	4	0.02
		Combined	15	18	21	23	26	31	39	25	4	0.02
189	**Hand depth at thumb base**	Male	26	34	37	40	44	50	65	42	5	0.03
		Female	29	30	34	37	38	43	44	37	4	0.02
		Combined	26	34	37	40	43	50	65	41	5	0.03
190	**Fist circumference**	Male	220	240	252	264	279	294	373	266	19	0.16
		Female	200	205	219	229	237	249	250	227	13	0.15
		Combined	200	219	247	259	275	294	373	260	23	0.16
191	**Grip inside diameter, maximum**	Male	39	42	46	49	51	56	60	50	4	0.03
		Female	39	40	42	46	49	52	57	47	5	0.03
		Combined	39	41	46	49	51	56	60	49	4	0.03

III. CONCLUSIONS

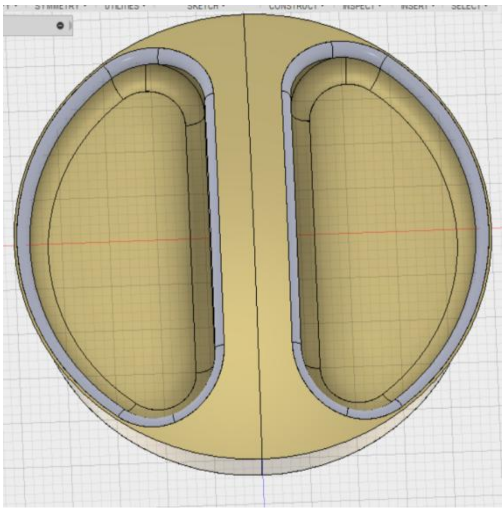


Fig.2 Proposed Knob design

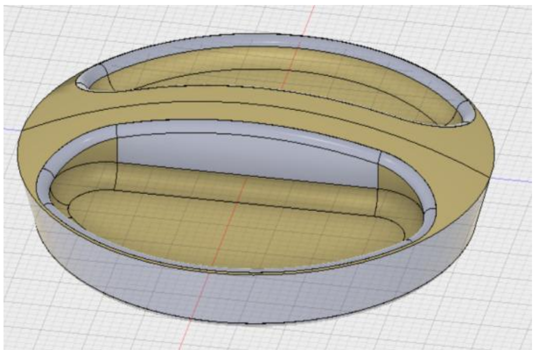


Fig.3 Isometric view of Knob design

The knob made is universally designed after considering all the factors and using User Centered Design(UCD) approach i.e made according to users' needs & demands and for the two wheeler riders'.

The knob made provides easy inserting of fingers resulting in better grip and no screw is used for tightening it with two wheeler's body,reducing chances of theft and is corrosion resistant too.

REFERENCES

[1] Controls Positioned at Peculiar Positions." International Journal of Industrial Ergonomics 36(8): 737–745.

[2] Chan, W.H., and A.H.S. Chan. 2007. "Strength and Reversibility of Movement Stereotypes for Lever Control and Circular Display." International Journal of Industrial Ergonomics 37 (3):233–244.

[3] Chan, A.H.S., V.W.Y. Shum, and K.K. Poon. 2002. "An Empirical Study of Compatibility on Rotary Control and Horizontal Display." Proceedings of the Institution of Mechanical Engineers,Part B: Journal of Engineering Manufacture 216 (5): 683–696.

[4] Chen, J.X.J., and G.B. Jackovin. 2004. Rotary control knob for an appliance. USA Patent Application USD493090S,filed July 20.

[5] Ciriello, V.M., R.V. Maikala, P.G. Dempsey, and N.V. O'Brien. 2010. "Psychophysically Determined Forces of Dynamic Pushing for Female Industrial Workers: Comparison of Two Apparatuses."Applied Ergonomics 41 (1): 141–145.

[6] Shaheen, S.A., and D.A. Niemeier. 2001. "Integrating Vehicle Design and Human Factors: Minimizing Elderly Driving Constraints." Transportation Research Part C 9 (3): 155–174.

[7] Shih, Y.-C., and Y.-C. Ou. 2005. "Influences of Span and Wrist Posture on Peak Chuck Pinch Strength and Time Needed to Reach Peak Strength." International Journal of Industrial Ergonomics 35 (6): 527–536.

[8] Stevenson, M.G., N. Coleman, A.F. Long, and A.M. Williamson. 2000. "Assessment, Re-Design and Evaluation of Changes to the Driver's Cab in a Suburban Electric Train." Applied Ergonomics31 (5): 499–506.

[9] Swanson, A.B., I.B. Matev, and G.d. Groot. 1970. "The Strength of the Hand." Inter-Clinic Information Bulletin 13 (10): 146–153.

[10] Tsai, H.-C., S.-W. Hsiao, and F.-K. Hung. 2006. "An Image Evaluation Approach for Parameter-Based Product Form and Color Design." Computer-Aided Design 38 (2): 157–171.

[11] Vatavu, R.-D., and I.A. Zaiti. 2013. "Automatic Recognition of Object Size and Shape via User-Dependent Measurements of the Grasping Hand." International Journal of Human-ComputerWoodson, W., P. Tillman, and B. Tillman. 1992. Human Factors Design Handbook. 2nd ed.New York: McGraw-Hill Professional Publishing.

[12] You, H., T. Ryu, K. Oh, M.-H. Yun, and K.-J. Kim. 2006. "Development of Customer Satisfaction Models for Automotive Interior Materials." International Journal of Industrial Ergonomics 36(4): 323–330.

[13] Crilly, N. (2005). Product aesthetics: Representing designer intent and consumer response, Unpublised doctoral dissertation. Cambridge: University of Cambridge.

[14] Schmitt, B., & Simonson, A. (1997). Marketing aesthetics: The strategic management of brands, identity and image. London: The Free Press.

[15] Liu, Y. (2003). Engineering aesthetics and aesthetic ergonomics: Theoretical foundations and a dual-process research methodology. Ergonomics, 46 (13/14), 1273-1292.

[16] Crozier, W. R. (1994). Manufactured pleasures: Psychological response to design.Manchester:Manchester University Press.