2. REVIEW OF LITERATURE:

Motion stereotypes are extremely important factors which must be considered for each population with special concern to man-machine interface design. Stereotypic movement of the user is a kind of response against a specific stimulus; from a very old study it was evident that the user's response preference against a particular stimulus is consistent (Fitts, 1951) among a series of choices. Apart from the motion stereotype the colour stereotype is also important for man- machine interface design. Colour is something which is quite important in industrial design. It is one of the key factors in product semantics which is the study of symbolic characters of man-made forms in the perspective of their use and the application of this knowledge to industrial design. Symbolic qualities represents psychological, social and cultural context of a product.

Research on this topic was started quite a long ago (almost sixty five years). There are some studies on American and Chinese population on motion stereotype. However, limited factors were studied regarding motion or colour stereotypes.

In this particular chapter the findings of the topic related to the previous studies cited in the literature were reviewed. This literature review has been conducted to get realistic and established views of the eminent researchers mainly on motion and colour stereotypes and some of the factors related to it.

2.1 Review:

Courtney (1994) tested stereotypes of the Hong Kong Chinese subjects for direction-of-motion between controls and displays by using a paper-pencil test. Three different types of controls and three different planes for the controls were used in this study. The result specified that there were

some areas of concurrence with Western stereotypes, but the Hong Kong Chinese subjects also showed pattern of stereotypes which was not found in Western subjects. Hoffman (1997) did three tests on motion stereotypes. He used two dimensional horizontally moving displays, three-dimensional control-display combinations; the association between response times and the strength of stereotypes were analyzed. For every case, equations were formulated for stereotype strength in terms of the direction forecasted by different principles and alterations of these for three-dimensional arrangements of control and displays. There was powerful impact of subject groups on the strength of the component principles. The key finding was that the stereotype strength was a linear sum of the strength of the every contributing principle. Response time was found to be reliant on the amount of the component principle creating the maximum contribution to the strength of the overall stereotype. Worringham and Beringer (1998) studied the base of directional stimulus-response compatibility by using a task where 128 subjects moved a pointer into targets with a joystick, which was almost similar to the action of some industrial and construction tools. Visual Field compatibility was established as a vigorous spatial compatibility principle which was not influenced by the direction of the operator's extremities or head or the muscle energy expenditure in performing the task. It offers rapid performance and reduced rate of risky directional errors. Sen and Das (2000) showed in an ergonomics study on the machine control and the resulting motions of the cabins and the hooks in electric overhead travelling cranes in a plant that control-movement compatibility was not present in most of the cranes. They suggested a number of inexpensive ergonomics solutions to minimize these tribulations. Kang and Seong (2001) analyzed the communications between operators and control room equipment and showed that a number of factors influenced the information-gathering and decision-making procedures. The result showed that the framework successfully put together

various aspects of human-machine interface and assessed the psychological workload of the operators.

The control knob position may be an important factor for the effective operation of the control – display units. Chan et al. (2003) used a real mechanical setting in a study to predict the consequence of control knob position, type of indicator and scale side on strength of motion stereotype, reversibility index and response time for a horizontal display-rotary switch setup. They found that the effects of the three most important factors and the control position scale were very much significant for response time, whereas the direction of instruction has predominant impact on stereotype strength. In an experiment Chan and Chan (2006) studied strength and reversibility of direction-of-motion stereotypes and response times for circular display-rotary control units placed at peculiar arrangements. The impact of pointer location, instruction of turn and control plane on motion compatibility were evaluated by using quantitative measures of stereotype strength and index of reversibility. Comparisons were made between the results found for peculiar control positions with those where controls were placed in normally used planes. The result suggested that for better performance designers should not place rotary controls at peculiar positions, the normal frontal plane is the best option for placing rotary control for the circular display and it is also suggested that the pointer should constantly positioned at 12 o'clock for verify reading or rearranging purposes.

The movement stereotype and its related factors may be different in different populations. Yu and Chan (2004) conducted a comparative study on response stereotypes for every day operation tasks of the Chinese and American engineering students. They found that stereotype strengths of engineering students from the three regions were usually dissimilar. The Mainland and Hong Kong Chinese were more similar in making choices on questions of theoretical compatibility,

whereas more steady preferences on movement compatibility and spatial compatibility were found between the Mainland Chinese and American students than Hong Kong Chinese.

Chan and Chan (2007a) Used actual mechanical controls and studied strength and reversibility of direction of motion stereotypes and response times for some regular control-display configurations in human machine interface. The results depicted that the finest control-display configuration was the rotary control-circular display unit. Four-way lever-digital counter and the rotary control-vertical scale combinations were found to be the poorest configurations. Subjects' response times were found to be commonly longer when there were no clear cut movement stereotypes. Chan and Chan (2007b) did another experiment on strength and reversibility of direction-of-motion stereotypes and response times for different configurations of digital display and rotary control. The results of this study showed that the CI and AD stereotypes were commonly strong in the rotary control-digital display test. On the basis of mean stereotype strengths and indexes of reversibility, the compatibility of rotary control-digital display is comparatively lower than that of rotary control-circular display configuration. This study suggested that if the rotary control needs to be used in the sagittal plane, a digital display is a better choice than a circular one placed on the frontal plane.

The configuration of control and display also plays an important role on the efficiency of the operation of control-display units. Subjects are needed to do a smaller amount of brain work in compatible setups. The location of display pointer may also be important factors for efficient operation of control display units. Chan and Chan (2007c) in another different study tested strength and reversibility of movement stereotypes, and response times for different lever controls with circular displays. To evaluate the impact of pointer position quantitative measures of the strength and reversibility of stereotypes were utilized in this study. Strong and

significantly reversible motion stereotypes were noted for the horizontal and vertical levers at 12 o'clock and 9 o'clock pointer locations, respectively. This study offered practical information for betterment of the design of control units used in man-machine interfaces. Hoffmann (2009) in his study concluded that Warrick's principle in two-dimensional display/control relationships has been found to be a vital factor in determination of stereotype strengths. This principle has an indirect linkage that may bias the responses of a user such as engineers who have awareness of mechanisms and hence create stereotypes that does not represent general population. It is shown that such thing may also exist for three-dimensional display/control associations, where the control in another plane than that of the display. 'Hand /control location' (HCL) is a factor which is related to the location of the control near to the body. That's why to handedness, hand used and hand position used in controlling the interface. A number of examples proved the weight of this concept for two- and three-dimensional display-control interactions. In a scientific study (Chan and Chan, 2008) where real mechanical controls were used, strength and reversibility of direction-of-motion stereotypes and response times for most common control–display configurations were analyzed in the man–machine interface for the Hong Kong Chinese population. The results depicted that the best configuration was the rotary control–circular display unit. The worst performing combination found were the four-way lever–digital counter and the rotary control–vertical scale.

Commonly, the response time of the subjects were found to be lengthier without clear cut motion stereotypes. Kantowitz and Roberts (2009) concluded in one of their studies that control-display compatibility was enhanced when frames, rules, and response tendencies were associated. Wong and Chan (2012) proposed a neural network-based method to calculate the contributory association among design variables and to calculate their comparative impact on the two

performance procedures, user response time and response accuracy. Depending on the results, the study showed the best operating situation with which to optimize each one of the measures as recommended. Some valuable explanation about the association between design variables and measures too were presented. The key role of the study was to offer some deep down look into the worth of quantitative methods in assessing display-control compatibility. A lot of the current research in control-display compatibility was reported in the work of the researcher duo Chan and Hoffmann (2010 and 2012), Hoffmann and Chan (2013). They showed that various key principles like Warrick's principle (Warrick, 1947), scale-side principle (Brebner and Sandow, 1976), clockwise to increase principle and hand/control location effect principle (Hoffmann, 2009) be able to account for the main part of the movement stereotype strength with a lot of dissimilar arrangements of controls and display units.

According to Mehta & Zhu (2009) colours could be particularly advantageous in educational settings where children are progressively developing. Olds (2011) highlighted colour as a constituent that may promote a sense of comfort, faith and security that are believed to be the most vital bases for the cognitive growth of the children. Colours are the influential constituent in our surroundings and usually one of the primary characteristics that are observed when entering a room (Tofle et al., 2004). Maier and colleagues (2009) suggested that there is definitely a prominent impact of colors on psychological condition, cognition and behavior. Hopkin (1994) in one of his study concluded that implementing colors well-matched with color associations for a population could decrease the hazard of information misunderstanding and improve safety by the quick detection of operating situations and exercising proper control actions. Van Darr and Deshe (2002) found that the search time to place clear-cut information could be cut down by the application of appropriately designed color screens. In some of the

previous studies (Osgood et al. 1975, Jacobs et al. 1991, Chan and Courtney 2001) the researchers concluded that studies on relationship of colors with concepts will offer industrial designers with the information regarding the significance of color coding used by them. Chan and Courtney (2001) studied population stereotypes for color with the Hong Kong Chinese subjects, and showed that there was a difference and quirkiness of subjects' preferences of colors with global standards. In an another work Chan and colleagues (2003) did a comparative study on three Asian populations which were Hong Kong Chinese, Korean and Thai to explore if there was any cross-culture divergences existed in the color associations with concepts in the cases of warnings, sign and equipment status, and actions required. The results showed that all the 37 concepts (except the "decrease" concept) were significantly linked with the colors supplied, and 26 concepts were linked with the similar colors by all the three populations. Ekici and colleagues (2006) suggested that colour choices of persons are considered as associated with subjectivity. According to Akcay and colleagues (2011) it is quite complicated to understand an individual's color preference and most likely based on a broad range of color links for different product types. Cernovsky and associates (1998) suggested that though culture emerges as a vital issue in color preferences, the impact of it must not be overvalued as different studies provide contradictory results.

Stereotypes are most susceptible to the cognitive process as they consist entirely of cognitions concerning groups. Earlier examination of stereotypes was primarily related to their historical origins and the socialization and contact experiences that fostered them (Stephan 1989). Anderson's (1983) models of cognition deal with the structuring and processing of information

Motion stereotype of the population for control-display units, is a kind of repetitive fine movements of hand and fingers as response against a stimulus. So it could be said that motion

stereotype is well related to motor function or a motor control. Adams (1971) introduced closed loop system for human motor control. He defined that a closed loop system always has a feedback, error detection and error correction as the main elements. A closed loop system is self modifiable. In a recent study Leisman and colleagues (2016) argued that motor and cognitive procedures are functionally connected with each other and almost certainly contribute to the same kind of evolutionary history. Some brain regions combine both the motor and cognitive functions. Cognitive processes correspond to multifaceted motor output. They reported that motor and cognitive ability have active bidirectional impact on each other. Jagacinski and colleagues (1983) concluded that the feedback-related variations in the extrapolated trajectory were inferred as changes in two parameters of a cognitive demonstration of the pattern of motion.

Zuo and colleagues (2019) explored the association between counter-stereotypes and creativity; they found that neither shocking nor happy emotion mediated the impact of counter-stereotypes on creativity, while cognitive elasticity did. This study revealed a method of creative ability in terms of cognitive flexibility.

Cox and Devine (2015) studied stereotype structure in connections with theories of cognition. They found mixed directionality among the stereotype links connected to a specified social group and also between the associations of dissimilar social groups. Stereotype directionality is an understudied characteristic of stereotypes and stereotyping with extensive suggestions for the progress, measurement, preservation, appearance, and alteration of stereotypes, stereotyping and favoritism.

Barber (2017) reviewed topics focused on the stereotype threat faced by older adults regarding cognitive abilities. He provided proof that it is a self-concept threat and not a group-reputation threat. This review provided confirmation that the mechanism underlying effects of the stereotype threat may differ across the lifetime. Stereotype threat does not appear to diminish older adults' decision-making control resources due to age related improvement in emotion regulation capability. Overall he highlighted the requirement to approach the perception of stereotype threat with more care which will allow us to plan more efficient stereotype threat interventions. Mallot (1999) presented an explanation of cognition in terms of the intricacy of behavior. It was argued that spatial cognitive abilities can be clarified by ranging up simple, stereotyped mechanisms of spatial behavior. Behavioral research indicated that stereotype and cognitive mechanisms co-exist in human spatial behavior. Rosen and Jerdee (1976) confirmed that stereotypes concerning older employees' physical, cognitive, and emotional characters lead to biasness against older workers. Suggestions for older workers' inspiration and career contentment are discussed, and implications are made for organizational modifications to hold the special requirements of older employees. Macrae and associated (1996) worked on some topics like, the origin of stereotypes, accuracy of stereotype, its impact on interpersonal and intergroup relations and options for alteration of stereotypes etc. According to them stereotypes formed sets of viewpoints about the distinctiveness of constituents of social categories influence how people attend to, encode, symbolize, and recover information regarding the others, and how they judge them and respond to them. Incorporating cognitive, emotional, and linguistic perspectives, Stereotypes and Stereotyping reveals the variety and affluence of this field today and opens up new path for future research

Zarate and Smith (1990) concluded that the results of their study supported the strength of the method by verifying a straight relationship between the social classification of a target person and the social stereotype which is accessed and used to represent conclusions. The conclusion was drawn in terms of Social Identity Theory and the role of classification in social insight. Von Hippel and colleagues (1995) explored the effect of stereotypes on encoding processes and the role which encoding processes play on stereotype preservation. They tested how the viewpoint relating to stereotyping and encoding might alter the way of discrimination and its association with stereotypes is observed. In another study Freeman and Ambady (2009) worked on stereotype; there data supplied confirmation for the partial and parallel commencement of stereotypes fit in to alternate social categories. Wheeler and Fiske (2005) reported that the flexibility of stereotyping has impact in social psychology and the society. The study recorded brain activity in the amygdala and measured cognitive activation of stereotypes. The responses depended on subjects' existing societal-cognitive goal.

Johnson and colleagues (2011) examined the function of visual cues and gender stereotypes in view of biological motion displays, thus defeating the morphological perplexing inherent in facial displays. They revealed gender stereotyping. It was noted that subjects applied gender stereotypes of emotion to conclude sex category. Pavlova and associates (2010) studied stereotype messages regarding gender variations in a societal cognitive task, where no gender variation has been previously recognized. They have concluded that manipulation of stereotype messages bring out gender effects. A positive message improved performance while a negative one reduced it. This effect is more distinct in females. Reiss and colleagues (1996) and Gorski (1998) have reported that sex variation exist in the cerebral framework and also in localization of cerebral functions. It has been assumed that both biological and environmental factors might

cause the sex variation. Amongst the biological factors, differences in neurological structure and function have been reported (Blanch et al., 2004; Luders et al., 2004; Rilea et al., 2004). Researchers reported that hormones are linked with certain features of brain discrimination (Aleman et al., 2004; Burton et al., 2005; Driscoll et al., 2005; Gouchie & Kimura, 1991) in males and females.

Carlsson and associates (2015) reported that extra ten days of schooling increased the score of crystallized intelligence tests but test scores on fluid intelligence tests do not increase with additional days of schooling but increased reasonably with age. Falch and Massih (2011) concluded that 1 year of schooling significantly increases IQ by 2.9–3.5 points.

Midouhas & Flouri (2015) reported that there were no area differences in mathematics scores but children in areas with a blend of rural and urban population had a higher non-verbal scores. Children from main urban areas such as London secured higher reading scores. This study explained most rural-urban variation in young children's mental abilities.

Hermida and associates (2018) concluded that poverty and rural settings in Latin America affected child mental task performance. They have noted that children in rural settings performed consistently worse than children in urban settings. These differences might be due to the lesser amount of months of past preschool attendance and the parental education.

Bonoti and Vlachos (2018) evaluated that handedness can be regarded as an issue distinguishing mental abilities. Al-Hashel and collegues (2016) have concluded that Right handed children had greater visuospatial abilities, visual memory and better reaction time. Left-handed children proved to have superior simple reaction times also. In a current study (Somers et. al., 2015) it was pointed out that there is a little but significant spatial ability benefits in right-handers though,

in the verbal ability, this benefit was significant only in children. The researcher duo Mandal and Dutta (2001) conducted a chain of scientific studies and then reported that near about 10% population of this world is left-handed, but the occurrence rate might vary depending on some factors like, age, sex and cultural or geographical variations. In another study Pawlik-Kienlen (2008) have suggested that in case of flexibility and their capability of switching over their hands for performing tasks, rapidity in thinking when playing computer games or sports there are also some important variation between right and left handed subjects. Gutwinski (2011) have suggested that either the right or the left hemisphere of brain can be dominant for any motor function, ensuing in either left or right-handedness; it appears to be an issue of natural variation. McKeever (2000) concluded that left-handedness is mostly found in men than in women. Luders and associates (2004) revealed that corpus callosum of left-handers is generally found to be larger which may be an indication of better inter-hemispheric connectivity. This connectivity may be linked with some skills, like fluency in language, retentiveness (Christman and Propper, 2001). In another study Chaudhary (2009) concluded that better inter-hemispheric connectivity leads to better performance in attention and memory related tasks. Kopiez and colleagues (2006) found that left-handedness is common among talented musicians (2006), may be partially because they are better at using both hands at a time (Judge and Stirling, 2006). In addition Voracek (2006) have suggested that left-handedness is very common among successful sportspersons also, predominantly in one-on-one games like tennis, judo, baseball, fencing and boxing. In one of his works, Chaudhary (2009) have concluded that there was variation in learning styles between right-handers and left-handers. Judge and Stirling (2003) have reported that superior inter-manual harmonization is commonly found among the left-handers.

Rosso and associates (2016) concluded that Neighborhood socioeconomic status (NSES) was marginally associated with Digit Symbol Substitution Test (DSST) and was not associated with white matter hyperintensities (WMH). Yang and associates (2016) concluded that higher socioeconomic status was associated with better human performance at baseline. Seidler & Ritchie (2018) concluded from their work that direct relations found between parental SES and mental ability of the children was partly mediated by home ambiance. This study suggests that a chaotic home atmosphere might partly elucidate the connection between parental SES and mental development of the children.

Watt (1997) suggested that the impact of numerous stressors is engaged in the ruining of human performance. Rapmund (2002) in a retrospective type study depicted that twenty years of experience working in the Pentagon influenced him of the necessity for a better understanding of human deeds and of man-machine interactions to perk up military operations. Wastell and Newman (1996) suggested that a properly designed military operation setup must enhance human performance and cut down stress. Sauer and the associates (1999) conducted a study on Russian cosmonauts who were tested on a PC-depended mock-up of a MIR space flight. They were put in different exhausting situations like isolation and confinement. It was found that some impermanent performance degradations took place as time passed but Job performance was reasonably high in normal situations. Mason (1968) spent lots of time of his life in measuring stress hormone levels of humans who were subjected to different situations which he considered stressful to explain the psychological characteristics which could make any situation stressful. He was able to depict the three key psychological factors which could induce a stress reaction in anyone who is exposed to those. Further studies established the fact that the factors of stress response are extremely specific, and thus very much predictable and assessable. Dickerson &

Kemeny (2002) confirmed the importance of these factors and also added another factor that is the existence of a social evaluative warning to circumstances. Lupien and associates (2006) divided stress into two types- (i) absolute (a real threat induced by and (ii) relative. They suggested that response to absolute stressors is always adaptive in nature but relative stressors may be mild or prominent. Kudielka and colleagues (2004) reported a huge inter-individual difference in stress response to the psychological challenges. Selye (1998) suggested in his study that the stress reaction is the body's response to the incident and it is this body's reaction to the stress that is the basis for the studies that resolute the effect of stress on cognition. Eunice and associates (2012) worked with rat model and found that persistent stress could prompt maladaptive transformations linked with stress-related mental disorders but basic mechanisms remain indefinable. They found that exposing young male rats to recurring stress notably damage the temporal order recognition memory which is a cognitive process. Studies on acute stress confirmed the presence of an inverted-u-shaped linkage between stress and mental functions (Lupien and McEwen, 1997). A study reported that low self-esteem could be a powerful forecaster of augmented stress reaction among human subjects (Pruessner et al, 2004). Stress and tiredness both can influence mental ability but there was no study in the literature which had identified whether their actions were independent or linked. Actually, since stress and fatigue usually take place together these two issues are frequently considered as a solo construct (Friedl et al., 2004).

Chronic stress that is long term stress can have harmful effects on health (Charmandari et. al., 2005). Stress may be a negative or a positive condition that can have a powerful impact on mental and physical well- being. Acute stress that is a little bit of stress that keeps us active and alert. In response to a stressful incident the human system acts accordingly by the activation of

sympathetic nervous system which in turn initiates the fight-or-flight response, during this period body produces larger amounts of the chemicals adrenaline, nor adrenaline and cortical, which trigger a higher heart rate, sharp muscle attentiveness, sweating, and alertness - these factors help us guard ourselves in challenging circumstances (Lupien et al., 2006). Human body cannot be in stressed condition for long time; the parasympathetic system acts and restores the body's normal physiological conditions by homeostasis (Goldstein and Kopin, 2007). There are majorly four types of effects of stress which is cognitive, emotional, physical and behavioral. Stress has a psychological basis but it affects a number of physiological processes including electro dermal activity, heart rate, blood pressure, muscle tension, and respiration (Dawans et. al., 2011; Vrijkotte, et al., 2000; Lundberg, et al., 1996) According to WHO a healthy workplace is one where the workers and manager collaborate to use a continual procedure to promote the health, safety and well-being of the workers and to save them. There are different psychosocial, physical and chemical factors, which can influence the human being on the workplace are termed as stress factors which affect the central nervous system. Small workplaces (less than 50 employees) have lowest prevalance rate of work related stress (Health and Safety Executive, 2015), According to Houtman and his collaborators (1994), work stressors were highly correlated with psychosomatic complaints, general health, fatigue and boredom at work. According to Smith and colleagues (2000) Full-time workers are more prone to suffer from work related stress than the part-time workers. A number of environmental factors affect human performance in work setup (Kahya, 2007). Among these factors heat stress has a great importance. Heat stress can weaken operators' performance in a work setup. In heat stress condition the body goes under stress from overheating. Ramsey and colleagues (1983) concluded in one of their studies that risky work activities in a plant was found to be negligible within the range of 17–23 ℃ WBGT, but

hazardous acts augmented at higher temperature up to 35℃ WBGT. Since the inner body temperature should be kept about 37 ℃, according to Parsons (2003) heat swap over between body and environment appears to be indispensable. Heat stress decreases mental ability which is vital for decision making process and performing different level of tasks (Hancock and Vasmatzidis, 2003). When body failed to get rid of too much heat it will cause a raise in the inner body temperature (Gonzalez et al., 2010) as a result, heat provoked physiological damage may lead to health related impairments (Jalil et al., 2007).The person who suffered from heat stress may be puzzled at first or not capable to focus, which is then followed by more harsh symptoms, like fainting. There are two types of responses to the heat stress which includes: behavioral responses, and mental responses (Vasmatzidis et al., 2002). Heat stress can spoil physical and mental performance (Faerevik et al., 2003; Froom et al., 1993). Variation in skin temperature has a predominant impact on human performance (Pilcher et al., 2002; Hancock and Vasmatzidis, 2003) in an interesting way. In an another study it was noted that a short time exposure of heat for about 30 minutes have stimulated performance degradation path which is not originated from elevated core body temperature (Ramsey and Kwon, 1992)

2.2 Conclusion from the literature review:

From the prior research it could be stated that as motion stereotype is population specific there should be more motion stereotypic studies on different population. There are some studies on Chinese and American population on different control display units. There was a little or no direct studies regarding the impact of various important factors on motion stereotype response, which may alter the stereotypic response of the users like stress (work related or psychological or environmental), age, gender, handedness and socioeconomic status etc. However, plentiful direct studies regarding the impact of above mentioned factors on mental or cognitive ability (somehow

related to motion stereotype) were found. Moreover, a little or no research studies have been found in the literature on motion stereotype in India. So these areas can be explored in Indian population. In the present study attempts have been made to find and establish the pattern of motion stereotype and colour stereotype of Bengali (Indian) population.