1. INTRODUCTION:

1.1 Background: Stereotype is a word which is derived from the Greek word “stereos” that means solid and “typos” that means impression. Therefore stereotype generally means “solid impression”. It can be expressed as an extensively held but fixed and oversimplified picture or idea of a particular kind of person or thing. Motion or movement stereotype of a person is all about the repetitive movements which may be habituated / learnt or inborn. Like machine operating with several switches and handles can be classified as habituated or learnt motion stereotype but the hand and leg movement in new born babies are the example of inborn motion stereotype. Now why it is important to have data base of motion stereotype of a particular population – the answer of this question has many shades. The habituated or learnt stereotypes which people exhibits while interacting with any interface could not be imposed on someone by giving training. User preference is the key for designing a perfect interface. So to know the user preference of a particular population for designing any kind of interface which suits them the most, we can test their motion stereotype for different sets of interface units with different switches, handles, buttons and knobs. The phrase "population stereotype" portrays the response preference that indicates to long-standing practice and good understanding of a particular population (Kantowitz & Sorkin, 1983). Population stereotype is generally illustrated by the possibility by which a response is selected, while stimulus-response compatibility is demonstrated by the rapidity and correctness by which a response is exhibited (Kantowitz et al., 1990). So the significance of testing motion stereotype of a population is to design something either domestic or industrial for that particular population which is well matched with their stereotypical expectations. This kind of design could be more productive, safe and comfortable

for the user. So, more production could be achieved with less accidents and errors at work. So basically design is that central thing which encourages us to use the population stereotype data to achieve the highest level of production, safety and comfort.

International Ergonomics Association (IEA, 2019) defined Cognitive ergonomics (CE) as something that is concerned with mental processes, such as insight, remembrance, logic, and motor response. These factors influence interactions among humans and other elements of a system. Some important topics under CE which may relate to human-system design are man-machine interaction, psychological workload, decision-making, skilled work, human-computer interaction, human reliability, work pressure and training. Cognition in work and operational settings is the major emphasis area of Cognitive ergonomics which optimizes human well-being and system performance. As a design philosophy, cognitive ergonomics can be applied in that area where man interacts with any technology.

The relationship between a control movement and its effect most expected by a population is known as a direction-of-motion stereotype, and such a relationship is said to be compatible. There was previous research studies conducted on linear indicator and translatory control, linear indicator and rotary control, circular indicator and translatory control, digital display-rotary control and on pointer or indicator position. Designers of man machine interfaces must utilize a stereotype with a reasonable degree of reversibility to diminish uncertainty and enhance effectiveness and safety (Chan and Chan, 2007).

The mass proportion of responses ($\geq$ 50%) for a testing condition is the determinant of the strength of stereotype (Chan and Chan, 2007). A value of exact 50% specifies no choice preference while a value of 100% indicates an ideal stereotype (Chan and Chan, 2007a).

In the case of industrial design man-machine interface is the vicinity where humans and machines communicates with each other. The target of this interaction is to permit efficient operation and control of the machine from the human side, whilst the machine concurrently feeds back information that supports the operator's decision making process. Examples may include computer operation, hand held tools, heavy machine operations and light machinery controls. Ergonomics and psychology are the two areas which is applicable in design considerations to create compatible interfaces.

Generally, the purpose of user interface design is to create a user interface which makes it easy (self illustrative), capable, and pleasant (user friendly) to operate a machine in the way which produces the preferred outcome. This means that the operator needs to provide nominal effort to accomplish the preferred output, and also that the machine minimizes unwanted outputs to the user.

Walter Lippmann was first to use the word "Stereotype", in its contemporary sense in his own book named "Public Opinion". Stereotypes are habituated reflexes that have become involuntary and 'automatic' by nature (Kroemer and Grandjean, 1997). Direction-of-motion population stereotypes are choices within a specified population for producing a definite output on a display when an explicit input is generated with a control. Displays and controls make communication between machines and their users. Displays offer information regarding the operational condition, and control devices facilitate the operators to take required actions and change the status of a human-machine system (Kang *et al*, 2001). During operating a control people must expects an outcome that is the effect of the control on the display. It is possible to guide people to operate systems that do not go after the population stereotypes, this will take a much longer training time and their performance may decline in an emergency situation arises. Research on different

control- motion relationships has been ongoing for a long time since 1955.Reversibility of stereotypes is a grand matter for designing of different control systems. In case of motion compatibility, reversibility is an important term which portrays the situation where, a subject who makes a clockwise movement of the control to raise the display value will also move the control anticlockwise to reduce the display value (Chan & Chan, 2007). Research illustrated that a person's expectations are not reversible all the time. Results from different configurations of control and display must be studied in detailed to suggest about design features which are vital for control panel interface design, and to anticipate the effects of design on user activities. The recommendations on well-matched interface designs result in more prompt response times and less inaccuracy.

User performance is found to be better when the mapping of control-display configurations adheres to population stereotype principles, such as the Warrick's principle, scale-side principle, and clockwise-to-increase principle.

If a great part of the population has the same anticipation about the way in which the control/display relationship works, we could say that there is a stereotype for the control/display association and the relationship between control and display is compatible.

Human dealings with complex manufacturing systems are always affected through displays and controls for a two-way exchange of information. Displays supply operational status information of the systems to human operators, and control devices facilitate operators to take required actions to change system status. Methodically designed displays and controls are thus important for the proficient and fault-free functioning of a highly developed manufacturing system. Consequence of continuing advances in current manufacturing technology, human operators

usually suppose to play the roles of managerial controllers for functions of supervising and intervening in machine operation in a man-machine cross system. The design of manufacturing tools therefore becomes a vital area where the ergonomic researches are applicable. With the understanding of ergonomics research carried out on human capabilities and characteristics, the paramount match between physical and cognitive characteristics of the users and manufacturing tools can be accomplished.

The stress may have some influence on the motion stereotype. Physiological or biological stress can be defined as an organism's response towards a stressor that is a stress factor, which can be an environmental condition or a stimulus. In general the more stressors one experience at a time, the more stressed he /she feels. Stressor is a mediator or a stimulus that can cause stress. Stress can have a lot of deep impact on the human biological systems. 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 mainly four types of impact of stress on human: emotional, cognitive, physical and behavioral. Watt (1997) suggested that the impact of several stressors is involved in the downfall of individual performance in Space. Wastell and

Newman (1996) recommended in their study that a good military system should promote human performance by lowering stress.

Human performance is influenced by an enormous range of environmental factors in working systems (E. Kahya, 2007). Among those factors heat stress is a major one that can spoil human performance. Heat stress comprises of a series of condition where the body is under stress from excess heating. The person suffered from heat stress may primarily be confused or unable to concentrate, followed by more harsh symptoms, such as fainting or collapsing. Besides, there are two types of external human responses to the increased internal temperature including: behavioral responses and cognitive responses (Vasmatzidis et al., 2002).Heat stress can impair both physical and mental performance (Faerevik et al., 2003; Froom et al., 1993). Ramsey and colleagues (1983) found that hazardous work behavior in products manufacturing plant was nominal within the range of 17–23 ℃ WBGT, but risky acts increased at higher temperatures up to 35 ℃ WBGT. So, to improve wellbeing in the workplace, emphasis should be given on assessing the cognitive as well as psychomotor abilities of the workers. Heat stress has been shown to diminish cognition and mental processing that are vital for decision making and easy to composite tasking (Hancock and Vasmatzidis, 2003). It seems that the degree of decrements of these tasks is directly related to the time and amount of heat exposure (Hancock and Vasmatzidis, 2003).

Men are generally independent, more logical and goal oriented by nature while women are interdependent, and mostly oriented towards others (Eagly and Steffen, 1984; Spence and Helmreich, 1978). These social stereotypes influenced important life outcomes such as job hiring and promotion (Cuddy et al., 2004; American Sociological Review 2005) job performance evaluations (Fuegen et al., 2004; Heilman and Okimoto, 2007) and educational performance

(Gudykunst et al., 1996) Cultural differences in independence-inter dependence were evident in the fields such as communication (Schwartz, 1999), creativity (Nisbett et al., 2001), and even basic cognitive processing (Rhoads, 2004). Women usually do better than men in episodic memory (Herlitz & Rehnman, 2008), but men do better in spatial tasks (Lövden et al., 2007). Studies showed that gender differences in case of general knowledge favoring men amid younger age partners (Lynn et. al, 2009), but this is not totally supported across the adulthood (Maitland et.al, 2004). So it is evident that the gender difference is an influential factor for cognitive performance.

Human motion stereotype may be related to the cognitive process. There is sufficient evidence that alterations in brain structure and function are closely tied to alterations in cognitive function (Glisky, 2007). The neural and cognitive functions are complex and depend on each other, precise mapping between brain and behavior is extremely difficult, so these complex relations remain mostly depends on speculations, even though ultimately testable. In aging, there are many potential 'common cause' factors that may affect both physical and cognitive performance. For example, diseases like Parkinson's affect brain areas concerned with cognitive and motor function. Older adults show white matter damage associated with motor function (Sosnoff et. al., 2008) and cognitive function (Wright et al., 2008)

According to Siengthai et al (2008) it is probable that laterality and dominance of hemisphere have a role in cognitive performance. Handedness makes a relatively small but statistically significant, contribution to cognitive function. Handedness may be one of the factors affecting the motion stereotype. Cherbuin and Brinkman (2006) at Australian National University suggested that left-handed people can think more rapidly when carrying out tasks such as playing computer games or playing sports, as links between the left and right brain hemispheres are

faster in left-handed people and they tend to use the whole brain more effortlessly. The fast exchange of information in the brain makes left-handers more capable when facing tasks that involve multiple stimuli. Naugels and associates (1998) suggested that left hand dominant persons are more common amongst the patients suffering from dementia which begins earlier to the age of 65 as compared to right handed people. The premotor area of cerebral cortex is concerned with the hand movements and it is bigger in left side of right handed persons than in the left handed people (Alexander, 1998). Left hemisphere is vital for language, logical decision making, analytical task, calculation and fine motor skills (Ferrari, 2007).

Socioeconomic status (SES) is powerfully associated with cognition. Education (Barnett, 1998; Ramey & Ramey, 1998) is all correlated with both SES and cognitive attainment. Socioeconomic backdrop has conventionally been associated with measures of cognitive performance. It has been well-known that socioeconomic status (SES) is decidedly predictive of a extensive range of outcomes, including psychological wellbeing, cognitive ability, and academic accomplishment (Adler & Rehkopf, 2008; Gottfried, Gottfried, Bathurst, Guerin & Parramore, 2003; Merikangas et al., 2010; Shanahan, Copeland, Costello & Angold, 2008 Sirin, 2005). SES must put forth its impact on academic performance and cognitive performance, through an effect on the neurocognitive systems underlying these behavioral outcomes. Prefrontal cortex is highly synthetic and goes through an elongated period of post-natal development (Casey et al., 2000), it may be predominantly prone to influences of childhood occurrence.

A large amount of the things what we see and relate with in our everyday life is colored. We are very familiar with colors – may be so much that we don't think about them a lot. On the other hand, it does bother us when we need to read a dark-gray label on a black button.Variations in

color is therefore highly effective in drawing attention. Whether this characteristic of color is a blessing or a curse to the user of a display system depends upon the skill of a designer in using color in a task-related way. Color is a kind of sensation which called up when light of the wavelengths ranged between 360nm and 720nm strike the eyes and then is processed by our visual system.

1.2 Problem Statement: From the prior research it could be stated that there should be more motion stereotypic studies on different population which is scanty. There are some studies on Chinese and American population on different control display units. There are a little or no studies on the impact of various important factors which may alter the motion stereotype response of the users like stress (work related or psychological or environmental), age, gender, handedness and socioeconomic status. Moreover, a little or no research studied has been found in the literature on motion stereotype in India.

As there was a little or no database found in literature on motion stereotype in India so the present study is addressed to a specific Indian population, the Bengali population to acquire data relating to motion stereotype. The main focus is given on building a database of motion and colour stereotype of Bengali population.

The motion stereotype may be influenced by several factors. Not much study is found to address these problems. Efforts have been taken to find out the factors affecting the motion stereotypes. Investigation should be made for finding out the impact of stress (work related or psychological or environmental) on motion stereotype. In addition to that the effect of other factors, viz., age, gender, handedness and socioeconomic status on motion stereotype should be studied. As it was found from the works of the prominent researchers that stress in any form could influence human

cognition (Sandi, 2013; Lupen, 2006) so in this piece of study it was tried to assess work related, psychological and environmental stress and their impact or influence on motion stereotype of three different working groups, viz., pole manufacturing factory workers, IT sector workers and bell metal product manufacturing workers. It was evident from the literature that biological age has a lot to say about many aspects of a human being. Cognitive development of a human being has different stages depending on different age groups. It was also noted from different studies that reaction time may vary in different age groups. So in the present study motion stereotype was evaluated and compared between adult and children subjects. We are aware of the fact that men and women are different from each other both mentally and physically. Men in general are self-governing and aim oriented whilst women are co-dependent, and sometimes dependent on others by nature (Eagly & Steffen, 1984 and Spence & Helmreich, 1978). Cultural differences in independence-interdependence were evident in the fields such as communication (Schwartz, 1999), creativity (Nisbett et al., 2001) and even basic cognitive processing (Rhoads, 2004). For this reason in the present study the impact of gender difference on motion stereotype has been taken into account for the study. Handedness or hand dominance is possibly the most obvious behavioral asymmetry found in humans (Corey et al, 2001). Studies confirm that about 90% of the people of this world are right-handed and 10% are left handed (McManus, 2009). Handedness is related with functional lateralization for cerebral dominance, and may also be linked with a range of features of people's mental health (Mcmanus, 2009). So in this present study the subjects selected randomly were divided into two groups (right handed and left handed) on the basis of the greatest strength of one hand (Bowman and Katz, 1984 and Chau et al., 1997) which represents the handedness of the subject. Then the motion stereotype of these two groups was compared. Plentiful population-based scientific works have recommended that socio-

economic status (SES) is well connected with cognitive performance (Seidler & Ritchie 2018; Yang et. al., 2016; Rosso et. al., 2016; Duncan et. al., 2012 and Wu 2016). The study of the effect of socioeconomic status on motion stereotype has been included in the present investigation.

The pattern of motion stereotype of the population is helpful for designing man-machine interface. The principle of stereotype can be applied in interface design with effective production and lesser human error. In the present study efforts have been made to apply such principle in one of the commonly used interfaces. A modification of a widely used interface, two burner gas oven has been suggested by the direct application of motion stereotype which might be more compatible and error free. There were some studies found on gas burner and knob position in literature but studies on modification of gas control knob on the basis of motion stereotype was not found. It was found that the existing common gas control knob showed both anti-clockwise to increase and anti clockwise to decrease the gas flame intensity which might cause confusion to new users. In this study stereotype preference of the subjects were noted and a modification of the existing gas knob was suggested which may reduce the user confusion and operation error.

The findings of the present study would reveal the motion and colour stereotypic response pattern of the Bengali (Indian) population which could be used to design more effective (productive, safe and easy to use) industrial interface particularly for this population.