INTRODUCTION

1.1 Setting the background:

The residential design aims to facilitate the fulfillment of special needs and life objectives of users into their environments. In fact, “good design directly impacts the quality of life” (Brawley, 2001). Residential interior space designing is a creative art which can transform an ordinary house into a very happy lively home. The purpose of interior designing is to make the home livable according to the needs and requirement of the family and the space characteristics. The interior designing should be able to satisfy the functionalism, expressiveness and beauty. It is not the decorating of the house; but it is the total designing of the house. The design should be such that it should be able to express the personality, aesthetic taste of the family living in through proper designing of the space, proper selection of furniture pieces, accessories and furnishing. The concept of designed living room area has deeply involved the elements of the interior environment (e.g. light, color, texture, furniture).

It can be risky to the elderly people if the room is planned unconsciously (Calkins, 1988). Interior designers need to understand the association between the physical environment and space. Such understanding can be achieved through three primary principles: 1) the physical environment needs to be designed with the users in mind and consider their needs, characteristics, and behaviors; 2) there should be integration between the physical environments occupied and the larger social system; and 3) the physical environments need to approach residential design style rather
than institutional style (Cohen & Day, 1993). This was also stated previously by Lawton, Moose and Lemke, (1980) and Nelson and Paluck, (1980).

In environment-behavior studies, the following ten general categories of home often occur:( Rapoport, 1995)

1. Home as security and control; people refer to their home as an area where they are in control of spatial design and social interaction. This provides people with a sense of freedom and emotional security.

2. Home as reflection of one’s ideas and values; people refer to their home as a symbol of how they see themselves and want to be seen by others.

3. Home as acting upon and modifying one’s dwelling; the process of controlling and acting upon one’s environment gives a sense of achievement and control, making the home a place for self-expression and for freedom of action.

4. Home as permanence and continuity; being in the same place for weeks, months or years makes the place familiar. This provides people with a sense of belonging somewhere. Memories can have an important function in this meaning category; they show the connection to the past. For example, the memories of the place where you grew up can be very detailed and strong.

5. Home as relationships with family and friends; a place to be together with people one cares for.

6. Home as centre of activities; the home provides a place for work, hobby and leisure activities.

7. Home as a refuge from the outside world; a place to get away from outside pressures and where one can control the level of social interaction and regulate the level of privacy and independence.

8. Home as indicator of personal status; it shows people’s socio-economic position.

9. Home as material structure; the concrete physical dimension of the home.
Home as a place to own; the positive experience of home as freedom of action, controlled space and permanence. It can also be regarded as an important economic investment (Després, 1991).

Keeping these points in mind; the present thesis sets out to illustrate the value in creating a living room design that follows the guidelines of ergonomics.

The word ergonomic was derived from the Greek word, ergon, meaning “work”, and nomos meaning “law or usage”. The literature suggests that the word “Ergonomics” was independently used in 1949 by a British Scientist, K.R.H. Murrell (Kroemer, 2003). During the past decade, research in ergonomics had led to heightened interest in the technology of work and furniture design based on biomechanics of the human body. These researches were focused on the development of new principles for the design of chairs and desks in the workplace (Parcells et al, 1999). Bridger (1995) and Chou and Hsiao (2005) believed anthropometry is a research area in ergonomics dealing with the measurement of human body dimensions and certain physical characteristics. Anthropometric data can be used in ergonomics to specify the physical dimensions of workspaces, workstations, and equipment as well as applied to product design. Presently, the importance of safety and ergonomic in the design and manufacture of consumer products had grown significantly. The latest technology had increased the option to broaden the ergonomic and safety features of certain consumer products.

However, it will also pose new risks which are more complicated to manage. Therefore, it is important for the product designer and manufacturer to use anthropometric data and ergonomic knowledge in making decision during designing of machines, equipment, products and systems (Mattila, 1996). Visual discomfort and musculoskeletal discomfort, particularly in the neck and shoulders, are occupational health concerns for people who work with computers (Bergqvist and Knave, 1994; Bergqvist et al, 1995; Hunting et al, 1981). In terms of ergonomics, comfort
integrates a sense of wellbeing with health and safety; conversely, discomfort could be related to biomechanical factors involving muscular and skeletal systems (Zhang et al, 1996). To apply ergonomics, we need to know about human capabilities and, of equal importance, what the person is trying to achieve.

1.2 Ergonomic in designing furniture.

The researches were focused on the development of new principles for the design of furniture in the living room space (Parcells et al, 1999). Ergonomically designed furniture resulted in a higher rating for features for example sofa height’ and ‘seating position’ (Troussier et al. 1999). In sitting, the lumbar lordosis tends to flatten and the pelvis rotates posteriorly. This kyphotic posture places increased stress on the posterior elements of the spine and raises intradiscal pressure (Keegan, 1953, Andersson, et al, 1974). Keegan (1953) described the process of sitting in great detail in his article entitled, “Alterations of the lumbar curve related to posture and seating”. According to Keegan (1953), as the lumbar lordosis flattens in sitting, the center of gravity of the upper body is moved anterior to the lumbar vertebral bodies. This creates a perpendicular distance and thus an external flexion moment about the low back. In order to balance this moment, increased tension must be created from the lumbar erector muscles along with support from passive structures, thus increasing the load on the spine. Andersson et al. (1975) found that intervertebral discs become anteriorly wedged in sitting, which places tensile pressures on the posterior aspect of the disc.

There are two other ways this load can be supported. First the pressure of the abdominal cavity can be used to support the spine. Second, if a fully slumped posture is adopted the erector muscles will turn off due to relaxation (Callaghan et al., 2001, O'Sullivan et al., 2006). In this position the passive elements of the posterior spine (ligaments) may be capable of supporting the trunk during sitting. In fact, this slumped or “kyphotic” low back posture is frequently adopted. In healthy, low back pain free
individuals, it can be maintained for some time without pain (De Carvalho., 2008). Mechanically favorable postures have been investigated. Supported arms and using a back rest tended to decrease intra-disc pressure because part of the load is transferred (Chaffin et al. 1999, Wilke et al. 1999).

The use of furniture probably started from the first day of human civilization. Even the primates make their beds and sitting arrangements on trees for maximum comfort and proper functioning. It is not known when the first furniture was made, who made it and what kind of furniture it was.

But it has been established that furniture was being used as far back as 3000 BC. Paintings, excavations from pyramids, sculptures, coins etc. gave us some idea of the kind of furniture we used in ancient times, and the kind of emphasis that was given to manufacturing and using it. From the diary of Roederner, written in 1801, it appeared that the furniture of that time was heavy, hard, ugly and uncomfortable and more emphasis was given to the decorative part of the furniture rather than to its functional aspect and comfort. In terms of ergonomics, comfort integrates a sense of wellbeing with health and safety; conversely, discomfort could be related to biomechanical factors involving muscular and skeletal systems (Zhang et al, 1996).

Currently, there are many examples of spaces that are not only designed to house residences as there body dimensions, but also to assist in increasing their comfort, safety and productivity in spaces where these residents in residential buildings in city choose to be active. These spaces are not only thoughtfully designed homes for aging, but they also exist as beautifully designed living room space and furniture like sofa and seating space.

To understand how to design living room space that includes aging residents in residential building, it is important to understand how living
room spaces, both those designed specifically for house residences and those for the public space, could assisting to furniture design. The science of ergonomics thus deals with the user, his usable product and the environment for maximum efficiency with the least cost involvement.

We often consider the monetary cost of a product, but rarely consider the physiological / psychological cost behind using a technically suspects, but wrongly designed product. Man has limitations, and there is a great deal of variation from man to man physically, physiologically and psychologically. A product to be used must fulfill the following criteria:

- The product must be safe.
- The product must allow for human limitations.
- Use of the product should follow the natural phenomenon of man
- The product should be easy to handle.
- The product must be reliable
- Low cost.

According to Calkins (1988), research studies considered the impact that elements of the micro-environment (e.g. acoustics, lighting, color, space layout, and scale) have on users’ lives. More attention was paid to the role of design in shaping the physical environment that also shapes the well-being of its users. This study and its subsequent conclusions are different from many similar studies that focus upon aging because the purpose of this inquiry is not to create living room environment that is solely suitable to the residents.

“Good design can have a therapeutic effect on the behavior and quality of life for residents with residential building users” (Hoglund and Ledewitz, 1999). According to previous experiences and a survey among the professional designers and engineers, not many of those professionals exactly knew how the anthropometric data could be used. Anthropometric data can be used in ergonomics to specify the physical dimensions of
living room space, workstations, and equipment as well as applied to living room space and furniture design. It is important for the furniture designer to use anthropometric data and ergonomic knowledge in making decision during designing of living room furniture, equipment, products and systems (Mattila, 1996). A fundamental issue in ergonomics is size. Humans come in a range of sizes. Not only are there those of us who are tall, short, thin or wide, there are those who have small hands, others with a long reach etc. When choosing equipment, the size range of that part of the person using the product needs to be assessed.

1.3 Anthropometric measurements and its relationship in ergonomics:

Anthropometry is the science of human measurement. Currently, there are many definitions of anthropometry but, one that is popularly accepted by all is; it is the science of human measurement. It includes the study of human dimensions, both of the parts and of the whole, including lengths, breadths, thickness, angles of motion, reach, grasp etc. as well as the capacity to exert force under varying postural conditions, in static and dynamic states according to age, sex. Static states are those measurements which are taken and considered while man is in static condition e.g. measurements related to chair design etc. Dynamic states are those measurements which are taken and considered while man is in motion or in dynamics conditions like measurements of different reaches, where the force is exerted by arms at different joints, angles etc. Biomechanics is a related areas concerned with the study of motion in living creatures, with particular respect to the forces acting on joints. Together the subjects provide essential data for the design for the man-machine interface.

Ergonomics is the science of the relationship between man and machinery and the equipment human beings use, and the working environment.
Ergonomic means that the item has been designed to maximize productivity by minimizing effort and discomfort. The diagrams describe the basic and average sizes (based on 90 percentile) of human beings performing various functions and movements. These are here as a tool for living room interior designers to aid working out how high or how far an average male or female may reach in relative comfort. These are factors that need to be considered when designing joinery or designing joinery, furniture, planning circulation spaces, work spaces, accessible spaces and to generally make the user comfortable in their interior environment.

Providing ergonomically appropriate furniture is an important part of the process. This does not necessarily mean all the old furniture should be thrown out and all new furniture purchased. Inexpensive ways to retrofit existing furniture have been identified (Parker, 1995). In fact providing fewer chairs and allowing more floor sitting during activities may have a beneficial effect for those in Western cultures. Ergonomic information that has been developed for adults and is being applied to children is based upon sitting in chairs (Gurr, et al., 1998).

Dramatically lower incidences of back pain have been found among native Indian jungle dwellers who customarily sit on the floor or squat: a reported zero incidence of back pain (Fahrni, 1975). There is a trend toward providing more carpeted areas for sitting areas and conducting activities while sitting on the floor. This trend should be encouraged.

Figure no1 and 2 depicts some of the anthropometric average data of male and female from 25 percentile to 97.5 percentile, these are here as a tool for interior designers to aid working out how high or how far an average male or female may reach in relative comfort, however it helps one to decide size and design of furniture for use of interior in relation to joinery and space planning for common living room standards.
Figure No.1: Anthropometric data standing adult male.
Figure No. 2: Anthropometric data - standing adult female.
1.4 Important point for designing space.

There is evidence in the literature stating that the design of care facilities can impact people’s behaviors and daily activities, and positive design can positively influence activity levels, social interaction, well-being, and lifestyle of elderly people (Bendar, 1977; Day, Carreon & Stump, 2000, Lawton, 1977; Carp, 1977; Moos & Lemke, 1980). Design of the physical environment is acknowledged as a supportive aspect in caring for elderly people particularly those impaired with Alzheimer’s disease (Day & Cohen, 2000; Lawton, 2001).

According to Lawton, design solutions should follow the characteristics of the proposed users. Such characteristics “are the starting point in the search for environmental features that will minimize unwanted behaviors and feelings, and maximize those that are desired” (Lawton, 2001). Client’s characteristics such as age, sex; preferences/likes/dislikes; needs/requirements; psychological/aesthetic/social/religious/personal development needs; anthropometry – measurements of body, height, maximum and minimum reach.

Task/work characteristics such as type of task; duration of task; infrastructure requirement; equipments/tools/furniture requirement. Space characteristics such as shape/size of the area; solar orientation; direction of the sun; wind direction; position of doors and windows; shape relationship with other indoor space; relationship with outdoor shape; architectural features/defects.

Each environment has a purpose which is to accommodate people and facilitate their daily activities. The environment could either facilitate or support people’s daily life activities such as dressing and eating. Regarding people with space, the environment they inhabit should support their life to the extent of independency (Calkins, 1988). This population, as stated by Lawton 1981, is a low-competent one; therefore, the physical environment should support their abilities to function properly in their life.
However, opportunities for various daily activities should be addressed in residential building for people with living room space. Residents should be challenged by their environments as much as they need to be supported (Regnier, 2003). Inactivity is one of the most crucial issues and enemies related to the well-being of a person with living room space (Lawton, 2001). Lawton suggested that providing space those promote types of possible activities to stimulate attention of the impaired people is the most crucial aspect of interior design. Furthermore, furniture and space layout could play a major role in stimulating impaired people to be more active. In such regard, enabling people with living room space to do furniture arrangement might be an effective way of increasing activity.

### 1.5 Justification of the study

Research justification refers to the rationale for the research, or the reason why the research is being conducted, including an explanation for the design and methods employed in the research. Traditionally in research conducted within any paradigm, researchers have been expected to provide an explanation about why the research is necessary. To explain the overall purpose, aims, and objectives, a rationale is constructed and may illustrate how the research endeavor addresses gaps in the existing knowledge base, contributes a new dimension or perspective, or generates theory about a phenomenon that has not been explored previously. Another aspect of research for which one might sometimes find justification in any description is the choice of methods employed to generate data; for example, the explanation for selecting interviews, focus groups, or participant observation (Given .Lisa 2008). A number of studies have been conducted in India and Abroad regarding the designing of the living room areas to increase the efficiency of the Interior Design. But there is not a single study carried out at Yemen pertaining to the designing of living room space and to increase their efficiency and to make the users of living room comfortable with the
improved design. Hence present study is planned to redesign living room space and furniture based on the concept of ergonomics which will teach them efficient use of equipment, furniture and living room space. The present study is just a step forward to the contribution in preservation of various aspects of interiors of residential buildings and identifying the style of construction and decorations used in the houses. With this background the present study was undertaken.

1.6 Purpose and Scope.

The purpose of developing these guidelines is to help develop the residential buildings in Hodaidah city zones with their special character and to redesign living room furniture and the living space for people who used the living room. However this study provides general guidance and outlines technical requirements that apply to living room in residential building related and furniture related ergonomic and interior design projects, new construction and renovation projects. The information provided through this living room in building will be used by interior designers, ergonomists and will serve as the guide line for minimum interior design requirements.

Excellence in design is the primary goal for all projects. Reaching this goal requires a commitment by the data collection and redesign living room ergonomically to a level of quality that includes the coordinated relationship of interior design with the space area design, as well as the details of design that affect the users of the facilities. Quality interior design is value addition to a project as it vitally improves facility operating efficiency, attractiveness, livability, life-cycle economics, and most importantly, the productivity of the users.

Home is the most important place in the world. After all, it’s the one space where one can live completely the way one wants; 24 hours a day, 7 days a week. The living room is generally seen as an important place to use.
Compared to other rooms, there are relatively few serious accidents in room (Kumar, 2006). The hazards one faces are different.

The major health risks in this room do not arise from immediate, potentially fatal hazards. Instead, the risks that user face comes from more subtle hazards whose effect accumulates over time. Research shows that furniture operators face a substantially higher risk of muscle pain and injury than user in other room. Studies also show that the frequency of persistent neck and shoulder injuries increases with years of user. One report found that furniture operators experience as many cases of repetitive strain injuries as important place in house.

These injuries lead to long-term health effects. This is why researcher wanted to look at the working conditions that can lead to such high rates of disability for living room user. That’s why the researcher has packed the study with lots of ideas on how one can make space more flexible, comfortable and functional to make space more meaningful .Research has consistently found that the physical characteristics of the work are an important risk factor for muscle pain and injury. The risks of poor living room design, furniture, organizational factors, repetition, force, posture and vibration are associated with higher rates of injury. But one can’t look at the living room area alone to understand these injuries.

Few studies, however, have investigated physical and organizational risk factors at the same time in more than one living room space and most studies have focused only on furniture arrangement, (Gunning 2001). The purpose of this study was to document and describe the current work conditions throughout the living room. Residential interior space designing is a creative art which can transform an ordinary house into a very happy lively home. The purpose of interior designing is to make the home livable according to the needs and requirement of the family and the space characteristics.
The interior designing should be able to satisfy the functionalism, expressiveness and beauty. It is not the decorating of the house. But it is the total designing of the house. It gives scope that the designing should be such that it should be able to express the personality, aesthetic taste of the family living in, through proper designing of the space, proper selection of furniture pieces, accessories and furnishing.

The primary research question guiding this study and the subsequent design solution is: What is an appropriate design solution for living room space that is conducive to residents in residential building at Hodaidah city who use living room space.

To answer this primary question, the researcher will also seek to answer the following questions:

1) How can design elements of ergonomics and ergonomic comfort integrates to create living room space that is conducive to residents in residential building at Hodaidah city? What is an appropriate balance of furniture arrangement and living room spaces needed for house residences?

2) How can living room spaces be designed for house residences to arrange furniture in living room space?

3) What other features should be included in the living room design to make the workplace more comfortable to residents in residential building at Hodaidah city.

**1.7 Research aims.**

**1.7.1 Objectives:**

The study aimed at design responsibility of living room in the residential buildings in Hodaidah city according to the requirements of the users or the people who would be living in them.
However design aims to facilitate the fulfillment of special needs and life objectives of users into their environments. In fact, “good design directly impacts the quality of life” (Brawley, 2001). With this objective the present study was set as follows:

**a) General Objective:**

The primary goal of this study is to develop criteria for designing living room space that accommodates aging house residents and to redesign living room that is shared by them, considering their measurement of human body dimensions. Based on environment and Ergonomic Investigation in the Interior Design of living room in the residential buildings of Hodaidah city, based upon research, observations and interviews of residents in residential building at Hodaidah city improvements would be planned and suggestions to the occupants would be given for safe living.

**b) Specific Objectives:**

The aims of the present study were as follows:

1) To study the anthropometric measurements of residents of Hodaidah city.
2) To Study existing living room Interior Design of selected residential buildings in Hodaidah city.
3) To identify issues and problems associated with space and furniture activities.
4) To use assessment information in order to redesign living room furniture for people how used the living room.
5) To ascertain physiological and subjective feeling (using Borg scale) of the residents in living room using a conventional design and suggest newly designed furniture and interior space design which is ergonomically suitable to the residents.
6) To create a prototype of living room space that is well designed and allows residents in residential building at Hodaidah city who used the living room space to enhance ergonomics comfort.
1.7.2 Limitations of the study

In this study, only living room in residential building at Hodaidah city and the residents participated in the research and data collection. This study mainly focuses on the physiological and perceived exertion of the Hodaidah city population. The postural angles were not measured using Goniometry due to unavailability of the equipment. Since the research was conducted within sample in the Hodaidah city, it is possible that external situations prevalent in other geographical areas may produce different findings from those presented.

The anthropometric data base created for the study and the new living room design developed would be applicable to population of the Hodaidah city only.

Delimitations of the study

1. The study was limited to the population of the Hodaidah city.
2. The study was limited to only living room interior re designing of the selected population.
3. The study was limited to ten selected house hold of Hodaidah city for redesigning the selected households.