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The Language of Living: Furniture for the Twenty First Century - A Workstation for the Home Office and Small Living Space

By

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A Master's Degree Project
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In partial Fulfillment of requirements for the Degree of
Master of Environmental Design (Industrial Design)

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The Language of Living: Furniture for the 21st Century User- A Workstation for the Home Office and Small Living Space

ABSTRACT

This Master's Degree Project details a workstation design for the home office or small living space. The aim of the project is to provide a design response to the lifestyle needs of the home office and small space occupant. The design attempts to provide a means of maximizing space, optimizing the mental well-being of the occupant by achieving a perceived separation of activity or space through a transitional design, attaining a sense of professionalism while preserving privacy, and leaving work in progress increasing user productivity. The design considers aesthetics, function, ease of use, assembly, repair, maintenance, safety, materials and manufacturing issues, human interaction and human factors, as well as cost.

The document is composed of three main parts: Background (research and theory), Design Process (design evolution), and Final Design (prototype). The *Background* describes the problem, provides an exploration of furniture, explains the home office/small living space explosion, details the problems experienced by the occupants of these environments and defines the design objectives. *The Design Process* illustrates the transition from theory to design, detailing the evolution of the workstation. This part explains how the project's objectives are molded into a functional design. As well in this section a discussion of different ways of considering space is presented. *The Final Design* describes the end user and recommended computer equipment, provides a product description, details the workstation's function and use, supplies ergonomic guidelines for the purchase of a readily available chair, details material usage and manufacturing processes, and a final summary of the project with further recommendations.

The workstation is a transitional design composed of; a full sized large (drafting) table and computer table, storage area and body in which all components fit in a mere 0.41 square meter (4.44 square feet) of floor space, when not in use. The workstation when closed appears as a cabinet, wall or divider, unobtrusive to the activities and function of the room. Upon opening, the design transforms the room creating a fully functional and comparable office environment.

Keywords: Workstation, Furniture, Industrial Design.

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Furniture for the Twenty First Century User- A Workstation for the Home Office and Small Living Space

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Part One – Background

Section One: Introduction

"It is time to design friendly objects, at the service of humanity, and which don't take up all the room. The notion of beautiful must be replaced with that of good."

- Philip Stark, in Azure 1994, p.19

Furniture is not essential to human existence. Nomadic cultures illustrate people can exist without it. However, furniture and its use reflect a sense of culture and society. For example, an individual using a specific chair for a particular function demonstrates a new behavioral norm for that environment (Lucie-Smith, 1979).

In North American society, individuals are so accustomed to the furniture surrounding them that they fail to process its detail; therefore, furniture forms are overlooked. Dormer (1990) captures this notion in The Meaning of Modern Design: "It is easily forgotten how far industrial design has succeeded in making things work well and how far technological culture has come, in taking the pain out of physical and mental drudgery " (p. 87). Throughout history the furniture maker has carefully designed products to make a difference in the consumer's quality of life. These individuals design furniture with distinctive characteristics to reflect the setting and consumer needs of the particular society.

Furniture design has always been prevalent in the Industrial Design field. An industrial designer studies societal needs and adapts furniture designs to meet these needs. With the amount of furniture already in existence why cannot the needs of the consumer be satisfied? How many different variations of a chair does a society require? A society's dynamic demands and needs dictate this quantity.

"Indeed they [furniture] are very precise barometers for they react rapidly and sensitively to social change otherwise almost imperceptible. Furniture and the rooms it is used in are so much a part of their owner that they indicate their social position and relationship to others in a very direct way."

K.Mang, 1979, p. 16

Inquiry within furniture design encompasses related Industrial Design issues and principles: analysis of societal needs and demands, assessment of user needs in conjunction with societal effects, and then implementation of design. This project will explore the relationships between the consumer, furniture and society via the fast -developing, expanding area of the home office and limited living space. Steelcase's and Herman Miller's establishment of their own home office furniture lines; various publications dedicated to the home office concept, such as 'Working at Home' and 'Home Office;' and the prevalence of home office features in popular media, such as 'Venture,' 'Style at Home,' and 'Canadian Select Homes' highlight current interest in the home office.

Interest

In a recent Calgary Herald article, Annabelle King (1998) writes "working at home is one of the fastest growing trends in North America " (p. K1). It is estimated that nearly two million Canadians work from the home (King, 1998). Statistics Canada reported that 153,615 citizens in Alberta work from the home in 1996 (Statistics Canada, 1998). In 1994, Leslie Roberts reported in her master's thesis that 35,000 individuals in Calgary work from the home (Crawford, 1998). Further academic interest is found in Venini's thesis (1987) *The Prospects for Home-Based work in Canada*, which examines the prospects of the home office and its characteristics. Also, Mackette-Stout's thesis (1987) *An Architectural Response to Changing Family Structures* assesses and develops an architectural structure for working at home.

Given the above pronounced interest, the home office environment warrants further investigation from the industrial designer's point of view.

Statement of Problem

Walker (King, 1996) criticizes the lack of foresight in the design of the home office: "Offices used to be crammed in a corner of a basement where you went once a year to do your income tax but now they're used every day " (p. K1). This again supports that the home office must adapt to meet the needs of the consumer. Working out of the home can be both a pleasurable and exhaustive experience. Within the confines of an ill-suited space, especially dealing with inadequate furniture, residing and working out of the home becomes futile. The sensation that the work is never-ending and the work environment is ever-present poses a difficult challenge to the designer. When there is virtually no sense of a mental and spatial distinction between home and work environment, common results are dread of the home and resistance to work.

Objectives

The objectives, stated simply, are three-fold:

(1) To demonstrate a design response to the lifestyle needs of the workplace residence.
(2) Maximize the mental well-being of the workplace resident.
(3) Provide opportunity to use the optimal space of the workplace residence.

Methodology and Document Presentation

The major research for this project is an academic and popular literature review. Reference materials include current articles and periodicals, texts, internet searches,

academic papers, and product literature. Furthermore, current and local interest research is surveyed as a special focus. Lastly, contemplation of personal experience and informal consultations with family, friends and colleagues about the home office, facilitate the process of design.

Part one of this document comprises the research component of this project. Chapter one, *Background,* illustrates the interest in the project area, objectives, methodologies, document organization, limitations and scope. Chapter Two, *The Evolution of Furniture,* gives a historical overview of furniture investigating how furniture and society are linked. Chapter Three, *Evidence of Working at Home,* illustrates the present day context, showing factors that propel and stimulate this trend. Chapter Four, *Development of Design Criteria, Assessment of Contemporary Home Office* examines key issues occurring in the present day working homes. Part One establishes the criteria for the design.

Part Two is the design process section of this project. Chapter One, *Space,* examines various concepts of space, such as flexible and adaptable. Chapter Two, *Design Process*, explains procedures, experimentation and follow-up in the design process. And it discusses initial ideas and concepts. Part Three, *Final Design*, details a workstation design, discussing its relevancy and usage. Guidelines for a readily available chair and materials and manufacturing processes are also discussed here. The final product is a working model with technical drawings. This section concludes with a project summary and further recommendations.

Limitations and Scope

The proposed design attempts to suggest possible directions for making working at home a viable and pleasant experience. This design addresses the potential frustration and stresses that coincide with the lack of separateness between the home and office. It is not the intention of this project, the desk's design, to identify and

solve all potential problems with working at home. For example, the home office user can obviously be at risk to isolation; however, the complexity of this issue is not as simple as the identification of the problem. There are several potential factors contributing to isolation, such as the nature of the work, personality traits and the person's values. Such issues are discussed in this project only in terms of how they apply specifically to the desk's effectiveness. A minimal discussion of ergonomic guidelines for a ready-made chair is included in this document. Finally, units in this document are provided in both imperial and metric systems, as materials for the prototype are purchased in the imperial system and some construction techniques use it as well. The metric system is also provided as this MDP is formally a SI unit document.

Section Two: The Evolution of Furniture

Introduction

" Furniture, particularly the pieces we choose for our homes, and grow up with, expresses complex meanings. The home is the most private of inhabited spaces- the focus for many of the psychological and social dramas we enact- and the pieces of furniture within it carry the full burden of that symbolic load. To tell the story of ordinary domestic furniture in any period is not, therefore, a simple task."

Sparke, 1986, p. 5.

Furniture takes on any form, size, shape and color. The variation of these characteristics illustrate that furniture design is a continual process of trying to meet the needs of each society and the individual user. Insight into what affects these characteristics is cause for exploration. A historical overview is presented illustrating domestic furniture and its relationship with each society and culture.

Historical Overview -The Nature of Domestic Living

"I had three chairs in my house, one for solitude, two for friendship, three for society."

Henry David Thoreau, Walden

Throughout history, many factors influenced man's domestic environment: social, cultural, political, psychological, economical, technological and symbolic. These factors influenced the appearance, function and acceptance of furniture styles throughout the centuries. What was considered basic needs changed drastically throughout the centuries and therefore demanded different requirements of furniture. Furnishings reflected the state of mind and priorities of a society. Reeves (1969) reflects this idea stating: " Furniture, in addition to telling openly that we have

permanent residence in our living-places, tells about the kind of life that goes on in them " (p. 23).

The Fifteenth Century

Being a 20th century individual it is hard to imagine living the domestic 'life' of the latter part of the fifteenth century. The scarcity of furnishings in this century's domestic environment revealed the nature of the times. A variety of furniture did not suit this period, because mobility and safety were prime issues at all social levels. (Reeves, 1969) In today's first world nations, this threat is not eminent as reflected in mass possessions.

Homes of the 15th century were cold, damp, dark and meagerly furnished. No homes, even those of the wealthy, possessed separate rooms. Harrison (1971) adds "everyone lives, eats, and sleeps in the same room, [even visitors] " (p. 12).(figure 1)

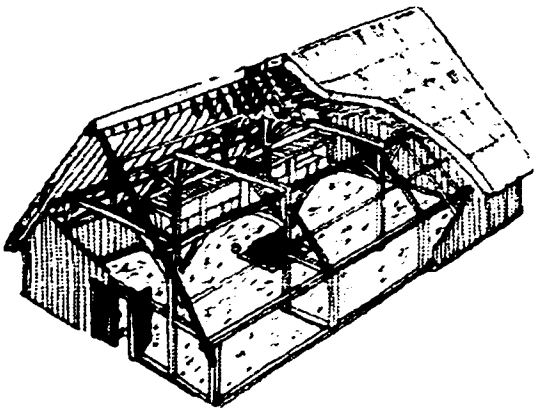


figure 1: 15th Century Living.
(Medieval Home, Oates, 1981.)

Privacy was nonexistent as much of the furniture of the medieval home was built into the structure itself. Furniture form changed later in this century. (Oates, 1981) Spaces for a kitchen, pantry and bedrooms evolved and freestanding furniture began to appear.

Social and symbolic influences on furniture design could also be observed here, as some designs were not solely based on the practical. For example, in the 15th century your social status dictated the type of seating you used. Lucie -Smith (1979) illustrates this hierarchy; the everyday commoner's seat was a bench attached to the wall at random; while the lord of a small estate had his own fixed bench located at the end of the hall, a step up from his guests. In the richer homes the master had an elegant armchair, which by the end of the fifteenth century, was not fixed to the wall. (figure 2)

figure 2: Social status influences furniture.

(Sloth detail from Table top of the seven deadly sins and The four last things. Lucie-Smith, 1990.)

Furthermore, the chair's comfortability indicated the individual's rank: the less comfort the higher the rank. Reeves (1969) discusses the effect of rank. The master's armchair was designed so that the individual sat straight up, a symbol of his power. It is interesting to note how the offering of a stool, rather than a chair, challenged the status of the individual. Chairs were reserved for honored and high-ranking guests. And even in the 20th century some remnants of power lie with the notion of the chair as a status symbol (Lucie-Smith 1979, Harrison 1971). For example the chairperson is offered the 'chair' to conduct an important meeting. Thus, furniture continues to reflect social status. (figure 3)

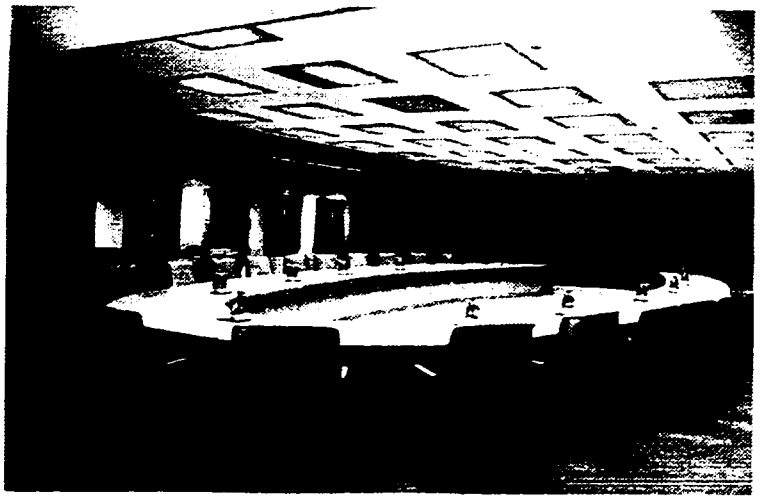


figure 3: Offering of the 'Chair'.

(The Boardroom with Horseshoe table, Pile, 1990.)

Examining available technology explains the physical appearance of furniture of this century. Lucie-Smith (1979) indicates that aesthetics played a distinctively minor role. Changes in furniture design were rare, due to limited materials, simple tools and laborious hand manufacturing techniques (Reeves, 1969). (figure 4)

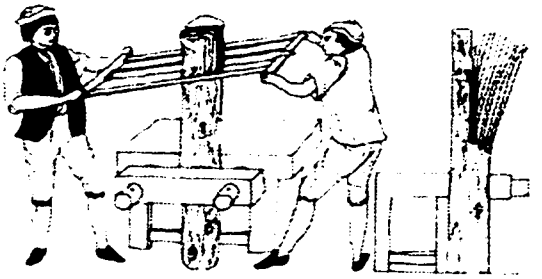


figure 4: Materials, tools and manufacturing capabilities affect furniture.

(Sawing Veneer by Hand, Oates ,1981.)

Furniture of the 15th century lasted many generations, and was passed on as heirlooms.

The Sixteenth Century

With the 16th century came change in social and economic conditions for society. These changes affected people's perceptions of themselves (Kron, 1983). For instance, in the last century your social status was defined at birth. However, in the 16th century it was not predetermined that you would be as poor as your parents. The New World allowed for the possibility of wealth. Reeves (1969) adds: "new ambitions were forming, and there was an increased self-confidence in people " (pp. 131-132). Harrison (1971) and Lucie-Smith (1979) concur that old ideas were rejected more readily, as communication via the printing press, helped new ideas spread. The individual did not feel as isolated as in the previous century and neighbors could now begin to affect him or her. Reeves (1969) adds: " life became less disturbed than it had been during the Middle Ages. ..., a more stable domestic life was possible " (p. 135).

Firstly, there was a crucial change in the building of the home itself. Homes were built to accommodate visitors, unlike in the previous century. Oates (1981) observes this adding, "chairs became more numerous as life became more social and intimate" (p. 57). Although most homes were still wooden, brick homes began to emerge, and these homes were grand in design. However some dwellings remained the same, due to material availability and local conditions. The individual's surroundings still partially dictated one's wants and desires (Harrison, 1971).

Prior to this century, furniture played a secondary role in most rooms (Oates, 1981). It was pushed to the side or placed directly against the wall providing for lots of space. In the 16th century, this changed. The bed, observed Harrison (1971), was no longer pushed against the wall, rather became a predominate feature of the bedroom. (figure 5)

figure 5: Furniture becomes a feature in the room.
(16th century oak furniture, Lucie-Smith, 1979.)

Thus, furniture evolved to become a focal point in the 16th century home. Reeves (1969) adds, "a piece of furniture [in this century] is designed for some particular purpose, that is, to serve some habitual performance, such as eating " (p. 27).

Harrison (1971) recognizes that changes in technology influenced furniture design. For example; as brick, stone and plaster became more commonly used for walls, there was less danger of fires; fireplaces gradually replaced the traditional open hearth. This fireplace contained a chimney for the removal of smoke, where previously it simply drifted into the rooms. Consequently, indoor air became much cleaner. This change in the home directly affected furniture styles; it became fashionable for furniture to remain in its natural finish, waxed or polished, rather than heavily painted as before (Lucie-Smith, 1979). In the former century, paint had its distinctive purpose: to hide the heavy smoke residue and act as a preservation technique. However, the natural appearance of the 16th century broadened the variety of wood materials used for furniture.

Furthermore in the 16th century table design reflected a major change in furniture's adaptability (Harrison, 1971). Long one-piece tables were used only in grand houses and dining halls. In most homes tables needed to be adaptable. The concept of extending tables stemmed from this dual need. Drop-leaf tables with single or double hinged leaves, supported by folding arms or hung gate legs, were also created at this time. (figure 6)

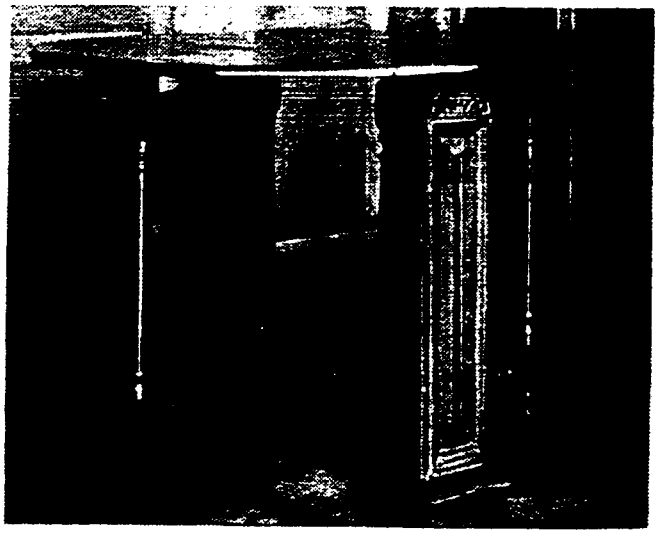


figure 6: Furniture needs to be adaptable.
(Early Stuart gate-legged table. Reeves, 1969.)

Thus, 16th century furniture demonstrated the designer considering societal needs and design modifications.

Also tied to technology was the physical appearance of 16th century furniture. The typical 16th century chair for example, was in essence a box with a solid back and arms; the design of which reflected the qualities of the wood (Lucie-Smith, 1979). (figure 7)

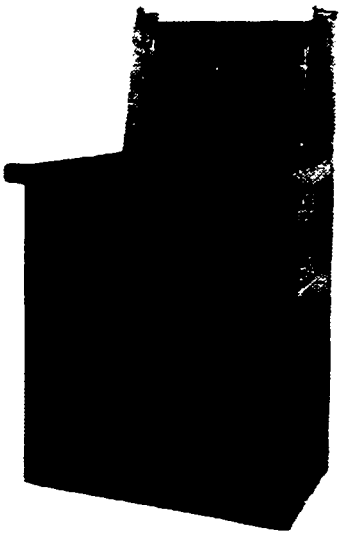


figure 7: 16th century armchair.
(English Oak Armchair. Lucie-Smith, 1990.)

All early oak furniture was basically rectangular due to the nature of how the wood split. Although the wood was strong, it was also very heavy and rigid.

Finally, changes in culture result in new development of furniture designs. Harrison (1971) illustrates this point in the development of the chest-with-drawers. (figure 8)

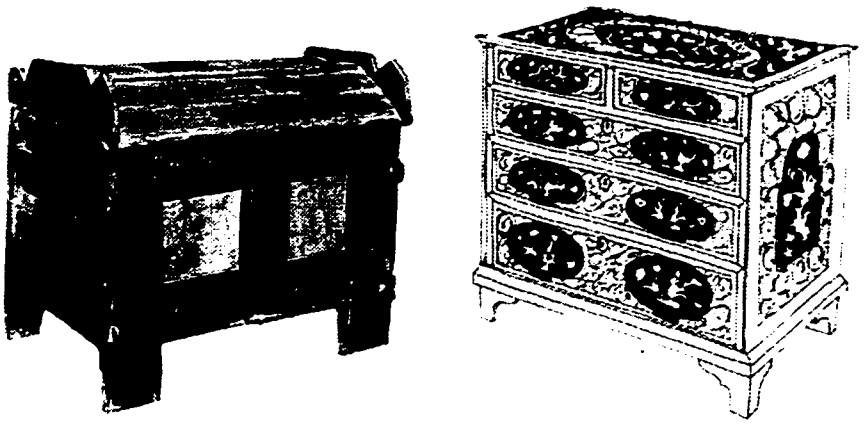


figure 8: Chest and chest-with-drawers.
(Chest, Harrison, 1971, and chest of drawers. Oates, 1981.)

Before the 16th century the only safe way to keep things private was to lock them in chests. As religious and political affairs became more stable, society perceived the home as being more secure and desired more furniture for private use. The importance of the chest declined as people demanded more convenient and tidy means of storing their valuables. Joiners introduced small boxes for use in these chests, which allowed the owner to separate his/her belongings. Although a step in the right direction, the owner still had to take out all the boxes if he/she needed something from the bottom. Oates (1981) concurs, stating "- to reach something at the bottom the entire contents had to be disturbed or taken out " (p. 97). Towards the end of the century a more efficient solution surfaced. The front panel of the chest was removed and the internal boxes were drawn out from specially made groves. Knobs on the front of each box facilitated this process and in time these objects became known as the contemporary chest of drawers.

The Seventeenth Century

The 17th century, known as the intellectual century, was considered a time of lavish living. Substantial wealth was spent on homes. Further, the establishment of new colonies increased wealth and power for the middle class and noblemen (Harrison, 1971). Corollary, societal development was seen in new furniture design of this century. For example, until the middle of the 17th century there was little writing done at home and the home did not need furniture designed for this activity (Harrison, 1971). This would soon change. Development and trade offered better employment to men who were literate, and many merchants found it necessary to have a furniture piece in the home particularly designed to facilitate writing needs. Specialty furniture types developed, notes Lucie – Smith (1979), as desks with drawers for letters and documents emerged. By the end of this century, bureaus with several drawers and a sloping desktop for writing, were fashionable. (figure 9)

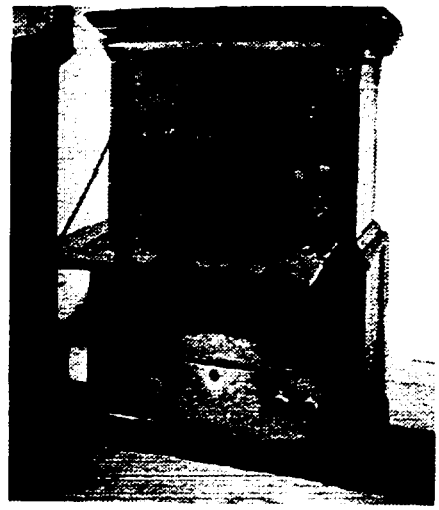


figure 9: Furniture developed for writing.
(English Scrutorie or scriptoire. Gloag, 1966.)

Gloag (1966) also notes the development of the scrutoire or scriptoire, in this century as the ruling classes literacy improved. He (Gloag, 1966) states: " the widening of their civilized interests led to the expansion of libraries, and to improvements in the design of writing desks and cabinets " (p. 113).

Moreover, societal and cultural effects on furniture design can be seen in the development of specialized "ladies" desks. During this century the desire to write also flourished in the female populous, as Aronson (1946) states "an epidemic of letter writing and memoirs raged [during this period]... [making] the [ladies]desks essential in every room." (p. 52) These pieces, varied in appearance, were composed of a tabletop with a small-enclosed top section covered by lids, doors, cylinders or tambours that rolled back. The cylinder variation became an important precursor of the 19th century roll top, "Calton" desk and numerous other table forms in existence in the 20th century.

Pull-out slides for supporting candlesticks also began to appear. This design feature corresponded with the illumination technology of the time. Bureau-bookcases required one or two of these slides to give ample lighting to the writing area. The

bureau doors were often fitted with mirrors to reflect the light of the candle. Today, seeing these unusual contraptions on antique desks are logical, considering their past.

Furthermore, the battle between dignity and comfort continued in the seventeenth century, with dignity losing. Harrison (1971) noted the idea to pad seating occurred in this century, as men's padded under garments went out of fashion. Padding appeared in furniture design to replace this lost comfort. Some extreme designs even had chair legs covered. (figure 10)

figure 10: Seating acquires padding.
(Upholstered X-chair, Harrison, 1971, and Upholstered settee, Lucie-Smith, 1979.)

At this time an important development, basic ergonomics, appeared in chair design. Arms were curved and sloped downward; seats were lowered and more comfortable, and the short straight back gave way to a longer shaped chair. The 17th century chair continued to echo the needs and wants of that society.

Comfort in this century was also expressed in the lax of stringent furniture placement. Lucie- Smith (1979) records furniture becoming more mobile in this century, as rooms became flexible in their function. Light furniture, such as small chairs and tables became common and moved freely about, although servants still replaced this furniture to its 'rightful' position at the end of the evening. Again furniture reflected the society's changing needs.

The Eighteenth Century

In the 18th century the middle class continued to rise in power and prestige (Oates, 1981). This class became particularly important in the world and asserted itself in politics. Long-standing barriers with hereditary landowners rapidly disappeared. This century became known for its tolerance of change.

The wealthy 18th century man of taste, dwelled in surroundings unsurpassed for elegance and fine craftsmanship. Room dimensions were based on the cube and the double cube, and architects decided the sizes of doorways, windows and fireplaces using math formulas. Libraries, music rooms, studies and drawing rooms replaced the long galleries of former times, and the great halls were used for concerts and grand social occasions rather than living rooms (Harrison, 1971). However these houses were uncomfortable to live in because of their enormity; " it was said that a man needed to put his hat on to go from room to room "(Harrison, 1971, p. 74). (figure 11)

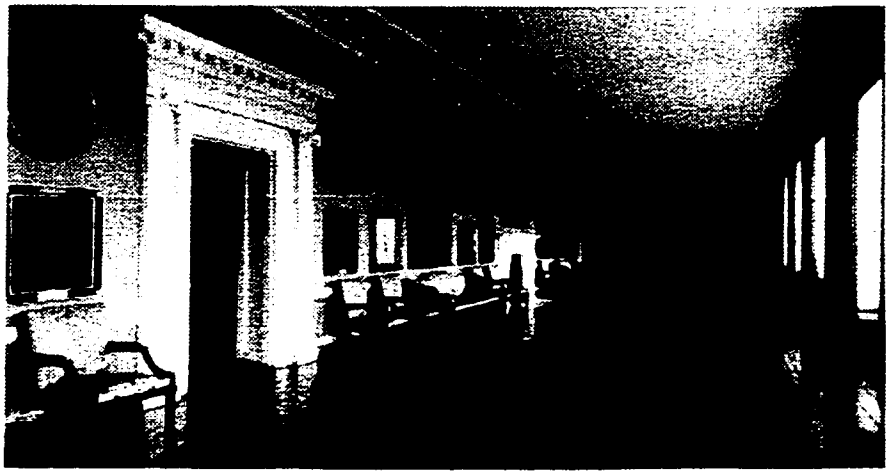


figure 11: Houses were enormous and hard to live in.
(18th century furniture arrangement, Lucie-Smith, 1979.)

In this century social activities influenced the type of furniture contained in the home, as illustrated by Reeves's (1969) and Harrison's (1971) discussion of the influence of tea. Tea drinking caused a cultural revolution and demanded new types of furniture. Originally, this activity occurred in public tea gardens, but was moved to the home when these gardens became overcrowded and unruly. For this special occasion, designers constructed small china tables that were commonly hinged so they could stand against the wall when not being used, with a specially designed edge to protect the fragile china. Reeves (1969) also noted this development, as small tables for coffee, chocolate and tea appeared. Thus, furniture modifications coincided with changes in social events of the time. (figure 12)

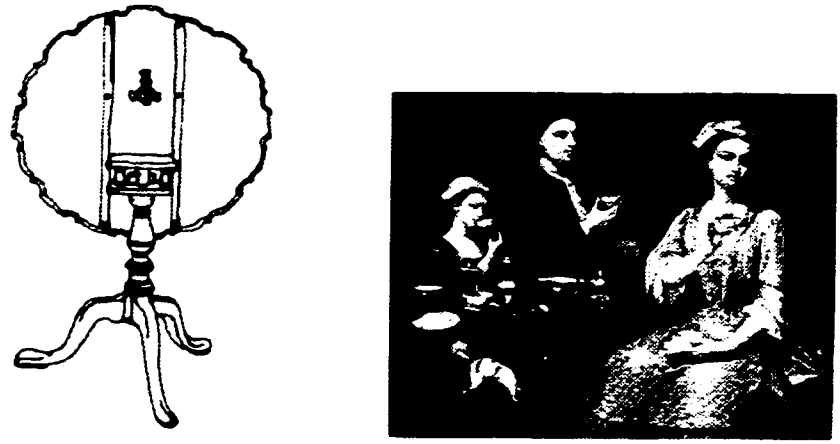


figure 12: Tea and tea table.

(Tea table, Oates, 1981, and taking tea, Harrison, 1971.)

It seems odd that our ancestors needed a piece of furniture at which they both could dress and complete business activities. The contemporary perception is that people dress in their bedrooms and write in studies or offices. But in the 18th century it was very common for the master to have a bureau located in his dressing room, so that he could write a note, sign a paper, or discuss an account, while still tending his wig or powdering his face (Harrison, 1917 Lucie-Smith, 1979). (figure 13)

figure 13: The bureau -to dress and write in the same room.
(Bureau, Lucie-Smith, 1979.)

Dressing in itself during the 18th century was so time consuming that the master would never complete his business activities without combining his activities in one location. Thus, customized furniture, the bureau, met individual needs.

Gloag (1966) concurs, adding that dressing desk tables and toilet writing tables were the norm in society and both sexes conducted their 'businesses' often from the dressing room. He (Gloag, 1966) states:

> In bedrooms by far the most important article was the toilet table.... [Prolonged] preparations for displaying youthful beauty or disguising age, were conducted with urbane publicity, for friends of both sexes were admitted to the spectacle, so the main business of the day, the exchange of gossip and court scandal, could begin early (p. 131).

The master and mistress enjoyed an abundance of leisure time, which they mainly occupied by letter writing. Salomonsky (1953) states: "writing became in the 18th century a familiar accomplishment" (p. 79). The cabinetmakers provided for this favored activity in every facility. Writing tables were combined not only with toiletry or dressing activities, but also with fire screens to keep the individual's toes warm as

they wrote. By the end of the century cabinetmakers continually refined the form and increased the convenience of the writing desk. "Any small table could be transformed into a writing desk with an inkstand or a standish. No room [] was fully furnished unless facilities for writing were provided"(Gloag, 1966, p. 148).

The elaborate and highly specialized tables of this century illustrate how furniture was adapted to meet changing desires of a society. The secretary or secretarie became popular with particular attention paid to its' interior influenced by the writing craze of the century. Numerous variations of this desk were produced some with fall fronts, others with drawers or tambour doors. Classical and architectural influences permeated most variations of this desk with the top portion of the design usually possessing cornices or fanciful forms. Aronson (1946) concurs, adding: "the late 18th century types [] are superb architectural compositions" (p. 371). Biedermeier secretaries for example, carried this further, sometimes possessing up to three architectural facades, as well as columns, cornices and pediments. These influences illustrates the growing middle classes' desire to display their new found power and prestige.

Functional influences immerge in desk design, as the 18th century user demands more choices. The knee hole desk, its name derived from the cutting away of the central portion, became a favorite, as it allowed the user to sit snugly and comfortably at the desk to write or dress. Some knee desks had upper portions like a scrutorie, while others evolved into a library desk type, with only a working surface and lower drawers. The tambour desk also became prevalent, it's sideways moving doors provided the user both a decorative and different means of concealing pigeon hole compartments and other smaller private drawers. The Happlewhite tambour desk was such an example (Salomonsky, 1953). The rolltop desk appeared in this century, as fall fronts could be replaced with a rotating cylinder. A flat writing surface was exposed when the cylinder was opened and some could be drawn forward to provide even more surface for the active users (Aronson, 1965). Usage

and popularity of the rolltop desk continued into the 19th century, and is still a prevalent design in the 20th century.

The tremendous variety of tables made during this century illustrates how much the growing middle class desires and their new power affected furniture design. The Chippendale's Directory for example showed how varied life became for those who could afford it (Harrison, 1971, Reeves, 1969, Oates, 1981). This age of wealth resulted in increased accumulation of possessions, and these possessions required elaborate and prestigious displays. "Now the wealthy [] bourgeoisie as well as the Court were prepared to pay exorbitant prices for fine pieces of furniture" (Oates, 1981, p. 112). People began using various pieces of furniture to store and exhibit their possessions, resulting in the invention of the first built in storage units, as well as many forms of the escritoire which proudly presented their accumulated treasures and antique collections (Gloag, 1966).

Around 1720 a government act abolished the heavy duty on imported timber, and cabinetmakers took advantage of this opportunity to launch a new fashion (Oates, 1981). Harrison (1971) stated mahogany became popular, possessing great strength, good resistance to worms; and a variety of colour. As well, it could be cut into wide boards. These new dimensions influenced the breadth of tabletops, cabinet doors and bookshelves and contributed to the broad proportions of mid 18th century furniture. Interestingly, politics played a role in furniture design.

The Nineteenth Century

"A period of rapid social and technological change," spawned the industrial revolution for which this century is best known (Oates, 1981, p. 155). Availability of iron and steel, the development of the steam engine and advancements in industrial production, brought about accelerated change. (figure 14)

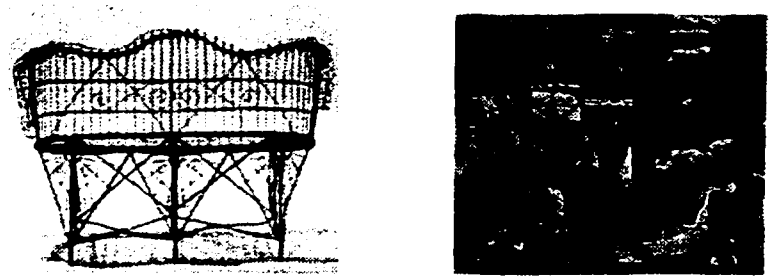


figure 14: Accelerated change due to technology, science and social alteration.
(Garden Settee, Hanks,1981, Steam, Ferebee, 1970)

Rail, post, newspapers and electric telegraphs joined societies. Unparalleled industrial and commercial development occurred (Harrison, 1971). Reeves (1969) and Ferebee (1970) note objects of all sorts could be made cheaply and in vast quantities. And "with the introduction of machine methods into furniture making a different attitude begins to manifest" (Reeves, 1969, p.172). The consumer was eager to acquire new products.

The desire of the average man to own as much furniture as royalty could now be satisfied, as craftsmen began to be replaced by the factory (Sparke, 1986). Technological advancements led to the introduction of springs in upholstery and mattresses, the use of iron and brass tubing for bed frames and clever mechanical devices for reclining chairs (Ferebee, 1970, Mang, 1979). (figure 15)

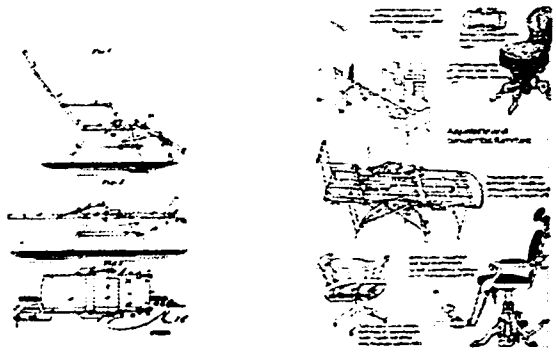


figure 15: Technological advancements.
(Sheldon's Invalid chair, Hanks, 1981, Adjustable and Convertible furniture, Oates, 1981)

"The inventor had his field day in the 19th century" states Aronson (1965) as thousands of patents were granted for mechanical furniture. (p.340) Everything from folding piano beds to trick chairs, desks, dressers and therapeutic devices sprang forth. The reasoning behind many inventions usually focused on portability, attaining comfort, providing multifunctional purposes, or experimenting with new material or manufacturing capabilities. Camp or campaign furniture for example, was one of the major contributors to the portability craze as the desire for transportable, low cost furniture was high in demand. This craze extended into the 20th century as the "need for light, inexpensive, yet durable and sturdy portable forms grew" (Hanks, 1981, p. 147). Various folding chairs, beds and tables, crowded the patent office and forms like the director and sling chair are still in use today.

In terms of comfort, furniture of this century provided this as never before possible. Hanks (1981) reports: "it was in the 19th century, that comfort became a key constituent of furniture forms " (p.121). Manufacturers could easily produce a variety of designs. In seating for example, coiled springs were patented in 1828 and their use altered the comfort of seating (Harrison, 1971). Since springs needed depth, the seat was thicker and arm thickness was increased to balance the design. Now a person sat within a chair, rather than on it. (figure 16)

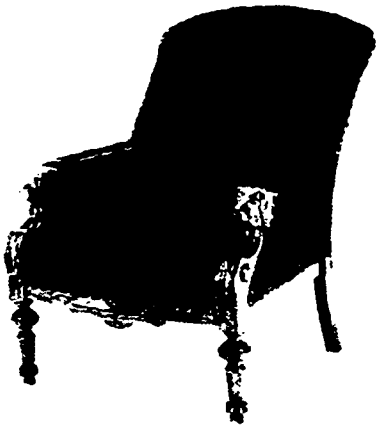


figure 16: Springs in chairs.
(Dog head student chair, Darling 1984)

Reeves (1969) adds: "private happiness throughout the whole 19th century meant chiefly physical comfort, and the furniture showed this " (p. 152).

As comfort indicated happiness, every class desired this. Unlike their wealthy neighbors the intermediate class had neither the space nor the means to satisfy their growing desire for comfort, yet demanded an alternative solution from furniture builders and inventors. Hanks (1981) reports: "the intermediate class wished, without overcrowding, to bring a modicum of comfort into a minimum of space "(p.168). The solution came in the appearance and abundance of convertible furniture forms that flourished throughout the century and into the next. Many forms were simple combinations, sofas that became beds, or tables that could be used in a variety of ways. Other more eccentric combinations, like the bedroom piano, also prospered for a time, but rarely survived into the next century. More practical forms like the Windsor writing armchair- seen as the forefather of the modern school desk, and the Wooton cabinet office secretary and rotary desk- seen as directing the future design of compact office equipment, were so influential and formable, that they influenced designs into the next century. (Hanks, 1981)

Furniture location also reflected social change in this century. Oates (1981) notes the movement and predominance of furniture to the center of the room. This informal arrangement was very different from the last two century's 'backs to the wall' groupings and spurred the design of new and exotic furniture pieces, such as the back-to back seat and the Ottomane. (figure 17)

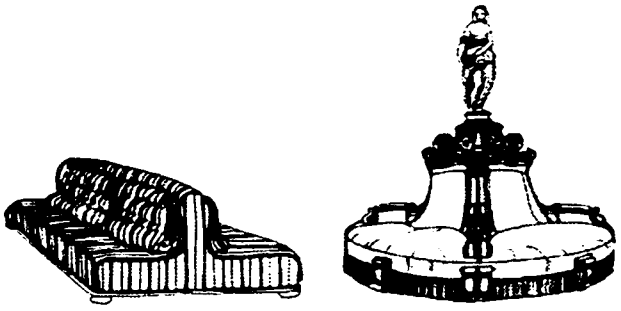


figure 17: Back–to back seat, and the Ottomane.

(Oates, 1981)

Vulgar fashionable pieces were often rejected for simple, distinguished furnishings in this century (Reeves, 1969). To 20th century eyes even these pieces seemed gaudy, but were revolutionary at the time, representing protest against prevailing taste.

The Twentieth Century

While the 19th century was considered a revolutionary age the 20th century is even more so. In no other period is the average person living a better life (Yelavich, 1997.) Advances in technology and medicine are lengthening and improving our lives. Communication is so advanced that society knows instantly what is happening on the other side of the world (Hanks, 1981).

Sparke notes (1986) " a furniture avant-garde exist[s] in this century experimenting with new ideas, new materials, and new forms in order to bring furniture into line with cultural change " (p. 6). The 1920s saw social unrest, prohibition and living in excess (Sparke, 1986). New aerodynamic technology was reflected in furniture designs. Ferebee (1970) cites chrome and tubular steel being implemented into everything. Streamlining was the desired appearance. (figure 18)

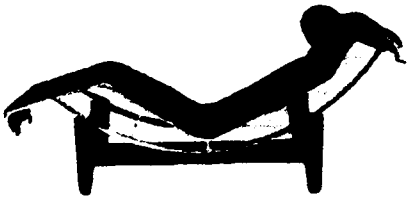


figure 18: Material selection affects design.
(S-1Locomotion, Yelavich, 1997, and Adjustable chaise longue, Mang, 1979.)

The 1930s were a period of severe depression. Many people had to sell everything in order to survive (Oates, 1981). Space was at a premium and people had to live in smaller areas. Although furniture design stayed relatively dormant during this decade, ideas like the pull down bed appeared, as rooms were used for more than one purpose. (figure 19)

figure 19: Utility furniture.
(Utility bedroom, Harrison, 1971, and Bedroom, Yelavich, 1997.)

The war of the 1940s brought society out of the depression. Economies improved and people started buying again. After the war, reconstruction in war torn countries and the building of new homes for the returned veterans, stimulated the economy (Harrison, 1971). This positive atmosphere created a desire for new furniture. Oates (1981) states: "a comprehensive re-evaluation of furniture design [takes] place [after the war] and an attempt [is] made to raise standards " (p. 224). This, along with technological advances from the war, promoted new ideas in furniture design that peaked in the fifties. Oates (1981) notes the desire for furniture was frenzied as stocks, high at the break of the war, were soon depleted.

The 1950s were a period of mass consumption and concern for quality (Reeves, 1969). In this decade, man was sold the idea of automation, which increased his leisure time. This brought about the invention of recreational objects such as the television and the lazy boy (Greenberg, 1984). In this decade, family was the focal point; two children, new car, new house and new furnishings were desired (Obst, 1969). (figure 20)

figure 20: Vision of prosperity and convenience.
(Populuxe view of prosperity, Hine, 1986.)

People of this decade were also enthralled with space exploration, scientific imagery and atomic technology (Ferebee, 1970). (figure 21) These interests left a mark on furniture design; kidney shaped coffee tables, Saturn shaped lamps, cosmic televisions and weird colors in arborite tables and sofas appeared (Sparke, 1986).

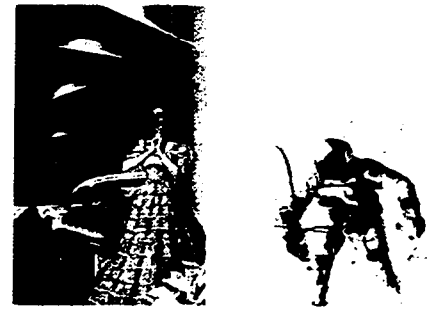


figure 21: Dreaming of space exploration.

(Horn, 1985, and Ferebee, 1970.)

The 1960s were a time of personal, political and sexual revolution. Communes were common, and beanbag chairs, lava lamps and floor pillows composed the furniture of the living room. The use of plastic in furniture became prevalent during this period as it was easily shaped into odd designs (Lucie-Smith, 1979, Oates, 1981). Sparke (1986) notes technologically, plastic finally came into its' own. (figure 22)

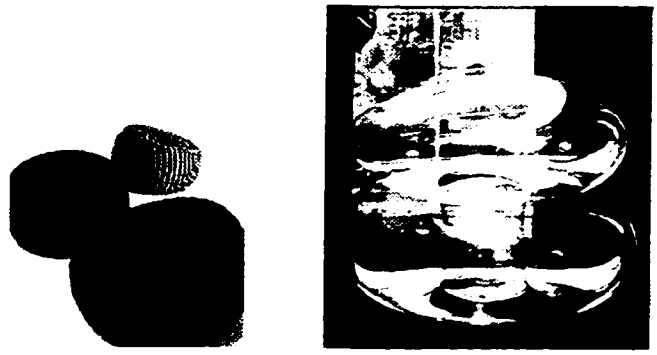


figure 22: Plastic.

(Gaetano Pesce's Upchair, Sparke, 1986, and 'Quasar' inflatable PVC chair, Harrison, 1971.)

In the 1970s, shag rugs, built in beds and drawers and macramé planters were the vogue. Sparke (1986) states 'neutral' was the big idea, and the domestic home is earth toned. The bright colors of the 1950s and 1960s gave way to imitation wood grains and paneling. These imitations were implemented in furniture design as well. Styles were simple, a table consisted of a top and four straight leg. Emphasis, states Lucie-Smith (1979) was placed on making furniture that could be sold flat, assembled with the least skills and in minutes. (figure 23)

figure 23: The Cube Kit.

(The cube kit, Lucie-Smith, 1979.)

The 1980s were an age of inflation and the black box look. Society was bombarded by electronic and home entertainment equipment that came in simple shapes and basic black (Sparke, 1986). Light steel shelving replaced the heavy fake wood of the seventies, walls were white and bare, and the recreation room was seen as a remnant of the past decade. The function of furniture in this decade was less significant than the part it played in creating a lifestyle notes Sparke (1986). (figure 24)

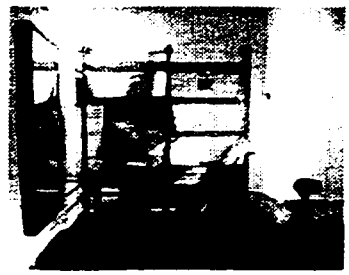


figure 24: Simple and basic black.

(High tech interior components, Sparke, 1986.)

In the early part of this decade there was a sense of optimism, and people felt secure in their traditional jobs. In the late 1980s, as oil and construction industries began to falter, security shaken workers considered their options.

In the 1990s, the domestic environment took on a different concept. Homes became people's workplace (Rosenbaum, 1995). Job security was a thing of the past, and many turned to contract work as a means of making their living. Unlike our parents and grandparents, no one was guaranteed a life time position anymore. Spare rooms were dedicated to businesses and house plans often included an office. (figure 25)

figure 25: Spare rooms now had dual functions.
(John Hall, Metropolitan Home, Oct, 1991.)

This was mirrored in the information technology of small copy machines, fax machines, computers and multi use telephones. Every year new space and time saving devices were put on the market for use in domestic working environments.

As well, in the 1990s, we saw a trend towards smaller living spaces (Sparke, 1986). Baby boomers were grown up and price increases in the cities made it popular to reside in lofts, apartments and smaller dwellings. This popularity was born out of need; as first time buyers, apartment dwellers and college students chose these dwellings instead of commuting. Although saving space meant time and money saved, for many it also meant less privacy. Furniture designs, such as built-ins and

multifunctional furniture, became appealing again. Other alternatives including living in boats, submarines and space stations, showed that man could cope in small cramped spaces effectively and have done so through many periods of history (Ball, 1989). (figure 26)

figure 26: Man living in small spaces.
(Ball, 1989.)

Much of the furniture designed for these situations provided clues to productive small space living.

Conclusions

Inevitably, furniture designs come and go. While basic furniture; the chair, bed and table, have had long histories, others have emerged only to disappear again, because of changes in society (Sparke, 1995). Through the ages man has shown he can adapt to his changing environment and many factors influence the furnishings within this environment. The appearance, function and necessity of furniture, in a given period, can be studied through an observation of these factors and provide a framework for furniture needs.

Section Three: Evidence of Working at Home

Modern Context

The previous section illustrates how social, cultural, technological and psychological aspects affect furniture designs and establishes the furniture needs for a given society. For the modern North American extensive interest in the home office, and home office furniture, reflects their new design needs. This interest is evidenced in popular literature, and academic literature. In order for the designer to understand the furniture needs of the home office, an examination of the current home office is required.

Roots

" The House is only a structure in the sense that culture is a structure within which we lead our lives."

House of Moderation Project Brief 1994

The concept of a home office has existed for many centuries and this is not the first time man has brought his work into his dwelling. The workplace residence is first noted in prehistoric times. Raymond de Beeld (1989) thought it is prevalent in medieval times. The medieval home provides a whole setting for the lives of its occupants, possessing a multifunctional nature. Workshops, stores and studios are natural extensions of the dwelling, and home and business are regarded as complementary rather than incompatible (Schoenauer, 1992). This combination of home and business declines during the Industrial Revolution as society evolves into a centralized factory system. The 20th century's information age, re-ignites interest in the workplace residence as "dwellings in the country, the suburbs, and the city now

have the same capability of communicating with the world that only the biggest companies in the richest countries did a few years ago" (Rosenbaum, 1995, p. 21).

According to a local news cast in February of 1996, 15% of Calgary households have businesses, full or part-time, working from them, 1 in 7, or 45,000 residences in this city alone (CFCN, 1996). Orser / Foster (1992) shows 1.02 million home based businesses in Canada in 1992. Statistics Canada's 1996 census shows over 1.8 million Canadians worked from the home up 28% in the last five years, nearly 13% of the nations labor force, compared to 10% in 1991 (Statistics Canada, 1998).

In The United States the figures are far greater. In 1997 more than 23.3 million people work from the home (Census Bureau, 1998). The Census Bureau reports that more than 25% of all incorporated businesses are home based, and more than one in three Americans work from the home, as well as 20 % of all businesses grossing $100,000 per year in sales are home based (Rosenbaum, 1995). In 1980 less than 1% of the work force worked regularly at home, in 1998 that figure is 10 %. This is projected to rise by 18 % a year. Alvin Tofffler's prediction in his book The Third Wave; " one day up to half the people in the country will spend all or part of their working lives at home" seems plausible (Fisher, 1995, p. 2). (figure 27)

figure 27: Home Office.

(Rafelman, Canadian Select Homes, March 1997)

Technological Factors

Movement to the home office has been made practical by technological advances in the past few decades. In today's information age, we have linked the world and made physical boundaries minuscule. " Now we have the tools to let you work, anytime, anyplace," states Joanne Pratt (D.Scheep, B. Scheep, 1995, p. 7). Companies are no longer bound geographically to a particular workforce or marketplace. Small companies can be as productive and global, as large companies. Communication technology, available computer hardware and business software, have made it both economical and feasible to work from the home. Druker states; (Howes, 1996) "our society will likely be fully transformed into a knowledge based society by 2010 or 2020 " (p. I1). (figure 28)

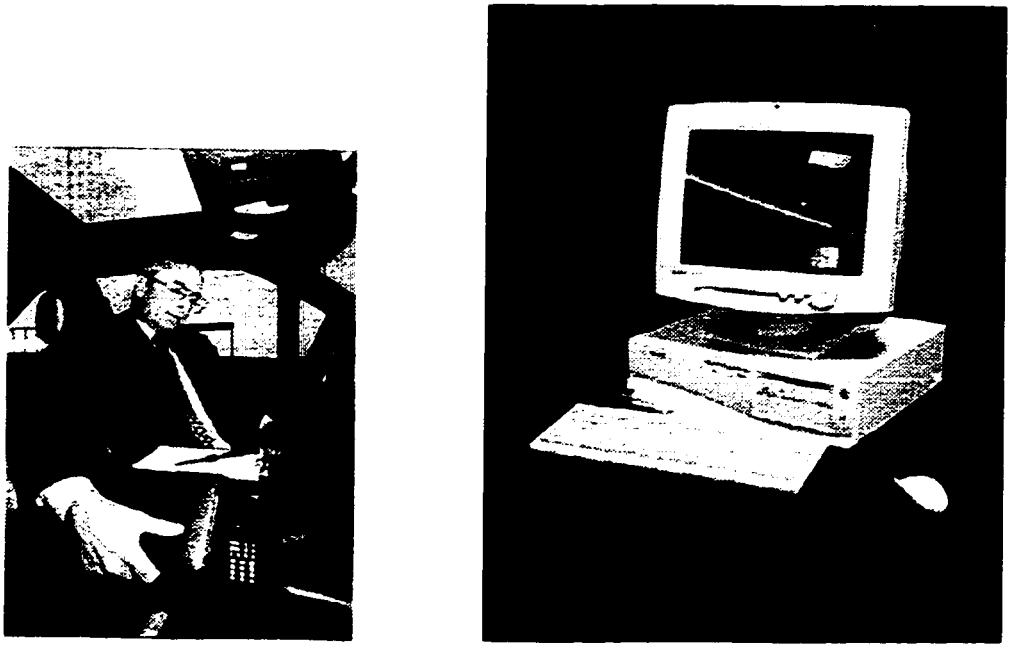


figure 28:Technological factors.

(Priddle, Calgary Herald. April 22,1995, W. Frisch, 1998.)

" She'd seduce innocent children"

Electronic Family- Computer Wins Heart. L. Herndon, Herald Jan 7, 1996

The home computer has increased the movement of offices to the home, as it allows the business entrepreneur to be a great deal more self-sufficient than ever. "Technology has now made this process easier, even the smallest service or knowledge operation can now look big with the right [equipment]"(Wanless, 1996, p. C1). The desktop computer has been a leveler in the business world. 73% use a computer in their workplace (Housing Family and Social Statistics Divisions, May 1995). A Nielsen Media Research study states that 37 million people in Canada and the United States are connected to the Internet (Walker, 1995).

1 in 3 American households have computers (Grady, 1996). In 1996, 3.6 million Canadians (31.6%) have computers, triple the number since 1986 (Office of Consumer Affairs, 1997). Dickinson, Sciadas (1997) states 1 in 3 Canadian homes have computers, and half of those have a modem. Brasen, (1997) states 35% of Calgarians own home computers, the highest in the nation. More than half of all employed people use a computer at work. Computers have grown more powerful and less expensive, and a fully configured state-of-the-art computer can weigh less than six pounds. "Eventually, television, even a telephone call, will be an application of computers. We will more likely to be running a major portion of lives from our homes, from our home computers" (Grady, 1996, p. F5).

Even large companies are changing their philosophies. "For years now, office workers have been begging for flexible time and the right to work at home", writes Patton. "Now, more and more employers are saying yes" (Fisher, 1995, p. 2). Companies are moving towards the virtual office, pushing their employees into cars and spaces designed for drop-in-work. "To trim costs and promote productivity, a growing number of companies are cutting their sales staff's office space, confirms Sales & Marketing Management magazine, equipping them with laptop computers,

cellular phones, and portable printers, then sending them on the road to create their own makeshift offices" (Fisher, 1995, pp. 2-3). (figure 29)

figure 29: The anywhere office.
(Metropolitan Home, March 1989.)

IBM, for example, designed its office in Cranford, NJ, with ports for employees' laptop computers instead of cubicles. "Telecommuting is the only way to compete in the Information Age, " says Pratt. 'It's inevitable as the virtual office trend takes effect" (Schepp, Schepp, 1995, p. 11). Workers are expressing enthusiasm for this new environment, "it's no longer my life fitting into my work, but my work fitting into my life (Fisher, 1995, p. 3).

Economic Factors

The trend to work from the home can also be linked to changes in the corporate world. Downsizing and corporate restructuring have had marked effects, Wanless (1996) illustrates; "everyone, it seems is staring their own business these days as economic restructuring sweeps through the Canadian economy " (pp. C1-C3). In 1996, 280,000 Albertan's were self-employed; 65 % of these were working from the home, experiencing the greatest growth in the west (Brasen, 1997, Statistics Canada, 1998). Corporate restructuring has also prompted a new population of home office individuals, those who other wise would not have ventured out, and those worried about job security. Doug Gray, in The Complete Canadian Small Business Guide,

(Wanless, 1996) states; " the average job these days only lasts four years, [so] there's no more lifetime security" (pp. C1-C3). Adds Gray, (Wanless, 1996) " When job security disappears, people turn to the only remaining way to gain security - being their own boss " (pp.C1-C3). According to Industry Canada, self-employment and employment by small businesses grew 31% nationally between 1982 and 1992 (Wanless, 1996).

"They may be doing it out of economic need, as a supplement to their regular income, as a job replacement, or because they're frustrated and bored with slavery in some big corporate setting. Whatever the reason, the trend, which first became noticeable about five years ago, has been accelerating"

Wanless, 1996, pp.C1-C3..

Every year, over one million workers are permanently displaced from their jobs (Thibault, 1997). This trend starting in the late 1970s is continuing through the 1990s and no sign of change is reported.

Furthermore, outcropping has become an indispensable formula for those companies that want to stay competitive. Outcropping means sending all work out to contract employees or consultants, developing a new service oriented business. According to Drucker, (Howes, 1996) "it is predictable that in ten years from now a company will outsource all work that does not have a career ladder up to senior management" (p. I1). Cohen states, "much job growth can be linked to the business opportunities that become available as a result of downsizing and restructuring of large corporate enterprises, coupled with the adoption of policies promoting contracting out and privatization by government" (Parsons, 1996, p. C1).

Home workers spend $30,000 a year on equipment (Rosenbaum, 1995). New types of business centers are developing to support the home entrepreneur (Duvall, 1996). These centers provide the home worker the ability to be even more technologically

competitive, providing access to expensive equipment and facilities in the community. It is common now for many copy centers to provide everything from copy machines to teleconferencing and even occasional space for busier months (Duvall, 1996). These businesses and their success indicate a connected, local and flourishing economy. The home office phenomenon is also kind to the corporate employer. Telecommuters can save a company between $6,000 to $12,000 a year through reduced office space, lower employee turnover, and increased productivity.

Ecological and Political Factors.

Ecologically, interest in sustainable communities has also sparked an increase in home offices. Sustainable development is defined by IUCN/UNEP/WWF (1991) as; "development that meets the needs of the present without compromising the ability of future generations to meet their own needs"(Neilsen, 1995, p. 6). Sustainable communities focus on social equality, local management and resource sharing. An opportunity for work and cultural development within the community is promoted (Neilsen, 1995). The home office concept thrives in these communities as it promotes local development, reduces both commuting time and energy usage, as well as increases the sense of family and community spirit. In the Ballerup Project, for example, the Egebjerggard Urban Neighborhood aims are to develop neighborhoods with business and retail integration. Multiple-use spaces are prevalent, and shared common spaces create a sense of community and openness. Homes that incorporate business units are located in the front streets, and small workshops are adjacent to common houses. One-person shops and businesses that can be run from home are encouraged in individual houses. As well houses can be designed to include special areas for a specific business need, for example drawing, pottery or photographic studios are commonly incorporated. (figure 30)

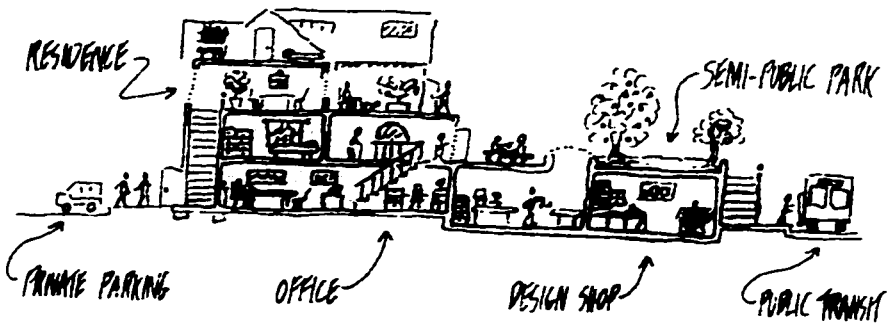


figure 30: Sustainable multiple-use space.

(Neilsen, 1995.)

The Berkley, Willmore, and MacKenzie Towne projects and studies are other sustainable communities that encourage and promote the home office environment. Once again these mixed-use neighborhoods encourage residents to live and work in the same area thus increasing home office numbers.

Politically, The Clean Air Act of the United States has prompted many companies to encourage and promote the home based worker. Government regulations have pushed the employer to lean towards a telecommuter as an employee, decreasing the number of vehicles on the road thereby reducing pollution. This movement is ecologically driven though politically enforced. In Canada, zoning laws have become more flexible, promoting the acceptance of the workplace residence and acceptance of this lifestyle.

Social and Cultural Factors

This component examines the influence different family units, changing lifestyles, and changing occupational values have on the emergence and acceptance of working from the home.

Family Units

Society has witnessed an explosion of different family structures. Mackett-Stout (1987) records: singles and divorces, couples with or without children, single parent families, part-time families and active retired adults to name a few.

Mackett-Stout's (1987) report states that over the next few years, single families should increase by 30-60 %, career oriented couples could make up to 55% of all families and career oriented singles will increase by 70 %. The 1996 Canadian Census reported that common-law and lone-parent families make up one quarter of all families in Canada, compared to one fifth in 1986. Total families in Canada increased 6.6% to 7.8 million between 1991-1996. Mackett-Stout (1987) stated that these family units are monopolizing the social structure and dominating the housing market. With this diverse range of households comes an expectation of an equally diverse range of housing. "The house may be seen as a place of business and a place of residence. There exists a mismatch of houses, to households" (Mackett-Stout, 1987, p. 3).

Changing Lifestyles

For some North Americans, 'choice' is the critical factor in deciding their place of work. Often working for someone else conflicts with people's lifestyles and commitments (Fisher, 1995). There are a number of individuals, who like the father who wants to be a part of his children's young life, choose to work from home as a preferred lifestyle. Some companies are providing its employees the opportunity to work or contract out from home. In the United States 12.5 million telecommute. For many, to be home with their children is having a marked affect in the business world. Fisher (1995) states in the United States:

> There are the 10 million business managers and professionals between the ages of 35 to 45 who are entering two passages of life at once - middle age and parenthood. For these mid-aged boomers, confronted with their vulnerability and the desire to pass along the right values to their children, quality-of-life choices have become paramount considerations. As a result, many boomers are exiting the corporate fast lanes, inventing new ways to live and work. And attempting to do it at home with their families (p. 5).

The US Census Bureau reports that 70% of people working at home in 1997 were married couples with families (Census Bureau, 1997).

Changing Occupational Values

American labor statistics show that the workplace resident is mainly white, and married. Only 21% live alone, compared to 27% of all workers. More men than women work at home, though women are twice as likely to work full time (Rosenbaum, 1995).

Home office workers are typically categorized into the following:

- self-employed, operating a part-time or full-time business. Link (Fisher, 1995) states in the United States there are 12.1 million full time self employed and 11 million part-time self employed homeworkers.

- working part or full time at home for an outside company. This figure is presently at 12.5 million (Fisher, 1995).

- working at a full time job outside their home but maintaining a home office for work related to their job. Link figures there are 8.6 million corporate after-hours homeworkers (Fisher, 1995).

These individuals choose working from the home for many reasons. In Home Office Commuting (Fisher, 1995) the annual reader poll provides nine reasons why people work at home:

1. They want to be their own boss. (72%)
2. They want less routine in their lives. (56%)
3. They want to change their life. (43%)
4. They want to do more interesting work. (41%)
5. They dislike the corporate world. (35%)
6. They want to spend more time with their family. (33%)
7. They want to make more money. (29%)
8. They have a great idea for a business. (25%)
9. They've gone as far as they can at the company they work for. (23%)

These reasons illustrate the changing values of the typical worker. The migration of the worker to the home is not just another fad, as many baby boomers will not increase the time they spend at work in the next five years and in fact 50% of the women and 37% of men are expected to cut back on their hours (Fisher, 1995). Saltzman says, (Fisher, 1995) "People are trying to find something more meaningful in life " (p. 4). "Downshifting" as Saltzman puts it, is: "the deliberate pursuit of greater personal fulfillment on a slower, more private professional track"(Fisher, 1995, p. 5). The 35-54 individual is looking for more self-satisfying work rather than just working. 65% of female and 43% of male Canadian home workers are in this age group (Statistics Canada, 1998).

This trend is not only popular in the 35-54 generation but in the 25-34 generation. According to Jann S. Wenner, (Fisher, 1995) the:

> twentysomethings in 1993 are looking beyond the figure on their paychecks when measuring personal success. They want work that makes them feel that they are accomplishing something meaningful. They want a lifestyle that affords plenty of free time to spend with family and friends. They want to live in communities where people know and support one another. They want the security of family and strong relationships, the security of community, and the security of knowing that they are making a positive contribution to society. Many of them are seeking it on their own (pp.5-6).

22.2% female and 16.0% of male home workers are in this age grouping (Statistics Canada, 1998).

Approximately 14 percent of Canadians between the ages of 20 and 24 are unemployed, compared with 8 percent of people over 25 (Barlow, 1996). Many individuals feel that self-employment, even after university or college education, is the way to go. "Students don't tend to see large corporations as providing career opportunities," says Russell Knight, professor at the university of Western Ontario Business School in London, " the idea of starting a business is slowly becoming the norm " (Barlow, 1996, pp. 94-98). In the book, On your Own, Joseph Plummer, (Fisher, 1995) found that: "30 % of the Harvard MBA graduates of 1942 to1978 are self -employed, and 87% of the graduating 1984 class indicated a desire to be the same." This according to him, "represents a 50 % increase in entrepreneurship over the past 40 years" (Fisher, 1995, p.8).

Location

Location also has an important affect on the emergence of the workplace residence. Many people's desire to live in a large city affects the choice of living and working arrangements available to them. Some couples, for example, move to the city for one individual's career while the other runs a profitable business from their residence.

Others, who cannot afford both a residence and an office, opt for a combined workspace. Examples of these can be seen in the growth of workplace loft dwellings developing in communities such as Inglewood and Sunnyside in Calgary.

Functional Factors

"There are some people who could work quite efficiently in the middle of a tornado."

Wendy Priesnitz, Bringing it Home, 1995, p. 133

The move of the work environment into the domestic environment has changed the way individuals run their lives, affecting the way they decorate and furnish their homes. This mixing causes problems in space for people. "By choice or by necessity, people are working from home a great deal today. They need file storage, shelves and desks that function," says Wilson, " but they don't want something that's unattractive" (Lasker, 1996, p. 2). In 1995, two of the leading office furniture manufacturers, Steelcase and Herman Miller, came out with lines of furniture expressly intended for the home office (Lasker, 1996).

" However be forewarned that if you work on a dining room table that functions like a combination snack shop/mail room/ homeworker sorting area, your client report may suffer from toddler scribbles or coffee stains"(Priesnitz, 1995, p.133).(figure 31)

figure 31: Productivity amongst the chaos.

("Automation" in the Calgary Herald March 26, 1996.)

It is important to know the type of work that is being brought into the home in order to understand the furniture needs. According to Home Office Computing, (Fisher, 1995) the top ten home-based occupations of the 1990's are: consulting, computer services/programming, business support/services, financial support/services, independent sales, graphic, visual and fine arts, writing, marketing/advertising, construction/repair, and real estate. Although the top ten work situations vary, each occupation needs some sort of work surface, storage and place to keep daily documents.

Conclusions

Many factors contribute to an explosion of the workplace residence. The increase in the numbers of workplace residences illustrates overwhelming interest. Technology has affected the move to the home most drastically, and has made it feasible and practical. The information age has dissolved the restrictions of the traditional office, letting the worker work wherever she/he wants. Many have chosen the home, as technology has allowed them to be competitive with similar businesses, providing the same quality and/or quantity through computers, fax machines, copiers, and scanners.

Changes in the business world, like downsizing and restructuring have also pushed for the acceptance of the workplace residence. Outcropping from large companies and an increase in potential contract work, has made the workplace residence a viable and a positive opportunity for many. Development of sustainable communities, influence of changing family structures, changes in lifestyles and values, all affected the acceptance and need for the workplace residence.

Location is also relevant, as many individuals desire close proximity to the city's core, or believe the workplace residence provides them more options in terms of compatibility with their partner's work opportunities. Common types of living environments include lofts, small apartments, bachelor suites and so forth. This calls

for change in furniture design to adapt to the smaller space, and how effectively that space is put to use.

Changes in city bylaws have begun to show an acceptance of the workplace residence. Zoning laws are seemingly more supportive of this tendency as seen in the surge of workplace residences in Calgary.

Finally it is concluded that the home worker needs a new furniture type. Large furniture manufacturing companies are getting into the home office frenzy. It is important to consider what work is done on, and where this apparatus should be located. The work area is the backbone of any business and fundamentally, a crucial element in any home. This is extremely important when considering the small space user. Various types of businesses illustrate the versatility of the home office. It is noted that although each occupation is different, some sort of work surface, storage and a place to keep daily work is the common factor.

Section Four: Development of Design Criteria; Assessment of Contemporary Home Office

This section examines the current context of working at home. This examination is necessary to establish a set of criteria for the desk's design.

Issues

In the previous section it was shown that many factors influence the current move to the home. Within the workplace residence various issues arise as the individual tries to cope with one's environment. This section examines both positive and negative aspects of the home work place. Mental health, convenience, finance, professionalism, family, space, self employment and regulatory constraints will be discussed.

Mental Health

In the literature reviewed there was significant attention paid to the mental stress of working from the home. Loneliness, isolation, compulsiveness and productivity are reviewed.

Loneliness and Isolation

How do we simulate in the home workplace a sense of community? Maybe video screen abilities of the future is one way, but the nurturing of human contact is an important component to any home worker. Scheduling meetings out, having business lunches, joining and developing home office associations and networking with others in the field, are constructive means of combating isolation. Isolation and loneliness occurs both in the home workplace as well as in the traditional workplace. deBeeld (1989) felt loneliness could be a significant problem, and the effect of this issue rests

with the individual and the circumstances surrounding their environment. "Loneliness," deBeeld (1989) states "for many is the single greatest drawback to working at home " (p. 17). Out of a need for social contact, home workers have to be aware of the possibility they may become more susceptible to persuasion and outside influences, instead of business objectives.

In response to this problem we see a growth in involvement with the home based business from the community. Small businesses provide meeting spaces, facilities for working and networking for the home entrepreneur. Initiative to get involved in the community is developing. A second and more immediate response to this problem is the development and growth of sustainable communities. These communities encourage the workplace resident with shared facilities and part time office working areas, connected to living spaces. These communities focus on a strong sense of belonging, which may be another solution to problems of isolation and loneliness.

Compulsiveness

Compulsiveness can be an issue for the home workplace resident. This person feels constantly bombarded, physically and mentally, by the presence of his/her work in the refuge that once was home. The workplace resident experiences problems with a sense of accomplishment and with 'leaving the office", feeling stressed by the presence of the business in the home. This leads to workaholism and burn out. Therefore a design objective is to provide a perceived separation between work and living environments.

Productivity

Flexibility, in terms of when you work as well as where you work, is a bonus of the workplace residence, although at times, this sense of freedom can lead to

procrastination. When work is moved to the home, productivity can increase or decrease. deBeeld (1989) explains: "until the workplace resident becomes self disciplined in terms of [his/her] work, it is easy to become distracted from these activities by demands imposed by the home environment, family, or friends." This decrease in productivity is often triggered from an external source; " even if the home worker wants to work one of the biggest issues is getting people to realize just because you're home doesn't mean you're available" (deBeeld, 1989, p. 15). Promoting professionalism through the workstation design is a relevant objective arising from this issue. Professionalism, defined by Oxford (Hawkins, 1988) is described as "the methods, manner or spirit of a profession; also its practitioners " (p. 400). It is crucial that the home worker, like the traditional professional, be perceived by the outside community, client, family members, as well as by the person him/herself as an expert and not an amateur. The workstation design therefore must emulate a skilled and proficient atmosphere.

A second concern in terms of productivity relates to time scarcity. Many individuals who work at home find that the continual resetting of work leaves little time to accomplish anything. This issue called for another design objective; to provide the ability to leave work in progress, thus increasing productivity time.

On a positive note, the home workplace resident can increase productivity through the elimination of non-productive time associated with commuting and unnecessary co-worker interruptions. Morale and job satisfaction can also improve from greater freedom and control.

Convenience

Convenience has been noted as a benefit of working from the home. As a rule, a workplace residence can be located anywhere the individual wants, providing more

opportunities for two career couples. The act of getting ready and the hassle of getting to work are eliminated. This provides more productive time and flexibility, which in the case of a couple with children, can seem more enticing. The Telecommuter's Handbook (Schepp, Schepp, 1995) mentions convenience as a positive aspect of the workplace residence. In this atmosphere the worker can maximize control over the work environment and daily productivity. Schepp identifies not having to commute, as well as setting one's own work hours as a benefit.

Finance

Compared to the traditional work place, the residential workplace offers significant financial savings. The cost of a separate workplace, expensive childcare costs, commuting, parking and expenses associated with business outside the home, such as meals and wardrobes, are almost eliminated. There are also taxation benefits to having your business located in the residence, as part of the rent or mortgage interest, utilities, taxes, insurance, maintenance and so forth, can be written off as business expenses.

Professionalism - Credibility

Professional respect is often a concern for the home worker. This lack of respect comes from all social circles. People are, at times, treated unfairly by their neighbors when they try to run a business from the home. deBeeld (1989) comments on this type of occurrence: "Neighbors, and community members have a tendency to view the home-worker with suspicion, and sometimes assume that they are actually unemployed, poor, a loser, social misfit or amateur "(p. 17). At times, home businesses and their products, are considered second rate in the eyes of clients and credit institutions. This treatment, sometimes unintentional, stems from the questioning of the seriousness, sophistication and substantiality of a home business.

Often this causes home workplace workers to possess lower self worth, and makes them think they must undercut their prices to compete with traditionally based businesses. A strong sense of professionalism is essential for the home worker and in order to achieve this, business manners, workspace and equipment must be improved. deBeeld (1989) states; "establishing a formal work area separate and private can do a lot to present a desired image " (p. 17). This approach may also correct the notion that some career couples have, that the home worker's career seems less important than the worker that leaves for the 'office' each day. Another design objective is to present a professional work atmosphere. This objective will help impress client, family and the home worker himself/ herself of his/her professional credibility and self worth.

Family - Life Interruptions

A common frustration for the home worker is not having enough time to devote to their work. Daily routines are continuously delaying the work process. This delay causes the workplace resident to feel physchologically drained. This problem is not specific to any one family type, but rather stems from the lack of a proper working space. Unless the work environment provides some privacy, family members invade on the home worker's territory causing interruptions. The problem of privacy can affect the home worker's partner as well, this individual feels restricted since sufficient space for both occupants is not present.

Needs of Modern Households

Family structures are changing. Traditional family expectations have greatly altered since the last world war. Two career couples are the norm as families cope with social expectations and responsibilities. The rituals of getting to work, staying at work and so forth, are continual challenges for today's family. It is not odd that many

families are seeking a better alternative when the major finding of a study done by the University of Quebec in Montreal (Canadian Press, Calgary Herald, 1995) states:

> Three -quarters of employees in large companies say they have trouble reconciling their jobs and childcare responsibilities. 56 % of the women & 42% of the men suffer high level of psychological distress that is, a sense of being overworked, of irritability and extreme fatigue. That's twice the rate in the general population. In single parent families, the percentage climbs to nearly 70 %. Illnesses, emergencies, and teachers' study days created childcare problems for 42% of participants. Problems increase when work shifts vary or are unpredictable, especially when the employer offers little advance notice (p. D2).

Working from the home seems a favorable option.

Self- Employment

The reasons why people work from the home are quite diverse. For some the workplace residence is a necessity; they may be home bound, trying to save money, or lack money to rent office space, but most often it is a lifestyle choice. The home workplace lifestyle often offers a better quality of life compared to the traditional workplace lifestyle.

The positive and negative drawbacks of self-employment depend on how the home office situation is viewed. deBeeld (1989) states: "Whether or not working at home is desirable, depends not on what the issues are, but how the individual feels about the issues " (p. 16). Self-employment requires self-discipline and being able to make decisions on your own, as well as setting your own production and performance levels. For some, these tasks are formidable. The poorly adjusted individual or someone who is forced to work from the home, usually experience this. Those that

can attain these tasks, often experience a sense of fulfillment, control over their work hours, greater satisfaction, less stress and their own sense of success.

Space

The issue of space is another aspect in need of consideration in the workplace residence. The impression of space is often a crucial element for a positive and productive environment. The question is, can this be attained in the home environment where other activities share the same physical space. For example, a commonly used area of the home is often the most sought after for the home office. The home office most often loses out and is relegated to a dark closet or hallway. Issues of light, noise, background, view, a sense of space and so forth, are elements that need addressing in the home office environment. The ability to blend the home office in a common area is a design objective.

Regulations

deBeeld (1989) mentions regulatory constraints in his thesis. The workplace resident in order to run a legal business requires a Home Occupational Development Permit. Regulations are in place to control the community environment, yet often the home worker overlooks these regulations. deBeeld (1989) states that thousands operate businesses from their home without a permit. In 1987 only 219 Permits were issued. Some individuals are unaware they need a permit while others are merely avoiding it. The reasons behind this avoidance can be anything from evading the licensing fee, not wanting their neighbors to know about their activities, or meeting the restrictions imposed by the permit. It is likely that regulatory laws will be revised to accommodate the homeworker, as the nature of work is changing and the number of home based workplaces increasing.

Conclusions

This chapter discusses issues that arise when working from the home and helps establish a set of criteria for the desk's design. Mental well being issues such as loneliness, isolation, compulsiveness and productivity are discussed. Financially, the workplace residence provides significant benefits. Savings are seen in possible; reduced child care costs, elimination of expenses related to a separate workplace, and commuting costs.

Professionally, credibility is a major problem for the residential worker. A stronger sense of professionalism is essential for the workplace resident. In terms of family, interruptions cause strain for the workplace resident. This problem is not family type specific, rather stems from a lack of a proper working space. Invasion of privacy and feeling cramped, are common occurrences. Secondly, since family structures have changed, today's families are continually facing challenges in meeting traditional working and living responsibilities. Families seeking an alternative often try the home office approach.

Self-employment is often a life style choice that leads directly to the home office. This lifestyle requires self discipline, decision making, and the ability to set production and performance perimeters. For some these tasks are unbearable, while others thrive in this atmosphere.

Impressions of space are relevant to the home office. Shared space, lighting and noise, are important considerations for the home office environment. Lastly, it seems some individuals are unaware of regulations and therefore face problems stemming from the neglect of them. Regulations and bylaws, are seemingly changing, though slowly, in favor of the home office setting.

Part Two: Design Process

This section is divided into two chapters. Section one, *Space*, discusses the perceptions of space as related to the home, home office and furniture. Section two, *Design Development*, describes the design process and illustrates the transition from research to design.

Section One: Space

"Houses have a language all their own."

Mangiacasale, A Home by Any Other Name, Herald March 16, 1996, p. F1

According to Webster (Londoll, 1993) perception is - "awareness, consciousness, knowledge attained through the senses"(p. 370). Perceptions influence the way we look at our surroundings. Perception affects the acceptance of the norms of daily life and what is considered suitable habits and practices. Perception plays a role in the traditions society chooses to continue.

Through the centuries societies have juggled the boundaries between home and public domains. As society moves its work into the domestic environment, this arrangement challenges the traditional perception of home and work as separate entities, creating mental and spatial issues. This requires the development of fresh ideas for the current home office environment. This transformation not only alters the perception of the home space, but the furniture found within this space and the functional and psychological requirements of environment and furnishings.

The Notion of an Ideal Space

> The point is, the word 'office' implies a place apart for business, no matter what it looks like or what it actually is the rest of the time. And the further you can position it mentally and emotionally from where you live, the better off you'll be. The mental drill of disengaging business and work from home and hearth is essential to the person who hopes to incorporate them all into the same environment.
>
> Fisher, 1995, pp. 69-70.

In popular magazines the home office is found in numerous locations, often a basement, a closet, hallway, spare bedroom or even a corner of the kitchen. (figure 32)

figure 32: Popular home offices.
(Ikea ad, and Rosenbaum, 1995, and Ikea ad.)

This environment seemingly provides for the home office worker's activities, but how completely it provides, is cause for examination. The prevalence of these home office arrangements illustrates that society believes the home office has to take a secondary rather than equal role in the home. This belief restricts the home office

from setting up in prime functional space as the home office is seen as foreign to the traditional home.

In the 'home office residence' this perception is different, the office co-habits with home activities. The office is not relegated to a secondary space and is given the option to be placed in higher traffic areas of the home. This location is also prevalent in small living environments, like a bachelor apartment, as the office like other activities all share one area.

An 'ideal' description of the 21st century domestic environment lies not only in its physical construction, but also in society's perception of that environment and how the activities within it co-exist. Alternative ways of perceiving space, following this line of thinking, are discussed.

Alternatives

Options more complimentary to the home office arrangement are; flexible, adaptable, add-in, Mackett-Stout's housing prototype space and architectural transparency. Discussions of these alternatives follow.

Flexible Space

Flexible space allows the user to define a space rather than have it exist in a predefined area. The occupant has the freedom to arrange the space according to need; this is attained through construction techniques that provide a set of detachable walls within a support structure, as well as a series of service cores (Habraken, 1972). True flexible systems can seem unreasonably costly, as many of the services cores installed are never used by the occupant (Mackett-Stout, 1987). Yet this system gives the occupant the means to think of the needs for a space rather than accept the predetermined tradition of such space. A practical variation of this system

retains the majority of open space, unobstructed by fixed partitions, but places limited constraints by including a predetermined master bedroom and bathroom in the design. Ted Smith's loft houses in California are such an example (T. Smith, 1985). A kit composed of freestanding cupboards and rooms dividers is included in these houses. This allows the occupant to manipulate spaces on the main floor and the remaining room(s) of the second floor.

Adaptable Space

Adaptable space is a second alternative allowing the occupant freedom in terms of use and conception of space within the home. Variations in room sizes, relationships and openings between rooms and downplaying the room function, define this space (Rabeneck, 1974). This concept of space is not a new idea but rather can be seen in the 18th and 19th century speculative houses (Mackett-Stout, 1987). Plans are generally simple in layout, allowing for adaptable use. The main rooms are usually equal in size and movement is flexible. Space is ambiguous, room use is not predetermined or set in stone. Contemporary use of this type of space can be seen in the New American house of T. West and J. Leavitt (Leavitt, 1985). This housing prototype is designed for non-traditional family groups, specifically single parents and home based workers.

Add-In Space

This space allows the occupant to increase the usable area of the home without increasing the size of the house (Mackett-Stout, 1987). During construction the add-in space is roughed in and left for the occupant to complete. This provides the occupant flexibility in defining space to meet needs. Major cost is absorbed in the original building stages so finishing is not a financial burden for the occupant later. Garage, basement and attic conversions are common examples of add-in space.

Mackett-Stout Prototype Space

In this type of space, rooms are designed as empty entities and the use of the room is left up to the occupant. The room has no single function and thus no direct connotation. This allows the rooms to be versatile and not preconceived areas of activity (Mackett-Stout, 1987). The office can exist in any room and not be perceived as an invader. There are three room sizes, which provide the occupant with choices when determining the use and function most suited to a room. All rooms have high ceilings, establishing a sense of equality, which validates the variety of uses for each room. Circulation spaces are thought of as rooms rather than links. This idea makes these spaces more useable rather than mere connections. Room relationships are designed to allow for the widest range of combinations possible. The overall layout provides the occupant the ability to create desired environments.

Architectural Transparency

Although previously discussed alternatives help some home workers, what about the occupant who has little control over his environment and must work within a traditional home. Individuals such as renters face this problem. They are limited by their options, yet desire a more constructive working and living space. An alternative for these individuals is in the way they set up their living workspace, using the furniture within to create specific settings and atmosphere. Furniture can be perceived as definers of space used as dividers or walls. Moods can be set by furniture in the same manner that lighting is used. Transformational furniture can create a sense of change and establish new environments within a given space. This type of thinking in furniture design can help the occupant control the feel of a room and provide the ability to have more than one setting and use within a room.

Conclusions: Final Interior

It is noted that the home office does not ideally exist in the traditional concept of 'home' as such thinking appears to inhibit its' success. Alternative ways of using space are presented to show that there are means of attaining the best atmosphere for the home office. For those who must work within the traditional 'home', alternative ways of perceiving this setting through furniture design is provided. Therefore it is shown that the ideal conception of the 21st century domestic environment is not only in specific construction but also in the perception of space, that determines its effectiveness. The home office, to be successful and accepted by society, must be thought of as an equal partner in any home.

Section Two: Design Development

Introduction

This project is design-based. The intention of this project is to design a product which meets the needs of the current workplace resident. The goal of the design process is to fulfill the stated objectives of the designer. The design objectives for this project are as follows:

1. Achieve a perceived separation between work and living arrangements.
2. Provide the ability to use the optimum space of the environment.
3. Provide the ability to leave work in progress, increasing user productivity time.
4. Promote professionalism, yet preserve a sense of privacy.

Process Description

Section one establishes initial directions and parameters for the design process. Research, writing, decision-making and design processes are pursued concurrently throughout the project. The physical design exploration begins after considerable background research is complete. This is necessary to formulate basic design concepts, criteria and constraints. Initial design activity focuses on broad concepts. Simple drawing, sketching and three-dimensional modeling is completed in this stage. This provides a creative outlet during research and formulation and helps to translate problems into actual forms. A workstation design is the final product of this project. This section discusses its evolution and illustrates factors that affect its appearance, components, function and final design.

Design Considerations

Early in the project a list of elements evolve that are continually worked on throughout the design process. These elements direct the final design and affect the design process. They are discussed below.

Maximizing Space

Space is found to be an important factor in the health of the home office, therefore maximizing space is a driving factor in the design process. Limited space becomes a design constraint. Concepts that increase placement possibilities for the product in the workplace residence are focused on because of this constraint.

Initial design concepts focus on different ways of making the workstation appear unobtrusive, occupying limited space when not in use and unfolding the 'office' when opened and being used. Vertical free standing, vertical hanging and horizontal conversions are explored. (figure 33, 34, and 35)

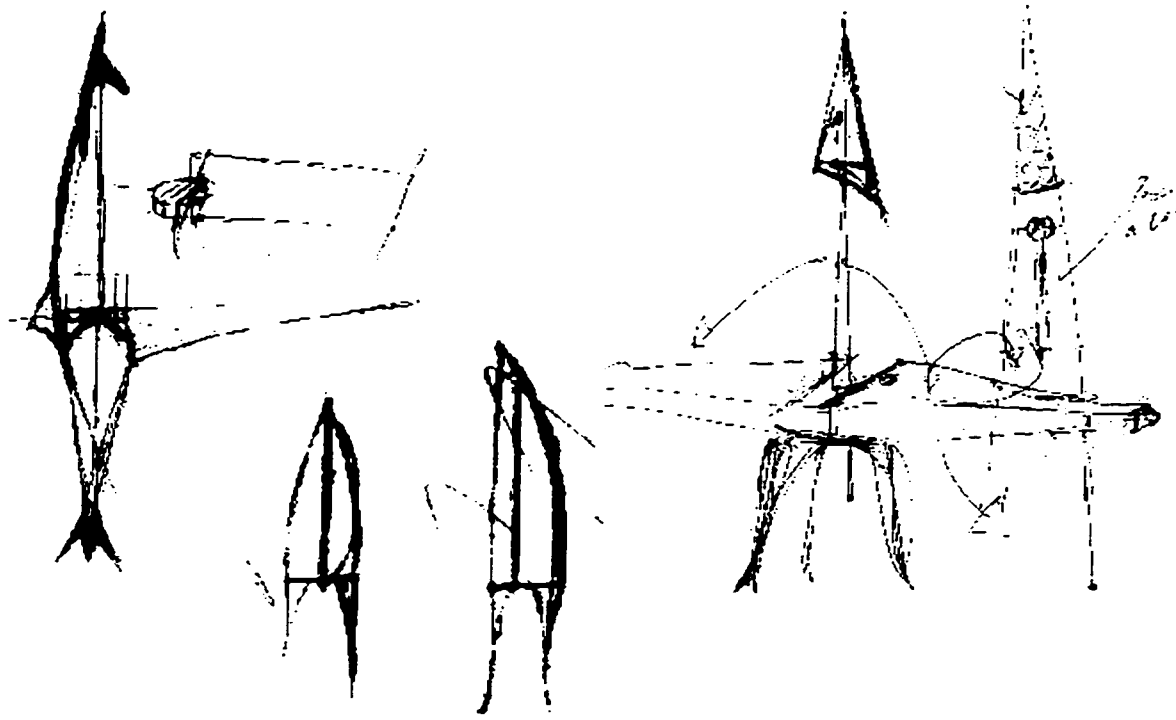


Figure 33: Vertical free standing concepts.

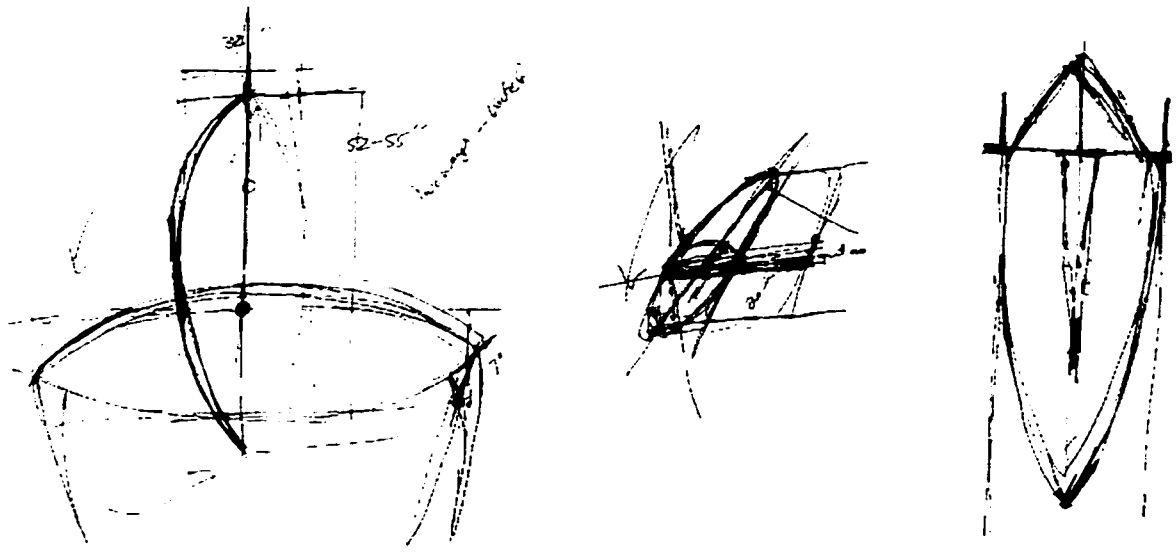


figure 34:Vertical hanging concepts.

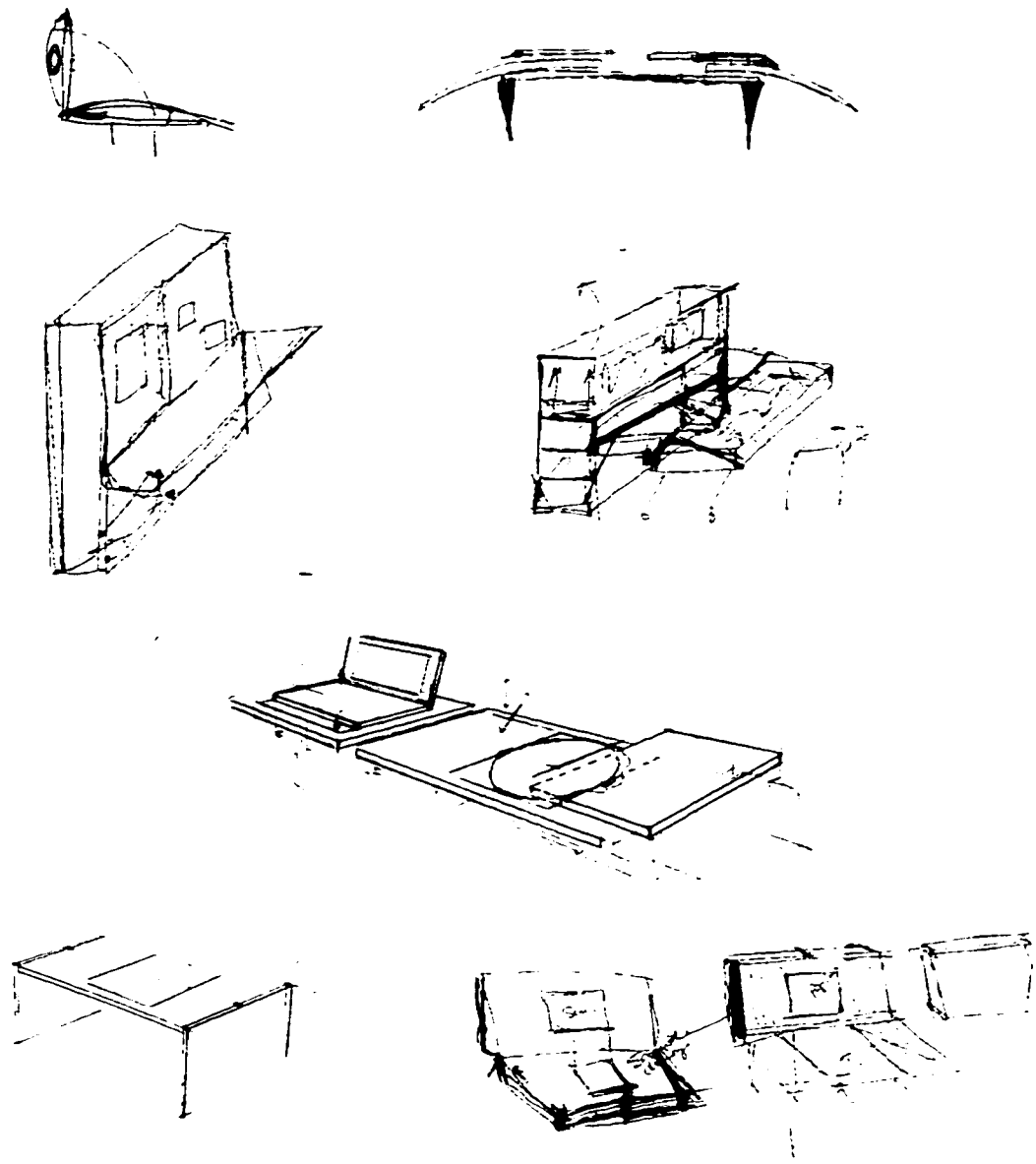


figure 35: Horizontal concepts.

The intention of the various explorations is to make the product meld into the room when not in use and alter the perception of the room when used. This transformation is important to help the worker travel 'to and from work' and separates the office from home by altering the perception of the entire environment. The intention of helping clients or family members view the home office environment in a more professional manner is considered in these concepts.

Vertical free standing and vertical hanging designs become the focal direction for further exploration, as these concepts seem more in tune with attaining: *a perceived separation between home and office in the workplace residence environment.* (figure 36 and 37)

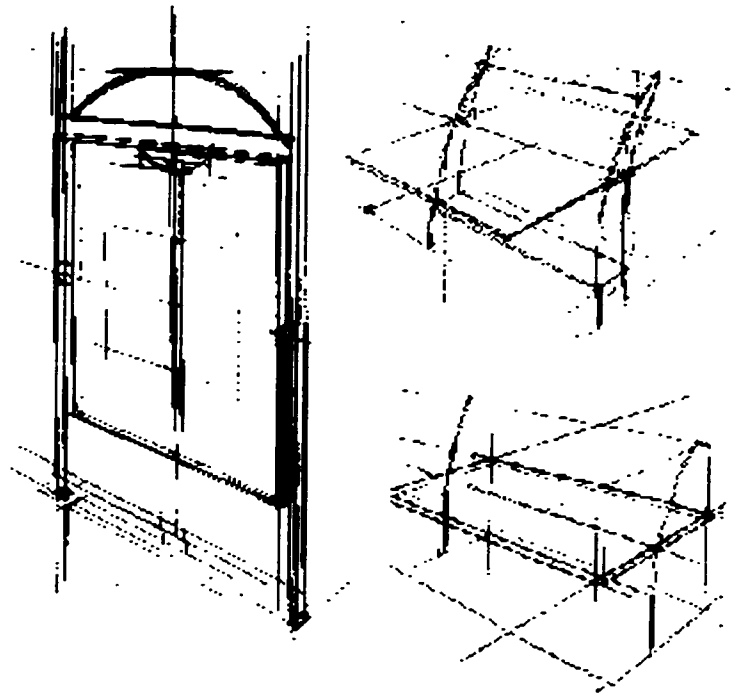


figure 36: Further development.

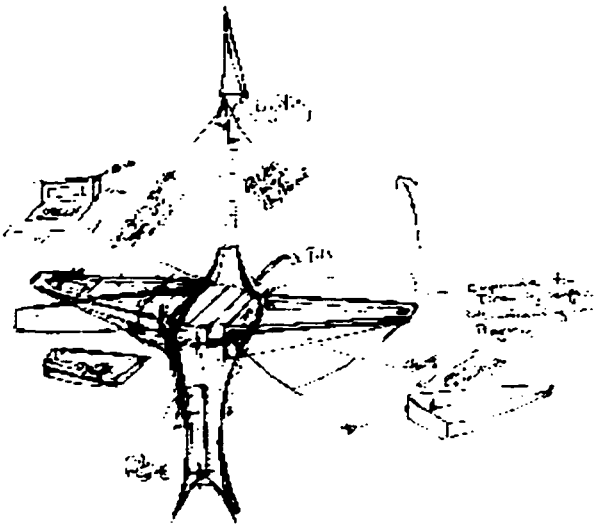


figure 37: Further concept.

It is thought that horizontal concepts hold too closely to traditional desk designs, continually reminding the worker of the office in the home. This objective is constant throughout the design process, affecting many elements of the workstation design direction.

Appearance

Factors that drive the appearance of the workstation design are; the design must be unobtrusive, thus conducive to the mood of the 'home' when not in use, and its immediate purpose must be ambiguous. These factors stem from research that shows perception can greatly affect the success of the home office. (See Part Two, Section One: Space) In conjunction with this research, the objectives: *to provide the ability to use the optimum space of the environment, and achieve a perceived separation between work and living arrangements* also created these appearance factors. As these factors become more rooted in the design, the workstation's appearance

becomes simpler. A struggle throughout the design process occurs, as aesthetics and the ability of the workstation to blend, continually conflict. (figure 38)

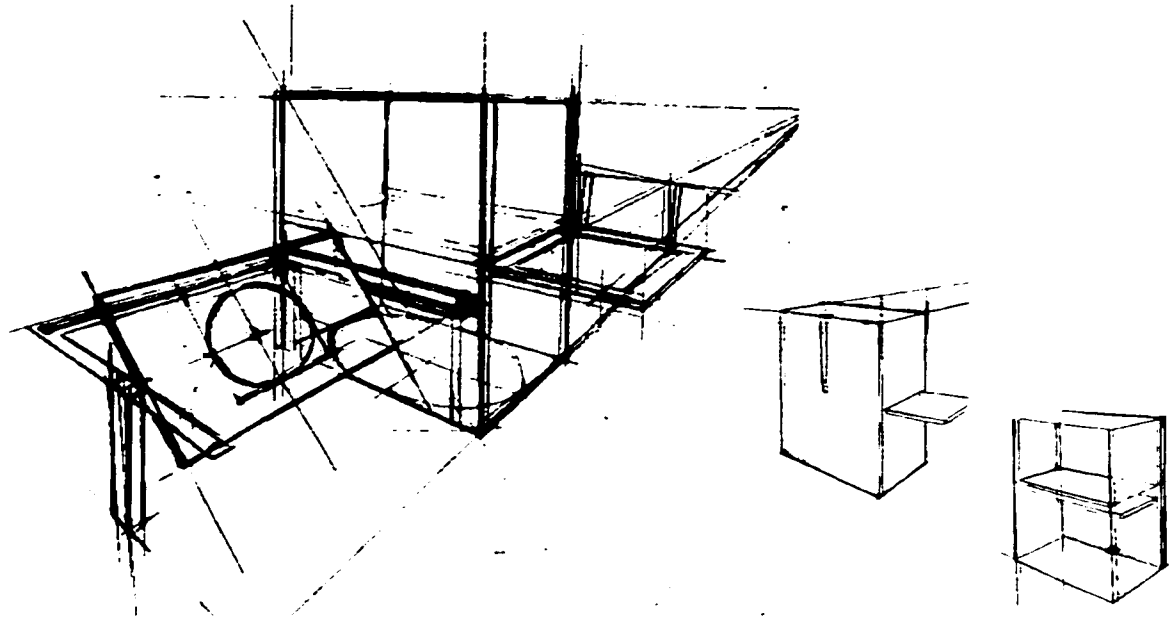


figure 38: Appearance concepts.

Professionalism

Attaining a sense of professionalism is a common problem for many home workers. (See Section One, Chapter Four: Professionalism) Combining a strong sense of professionalism, while maintaining the privacy and intimacy of the home, is a complicated objective. The idea to make the workstation a transformational station, one that is not initially perceived as a desk, lends itself to preserving privacy when the office is not in use. In initial design sketches, the desk's opening is used to signify to the user/client that this is now an office. This ritual marks a change, establishing a professional environment. It is thought that the workstation's opening will condition the user, family and clients, to accept the home office's professional status.

Although much theory is based in this objective, the challenge is in making it a concrete design feature. This continually affects the direction of the overall project and appearance constraints of the workstation.

User

The user is of course an influential factor in the design process. Who the end user will be affects the components and necessary requirements of the workstation design. Initially the main user is thought of as an individual(s) in the 25-40 age grouping, male or female, professional, artist or service oriented, entrepreneur or contract worker, with or without children, living in either their own home or rental property. The user runs a business from home or studio, full or part time and is not satisfied with present furniture abilities and workplace residence situations. A specific interest in the fields of industrial design, architecture, graphic arts, illustration, computer graphics and engineering is evident in early conceptions of the workstation design. Certain components are included in initial concepts because of these specific groups. This affects the direction of the design process. (See Part One, Section Three: Functional Factors)

A Working Surface

Early in the design process it is realized that a large working surface is a fundamental element. A working surface is a required furnishing in the small home and/or home office. Initial concepts conceive this table as convertible, maximizing space when not in use and providing a large area when used. The table's purpose is thought as multifunctional, acting as a conference table, large work area, or a drafting and sketching table. (figure 39)

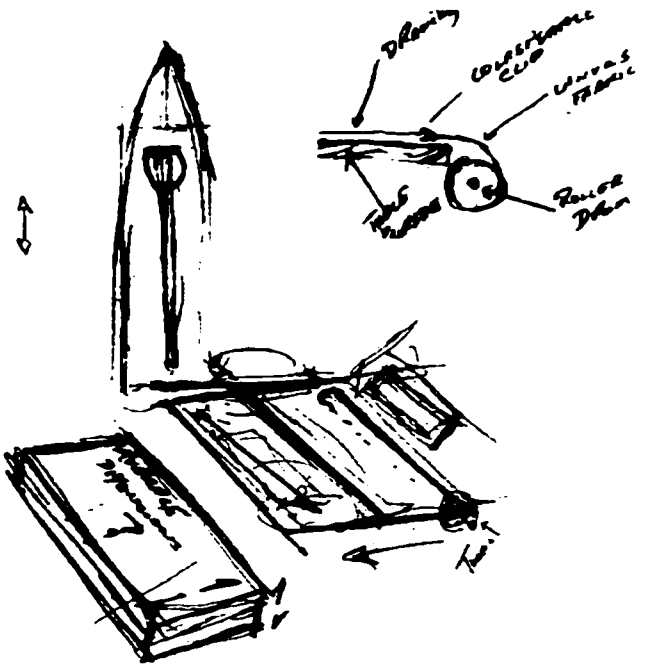


figure 39: Table conceived as multifunctional.

The size of the table is under intense scrutiny throughout the design process. Both the targeted users of the workstation, as well as projected activities affect this. An initial size constraint of A2 size paper (420 x 594mm /16.8" x 23.75") is required of the main table when fully opened. At this stage of the design process, it is determined that this size effectively combines space and work objectives. Much effort is spent in trying to attain a compromise between the functional aspects of the table and its compactness, in terms of space and storage. Various attempts to fold and compact the table's surface are explored. (figure 40)

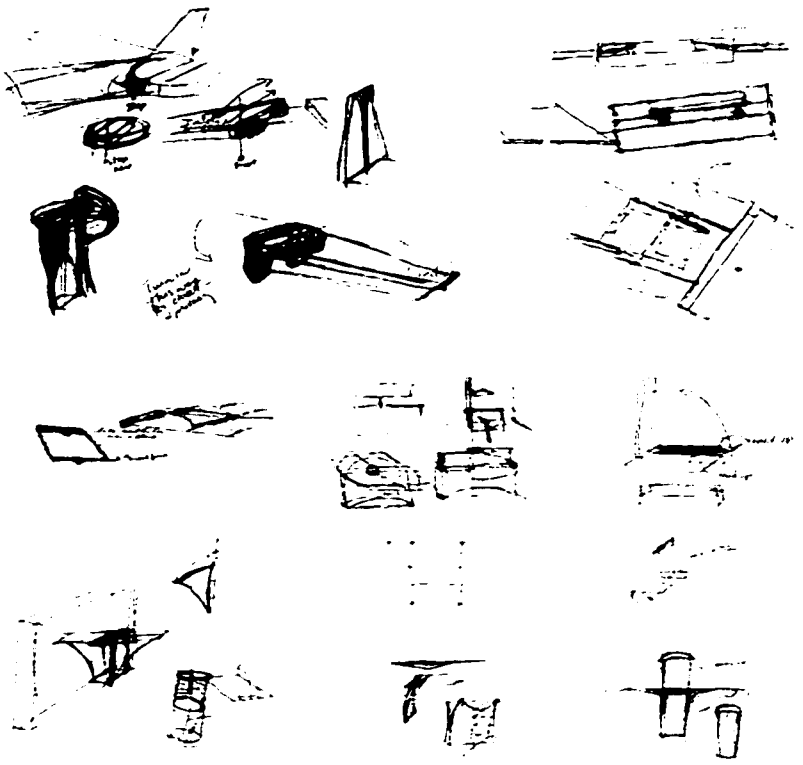


figure 40: Folding explorations.

Each exploration examines the effectiveness of the table's compactness, as well as how easy it is for the user to manipulate the table. This factor is relevant, as the table is used every day and therefore cannot be frustrating for the worker. As well, manufacturing and replacement of the table's components are important considerations during this stage. How easily components can be broken, bind or injure the worker is evaluated. These constraints affect the final design of the table.

A Working Surface - change in design direction.

Later in the design process it becomes evident productivity and time scarcity problems conflict with the desire to compact the size of the large table surface. (See Part One, Section Four: Productivity) The objective; *provide the ability to leave work in progress, increasing user productivity time* intensifies, as it is realized that

the ability to put away or start work quickly is a critical problem for many home workers, especially with children. The continual resetting of work leaves little time to accomplish anything. Exploration up to this stage has focused on compacting the table, requiring it to have many moving parts. This factor compromises the effectiveness of leaving work on the table surface. It is determined that the large table surface cannot be folded as quick storage and retrieval, as well as preserving work in progress, is more important to the overall workstation effectiveness. This alters the direction of exploration in the appearance and function of this table within the workstation.

A 900 x 1200 mm (36"x 48") table is now the working constraint. This size is deemed a suitable size in terms of use and ability to store. Exploration now focuses on how to store this large surface in a limited space. Vertical storage is considered the most efficient means of storing such a surface. (figure 41)

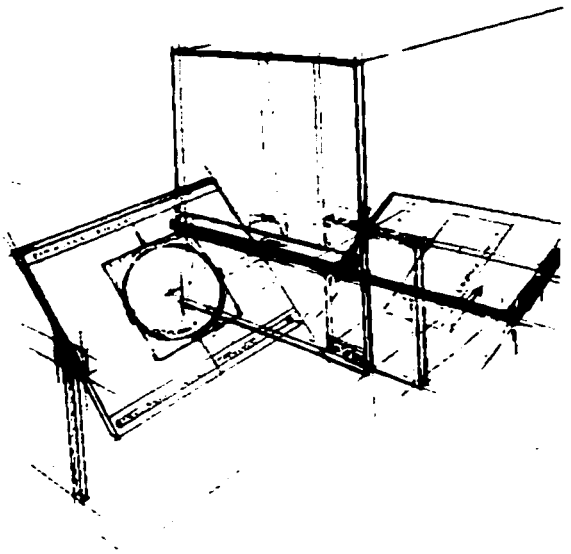


figure 41: Working surface – change in design direction.

The entire form of the workstation evolves within this new constraint. The table is now considered differently. It is thought that the table itself can act not only as a working surface, but also as a structural component of the entire design. Various

ways of moving, storing and using this large surface is explored. Space saving is still a desired requisite of the design, therefore, tall, vertical, thin in depth concepts are pursued. A maximum depth of 400 mm (16") is placed on the entire workstation design. (figure 42)

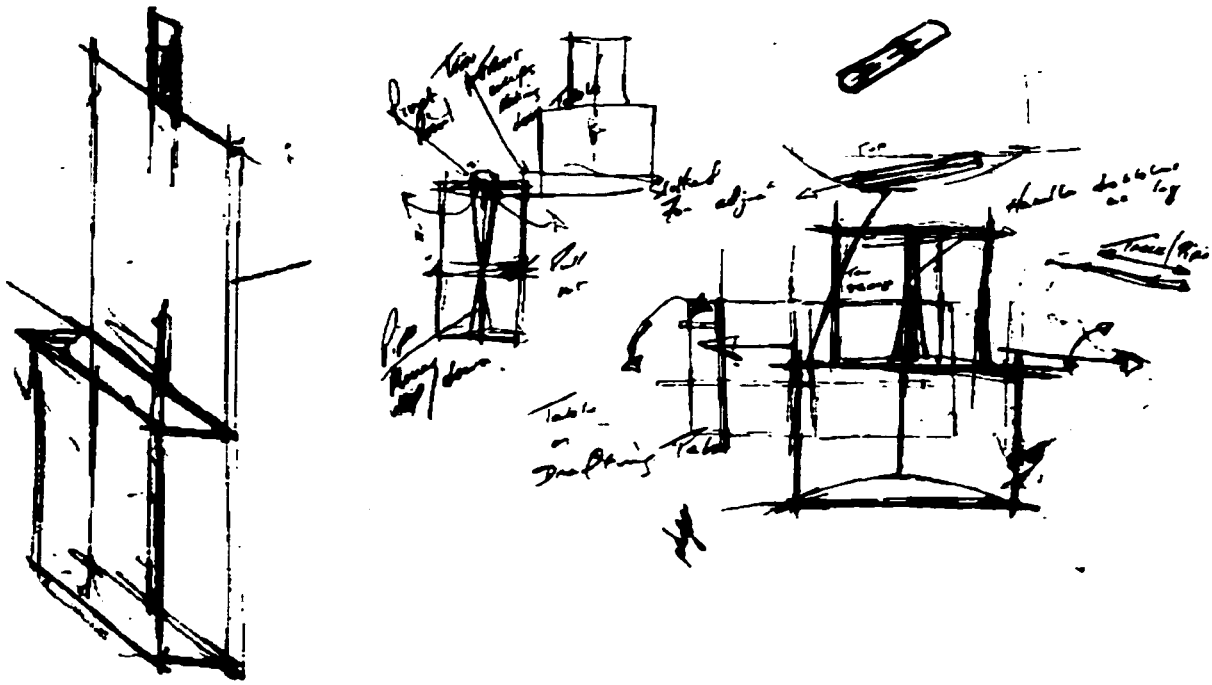


figure 42: Storing exploration of new table size constraint.

As the design process is not a true linear process, many factors are ongoing considerations. As mentioned previously, the object to *create a perceived separation,* affects the overall design possibilities and direction. In terms of the main table this objective continues to play a vital role. Part of the reasoning behind hiding the work when not in use, stems from the idea that this would help the occupant realize the 'home' environment. If the workstation, when closed, is unobtrusive, the room could take on many settings and if the design comes alive when used, a sense of separation is achieved. This direction is critical to the desk's overall success and is an underlying factor throughout the design process.

In this stage of development the table is considered as a hidden side, back and front layer. When stored the table is designed to lay flat in a thin protective wall that either slides behind or into a central unit that protects the work in progress. As a hidden layer, the problem now exists in getting the table from storage to a workable position. (figure 43)

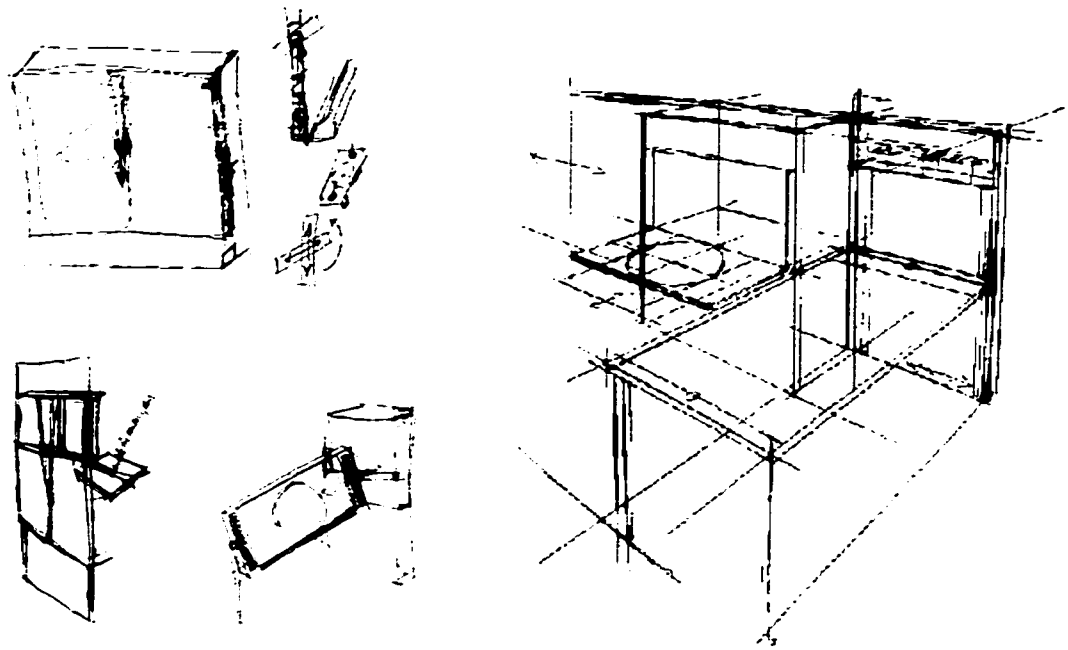


figure 43: As a hidden layer.

Exploration focuses on bringing the table from various storage points to the working position. A track system that moves the table up or down into the working height is tried. Pin and crank systems are also explored in these configurations as well as hinge, pulley and weight systems. (figure 44)

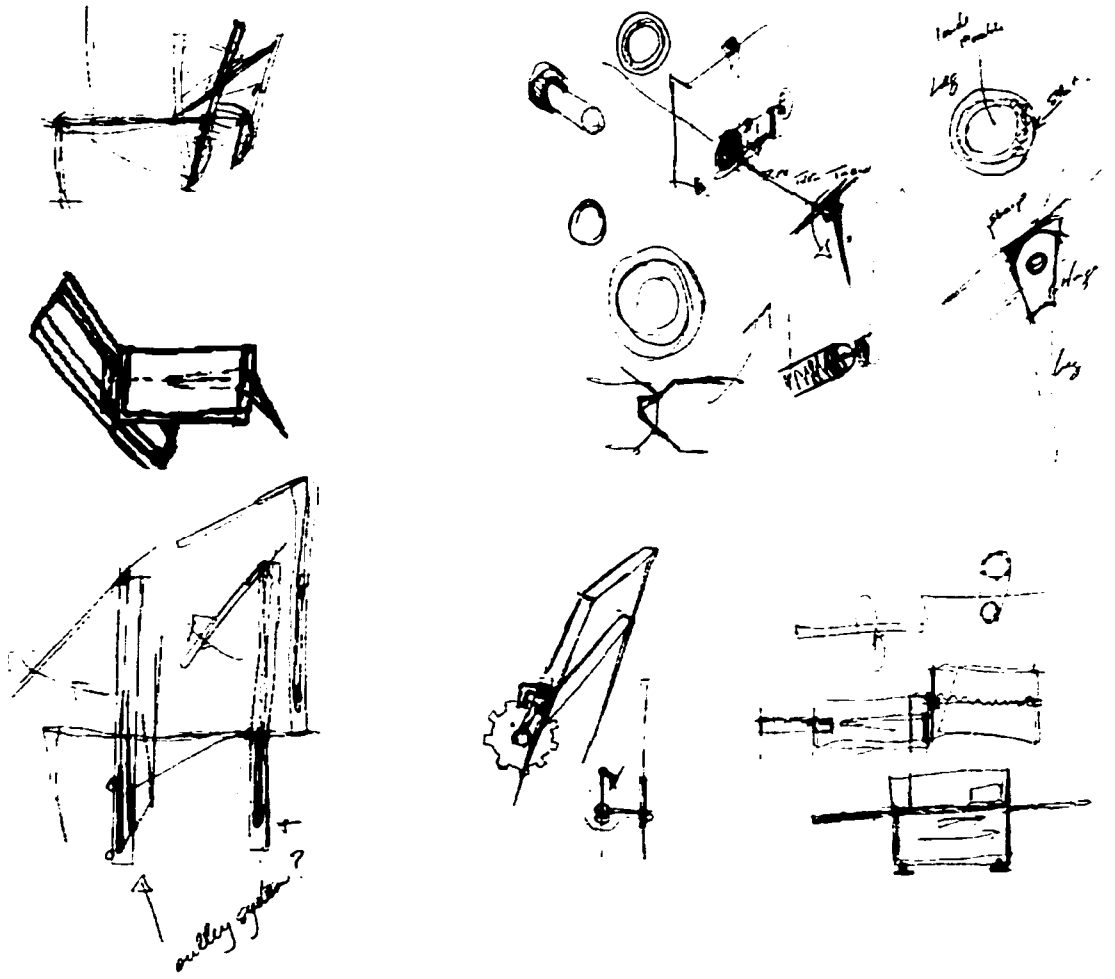


figure 44: Various systems explored to move table from stored to working position.

Since storing unfinished work is central thinking during this stage of the design process, design concepts that use the back as well as the front of the main table are focused upon. Although it is important that the user protects work in progress, it is vital that the table is moved either into a workable or storage arrangement quickly, easily and effectively. If this combination is not achieved, the worker will feel frustrated by the workstation design.

In conjunction with these considerations, effort is focused on a design easily used by a large population. A diverse set of the female and male population must be able to

use the workstation effectively. The table movement, placement and adjustability must be simple, easy and effortless for the user. (figure 45)

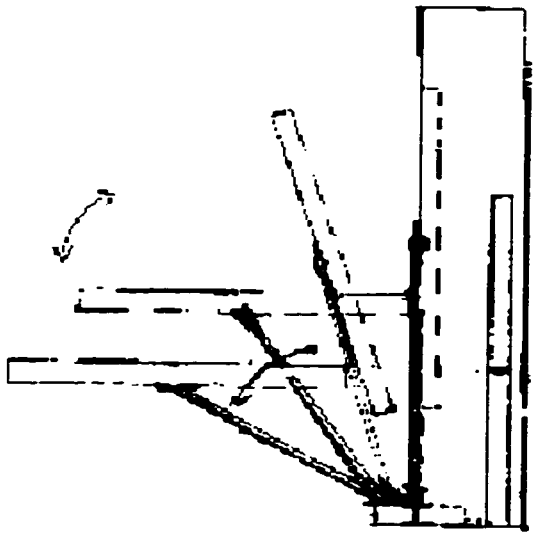


figure 45: Adjustability and user population.

A constraint is placed on the workstation design that makes the usage difficult for small children. This constraint is meant to protect the child, the integrity of the work-in progress and other materials hidden within the workstation. (See Part Two, Section Two, Mechanism: Foot Release)

A third problem arises at this stage. Since the workstation is meant for a diverse population, it is fundamental that the main table is adjustable in height and angle. Previous design concepts to this point downplayed this criteria, focusing only on size problems. Adjustability becomes a critical factor and now solutions are evaluated in terms of their effectiveness. As ease and adjustability are factors that influence each other, they become focal concerns at this stage of the design process. Many ways of adjusting the main table are explored. Various mechanical solutions are tried and

evaluated in terms of their adjustability, ease of use and maintenance, material components, cost and so on. (See Part Two, Section Two: Mechanisms)

Components of Large (drafting) Table

A discussion of components conceived to be part of the drafting table during the design process follows. These components are; light table, storage in table, drafting arm, leg and work in progress protector.

Light Table

Original concepts incorporate a light table within the large table. It is thought that this would be an useful feature for the user. Exploration in terms of size, shape and lighting are considered during this stage of exploration. The light table is later removed from the large table surface as weight and moving considerations are deemed more essential factors. (figure 46)

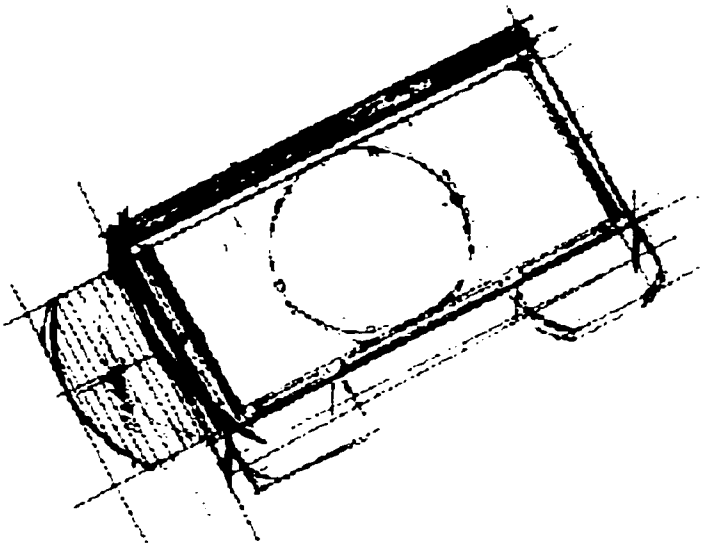


figure 46: Light table.

Storage in Table

The large table is also thought of as an opportune place for utensil storage specifically pen and markers, early in the design stages. Experimentation focuses on how to access these storage compartments easily.

Drafting Arm

A place for a mechanical arm is also considered in the development of the large table surface. A simple parallel ruler is deemed more appropriate because issues relating to storing the table and use of the arm arise involving this feature.

Leg

Many concepts for moving the table in and out of storage using a leg, are continually explored throughout the design process. Size, aesthetics, ease, mechanism manufacturing, cost, weight and structural integrity are critical factors considered throughout this exploration. (figure 47) (See Part Two, Section Two: Mechanisms)

figure 47: Exploration using leg in table.

Work in Progress Protector

A protector becomes part of the large table design in the middle stages of the process. Since leaving work in progress is a desired objective of the project, protecting this work is essential. Design considerations for this element includes; ease of use, material, maintenance and location. The size and location of this element changes throughout the design process. (figure 48)

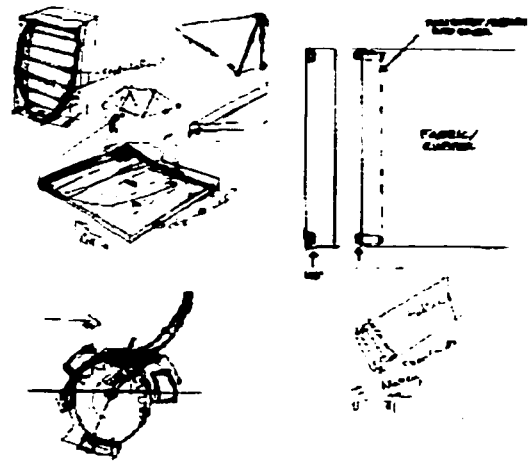


figure 48: Work in progress protector exploration.

Wiring

Experimentation focuses on attaining the most effective and simple means of providing power for various components of the workstation and its equipment. Wireless technology is also considered as an appropriate and recognized means of solving these issues, especially for essential computer equipment. (figure 49)

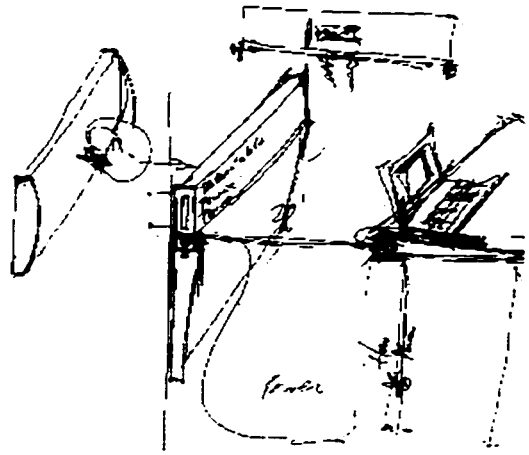


figure 49: Wiring exploration.

Storage

From conception, only daily storage is considered for the workstation design as space saving is a critical aim. (See Part Two, Section, Two: Maximizing Space) Possible user activities influence storage facilities. Storage for large drawings becomes essential for the worker who designs and draws and is considered a common problem. Book, utensil and paper storage is deemed important, as is storage for floppy and compact disks. Storage becomes simple providing empty compartments for individual preference. Since the overall design changes in form throughout the process, storage is continually evaluated. Research concentrates on different means of storage and expands the possibilities for the workstation effectiveness. (figure 50)

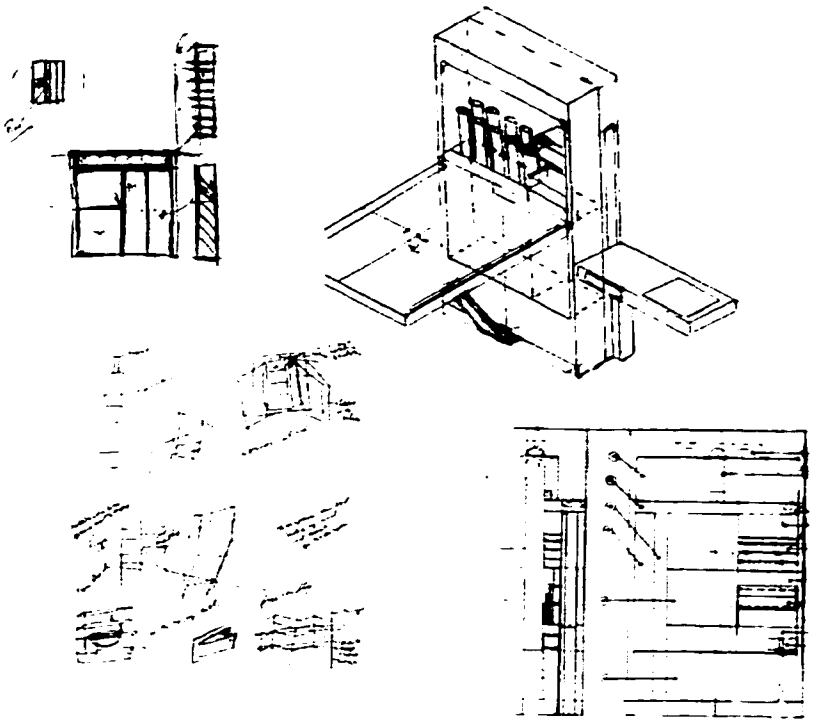


figure 50: Storage.

Office Furniture Layouts

Furniture layout research is explored early in the design process to provide a better understanding of working arrangements. This element is important in how the workstation design can maximize the efficiency of the worker, increase productivity levels and provide a positive and stimulating set up. Layout research helps confirm the realization that the workstation design needs to provide different combinations for the user. This thinking makes the large table, computer table and storage components both complementary and separate entities throughout the design process. The L-shape configuration is determined to be the optimum layout as this shape provides the ability to use the workstation components at the same or separate times. From this point, design concepts evolve within this L-shape configuration.

Computer Work Surface

Even in the beginning stages of design a separate work surface for computer and writing activities is considered important. Having a separate surface provides the user with the ability to perform more than one task at a given time, as well as leave work on the large working surface. The computer table when closed, is conceived as a hidden compartment, providing a sense of security in a separate component. The equipment placed within it largely affects the size and form of this component. Consideration in terms of cost, size and fundamental equipment needs are constantly evaluated throughout the design process. Early in the formative stages, laptop and flat screen technological are deemed essential equipment directions.(figure 51)

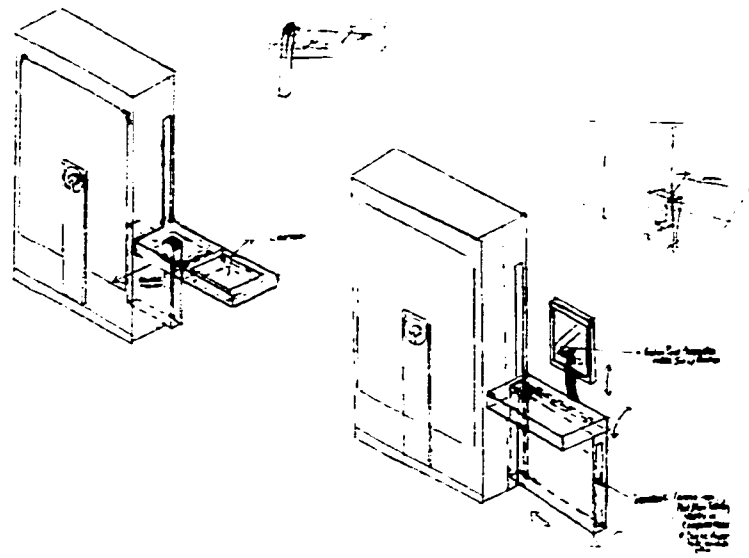


figure 51: Laptop and flat screen explorations.

Desktop equipment, because of its massive size, comparative cost and effectiveness to laptop/flat screen technology is deemed inappropriate future technology for the home office worker.

Because the computer table's equipment is stored within the table, security and stability become more important than adjustability to the design, as an ergonomic

chair is planned. Since the computer table is thought of as being a hidden component, the table must rotate from within the workstation. A set height is deemed the most effective compromise. Ergonomic research is conducted, evaluating the most appropriate stationary working height. It is decided that a set table height combined with a chair's ergonomic flexibility will provide a safe and workable station for the user. (See Part Two, Section Two: Chair)

Design exploration concentrates on making the use of this table simple and effective. Relevant elements become a laptop, combined printer/ scanner, place for wiring (if wireless technology is not implored) and mechanism considerations that bring the table from a stored position to a working position easily, safely and quickly. As well, it is thought that this table could be used as a writing or quick note taking surface so exploration that keeps the computer equipment within the table follows. The width, depth and length of this table also goes through a transition in the design process. As ergonomic heights are critical and knee clearance varies for the user population, table thickness is considered in terms of; computer equipment thickness, ergonomic effectiveness, weight and awkwardness. Some experimentation is done in terms of where the mechanism that moves the table is located, as this affects the location of equipment inside the table. (figure 52)

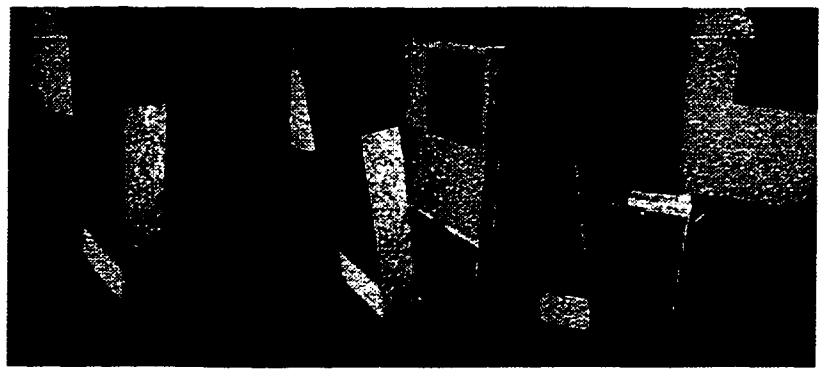


figure 52 : Moving the computer table easily.

Another consideration at this time is how stable the table is in the working position. Thought is given to how much force and weight can be placed on the surface. Because of this consideration the lower segment of the table, the table support or hard drive space, is continually explored in conjunction to the moving mechanism of the table. Length of the computer table expands throughout the design process, increasing the effectiveness and use of the table. (figure 53)

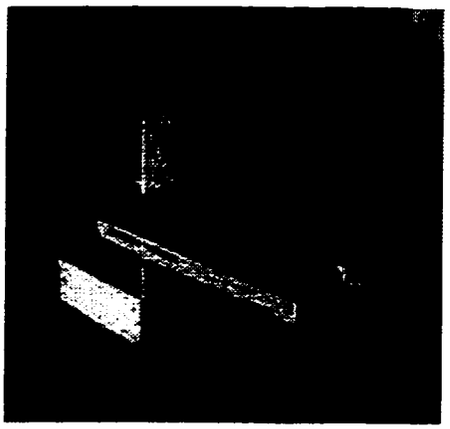


figure 53: Computer table in set height exploration.

Table width also goes through a transformation. When the overall workstation width changes so does the computer table width change. This design places the computer table parallel to the width of the overall workstation for two reasons; not to interfere with the possible working combinations of the large table and to provide more opportunities for mounting the overall workstation. (figure 54)

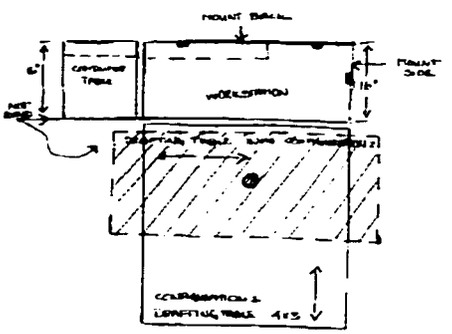


figure 54: Design considerations.

It is deemed that the computer table width becomes 400 mm (16"). This width is evaluated as the opportune width considering the following design factors; maintaining a minimal size and perception of size for the workstation, and ergonomic research showing this width as an appropriate minimum working surface for computer or writing use. (ANSI/HFS-100, 1988) (figure 55)

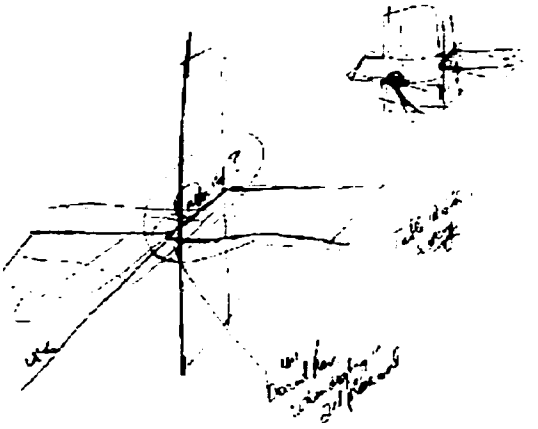


figure 55: Depth of computer table.

Chair

A chair is a relevant component of any office. It is decided early in the project that the workstation design would not incorporate a chair. This decision is due to two main reasons. Firstly, the scope of this project is substantial and it is decided that a chair design would be an entire project within itself. Secondly, it is determined that ergonomic evaluations of a chair would be more beneficial to this project's success and effectiveness. (See: Part Three, Section Five, Ergonomic Guidelines for a Ready made Chair.) Chair design is evaluated throughout the design process in how it affects the worker and the workstation design. (figure 56)

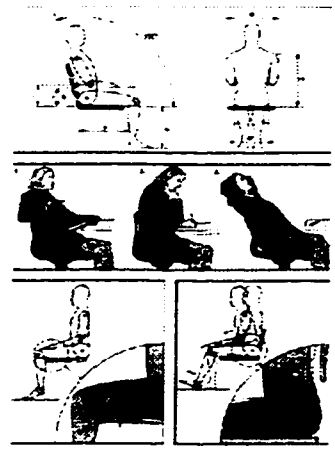


figure 56: Chair evaluated by ergonomics.

Ergonomics

Basic ergonomics are constantly considered during the workstation's conception and evolution. Activities completed at the workstation are affected by ergonomics therefore each decision is evaluated by this criteria.

Electronic Equipment

In the early stages of the project electronic equipment is researched in order to determine constraints for the workstation. Laptop and flat screen technology become the appropriate equipment for this project's design development. These technological areas are deemed the leading direction for the home worker.

Lighting

Lighting is initially conceived as two fold; establishing a 'life force' for the workstation in it's opening and illuminating the work surface for the user. Lighting research focuses on attaining the most effective lighting for the workstation, as well as environmental effects. Different lighting options are experimented with; tungsten, halogen and PL lighting.

Lighting makes the unit self-contained, increasing its use in any room, environment or setting and eliminates any possible placement problem for the workstation. It is determined that a light source in the 75mm(3") computer compartment is ineffective and that light from the drafting table's close proximity is sufficient. Different clip-on lights for laptops are considered and can be stored in the main storage area. Task lighting is conceived as a readymade element that could be kept in the storage area.

Workstation Mounting

Due to size constraints, immediate consideration is given to mounting and stabilizing the workstation. The unit is also affected by user limitations, such as construction or alteration constraints. It is thought limiting damage should be the operative factor in these design concepts, focusing on mechanisms and mountings that are easily installed and removed. Wall construction is researched, affecting the location of the mounting components. Various ways of mounting from the wall, floor and ceiling are experimented with. It is determined that wall mounting is the most efficient in terms of space, availability in the home, user accessibility and damage. Two possible ways of mounting the workstation evolve providing the user with more arrangements within a given space.

Materials

Very early design concepts focus mainly on workability of the workstation. It is not until later in the process that material and its effects on the workstation come into focus. Wood and metal become the essential elements of the workstation, as the project progresses from sketch modeling and drawing to appearance and working model stages. It is decided that these materials compliment the home as well as the home office environments. Wood and metal are also viable materials in terms of construction and durability, they are easily and locally available and considered complementary materials for one product.

Specific wood and metal materials are explored examining the appearance, strength, compatibility and finishing effect of each type considered.

Effect on the User

End product use is considered early in the design. The size of the workstation is relevant not only in terms of the design's objectives but also in terms of the ease with which the product can be moved into and within the home, transported, packaged, assembled, and disassembled. These factors cannot be problems for the end user and are continually addressed throughout the design stages.

Mechanisms

Exploring mechanisms and expanding mechanical knowledge are some original aims for the designer. Although considered secondary, mechanisms become an important area of exploration, as these elements truly determine the workstation's success and effectiveness. Mechanisms are thought of as tools to complete the objectives of this project. The intention of any mechanism found in the workstation design is to make the workstation easy to use for the end user. Discussion of the various mechanisms follows. These include; drafting table mechanisms, foot release, lock drafting table to cabinet, slider to move drafting table, computer table mechanisms.

Drafting Table

The large table is conceived as a transformation component, coming out of the main compartment of the workstation. (See, Part Two, Section Two: A Working Surface) Exploration starts by examining how to move the table from a stored to a working position. Research explores present drafting table mechanisms and applies their principles to this project. (figure 57)

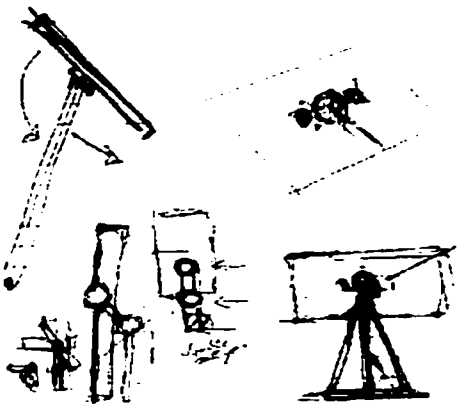


figure 57: Drafting mechanisms research.

Since the large (drafting) table goes through a transition stage in the design process, exploration for the moving mechanism follows this exploration. Original design concepts have the table being moved internally by some mechanism with a leg that acts to support the table in the working position. (See Part Two, Section Two, A Working Surface- change in design direction: hidden layer) This leg hides within the table's face when not used and acts as a stop as the table reaches the floor, as well as a handle to put the table away. This concept direction is dropped. It is thought that the leg and mechanism to move the table would be more efficient as a combined element since the previous concepts require the table to lose some working surface to accommodate the mechanism that provides a horizontal tilt adjustment. These previous concepts also require a separate mechanism for a horizontal tilt adjustment. It is decided that a ball joint system would provide the best adjustment for the user. The ball joint system can combine the horizontal and vertical adjustments to move the table and can be incorporated into a leg. This system is explained below.

Drafting Table - Ball-Joint

The ball-joint is conceived as being mounted within the table itself. This mechanism is chosen for three reasons; the table at this point in the design process, needs to be flipped completely around from storage to a working position. (figure 58)

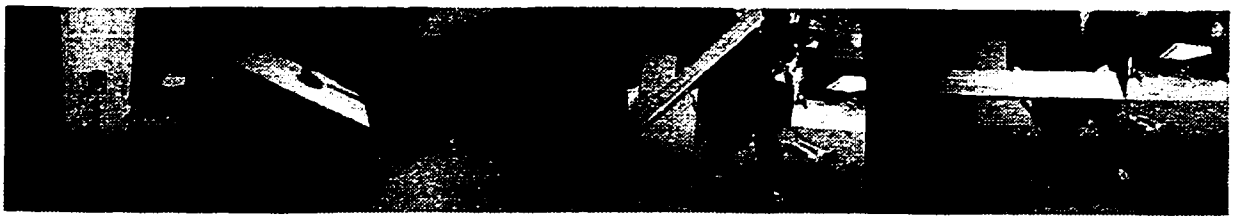


figure 58: Flipping table from storage to working position.

Secondly, it is thought that the table should be able to move into a variety of working arrangements for the user, thus it needs to turn completely right or left. (figure 59).

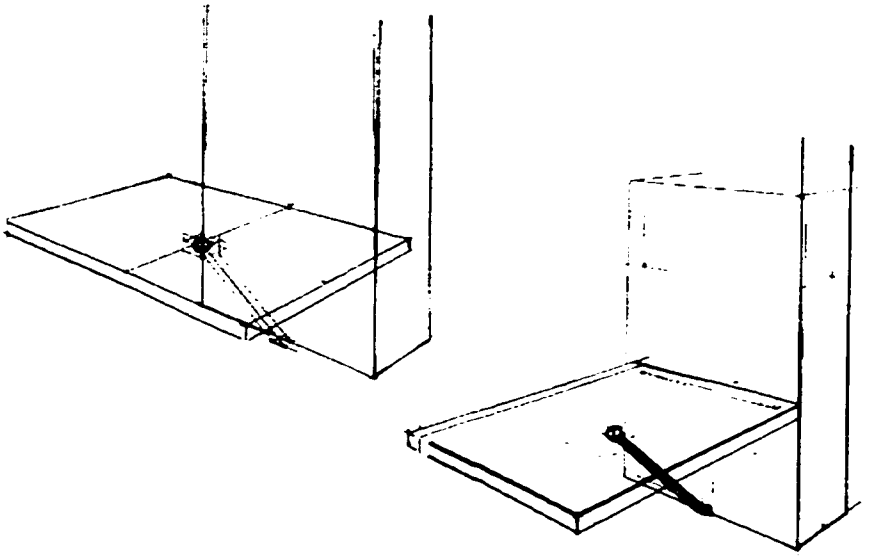


figure 59: Configurations of drafting table.

Lastly, the ability to adjust the horizontal and vertical angles of the table can be combined in this mechanism. (figure 60)

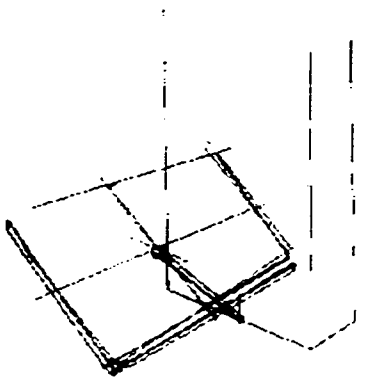


figure 60: Adjusting table angle.

The ball-joint and handle are tested for their strength, stability and holding power. Much exploration determines the optimum; ball size, material choice, construction techniques and attachment of the joint to the table. The ball-joint cover and handle are examined in terms of; material, construction and fastening. (figure 61)

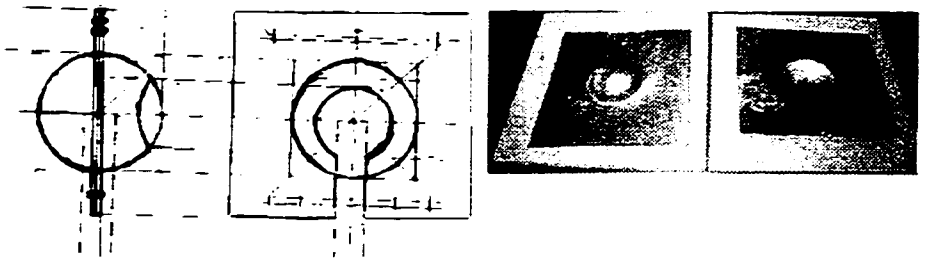


figure 61: Experimentation with ball-joint covers.

Drafting Table - Mounting Ball -Joint to Drafting Table

It is thought that the ball-joint should be mounted within the drafting table to blend in when the workstation is closed. Some experimentation is done as to how far the mechanism should be placed within the table. (figure 62)

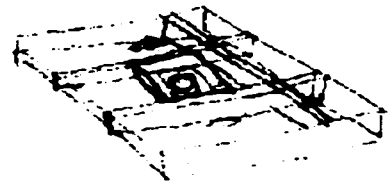


figure 62: Mounting ball-joint in table.

Putting the mechanism in the middle of the drafting table is deemed the structural opportune location. This decision affects the outside appearance and overall height of the workstation. The height adjustment requirements of the table leg mechanism are also affected by this location, as the table is designed to accommodate different users. (See Part Two, Section Two: User) Some compromise between optimum overall height, table placement and adjustment is attained through experimentation with the front kick height.

Drafting Table - Height /Locking Adjuster

The lower half of the ball-joint evolves to become a height and locking adjuster for the drafting table. During this stage much exploration is completed to determine the most efficient mechanism to move and lock the table. This mechanism goes through an immense evolution, as attaining infinite height increments becomes a design constraint of the table height adjustability. (figure 63)

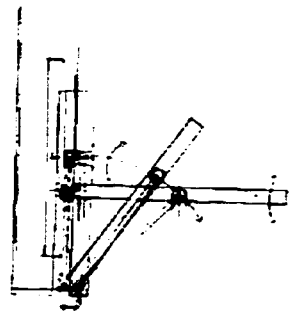


figure 63 : Infinite adjustability becomes a criteria.

As each mechanism is completed, the stability and holding strength of the table while in use is tested. Play in slight upward motion of the table surface is allowed, although a downward pressure of 60 pounds is given for the table's holding requirement. Different mechanisms are developed and constructed in this stage. These mechanisms; simple pin, simple gear, three-gear, internal cone, internal plate and spring, are explained below.

Height/Locking Adjuster - Simple Pin Mechanism

The simple pin mechanism is a very early concept where the table leg rotates within an arc whose height adjustment is controlled by a hole and pin locking system. (figure 64)

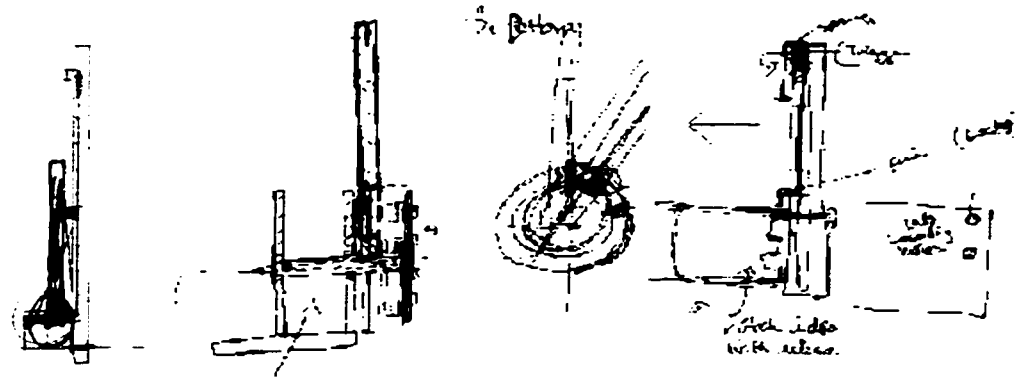


figure 64: Simple pin.

The main problem with this mechanism is that the user has minimum height positions. Variations of this concept experiment with; hole spacing, pin position and thickness, release mechanism and location and the location of the central shaft within the arc(s).

Height /Lock Adjuster - Simple Gear Mechanism

The simple gear mechanism makes the main leg a central shaft within a gearbox. As the central shaft is released by a pin mechanism it becomes free floating, and able to move into the desired height. Replacing the pin locks the central shaft, as the internal stopper finds a tooth gear to slip into. (figure 65)

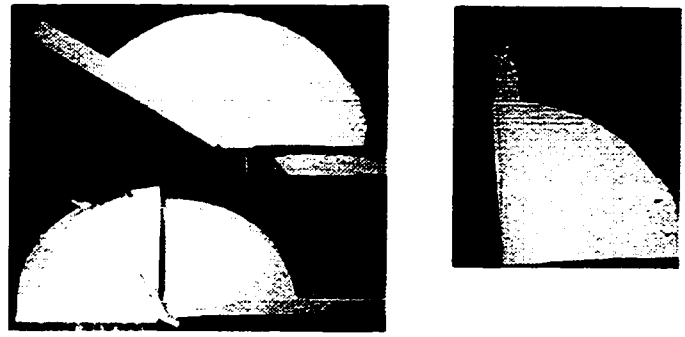


figure 65: Simple gear.

Although this mechanism is strong providing a secure lock on the central shaft (table leg) that does not easily slip, the problem is that the tooth system only allows a few height positions, as the small tooth ratio to long leg ratio converts. Various forms of this system are explored changing the number of teeth in the gear, the size of the gear, placement of the gear to shaft as well as differing pin internal stop mechanisms.

Height/Locking Adjuster – Three-Gear Mechanism

Stemming from the simple gear mechanism, the three-gear system explores a series of gears. The intention of this exploration is to provide more height adjustments, as well as a smooth opening and closing of the table. A large gear is enclosed in a hollow tube that the central shaft (leg) is attached to. This gear is mounted on a central horizontal shaft that interacts with two smaller gears that rotate, to create the leg movement and height adjustment. (figure 66)

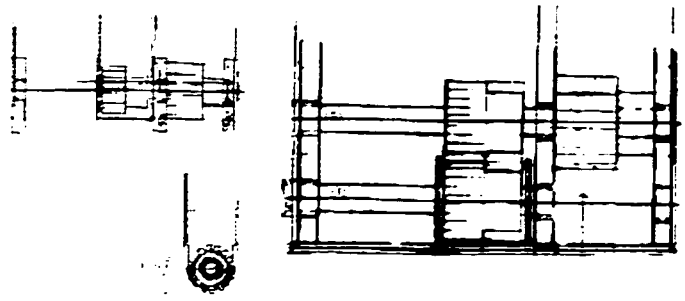


figure 66: Three gear exploration.

Again, problems with attaining more than a few height adjustment stop further development of this concept.

Height/Locking Adjuster - Internal Cone Mechanism

In this system the central shaft is mounted on a hollow tube that rotates on a central horizontal shaft secured by outside plates. The table is released and locked by internal cone components on a friction-based system. (figure 67)

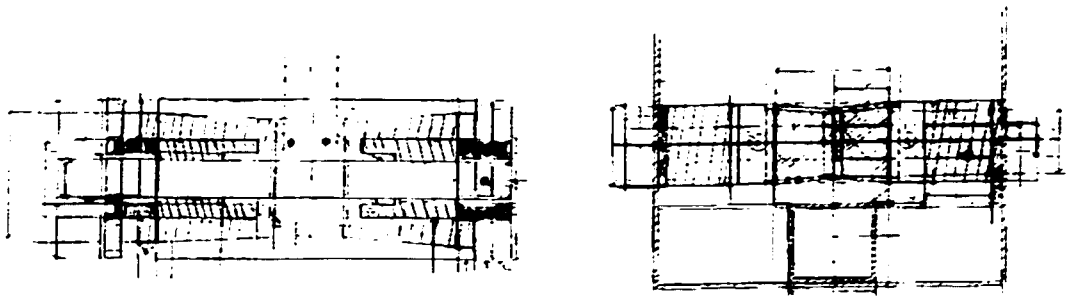


figure 67: Taper systems.

These cones are released by a central pin that increases pressure on the internal springs (away from the cones), allowing the cones to move slightly out of the internal taper that locks the cones and attached leg in place. The spring, compressed

inside each cone, places pressure from the outside edge so that when the release is let go, the cones are shoved back into the locking position. This mechanism includes the foot release concept. (See Part Two, Section Two, Mechanism: Foot Release) (figure 68)

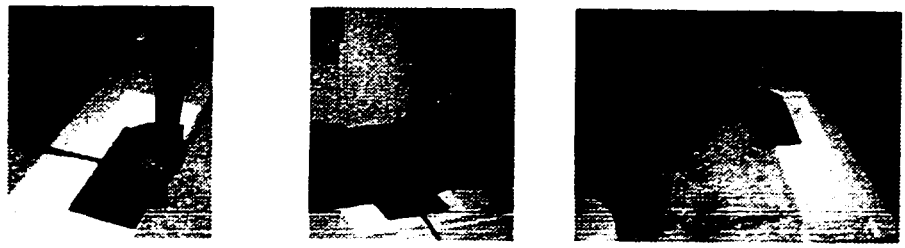


figure 68: Friction system.

Exploration within this concept concentrates on: altering the internal taper to cone surface, spring tension, length and power, outer cylinder diameter, cone diameter, width of entire mechanism box, plates that rotate with central shaft, central shaft thickness and weight and material selection for components. (figure 69)

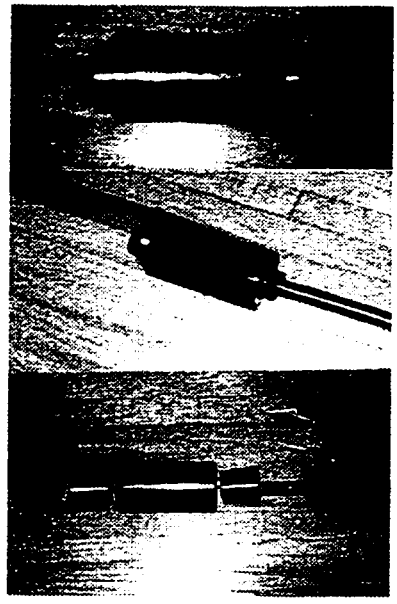


figure 69: Friction system internal components.

Although this system provides infinite height adjustments the holding power is questionable.

Height/Locking Adjuster - Internal Plate and Spring Mechanism

Developing from the internal cone and taper friction concept, this system follows the same basic principles as the last concept in attaining infinite height adjustments, but alters the internal components to increase and stabilize the holding ability of the mechanism. The hollow cone that the central shaft is attached to is not tapered and a series of plates are inserted. These plates come in two sizes and materials and alternate within the hollow tube. (figure 70)

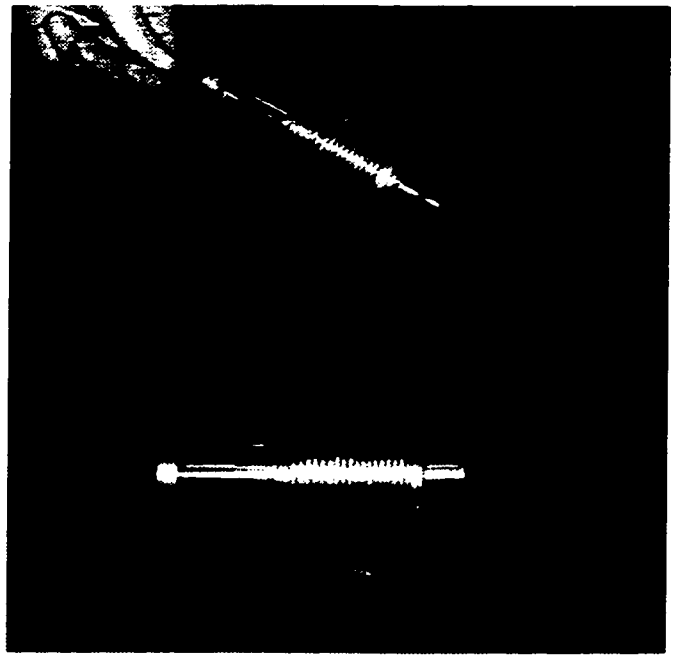


figure 70: Friction plate system.

A spring is inserted to lock the plates into a friction hold and the different plates are keyed to the internal shaft and hollow tube to complete the locking mechanism. The release mechanism moves to a side configuration from the central location, releasing the spring tension, which in turn releases the internal friction created by the surface

and number of internal plates. In this concept, a foot release is used. Experimentation focuses on: shaft thickness, key-way thickness, key-way numbers and positions, plate material, plate thickness and diameter, plate numbers and location, hollow tube size and thickness, internal spring tension, spring length, size and number, foot release spring tension, foot release spring numbers and length and foot release linkage system. (figure 71)

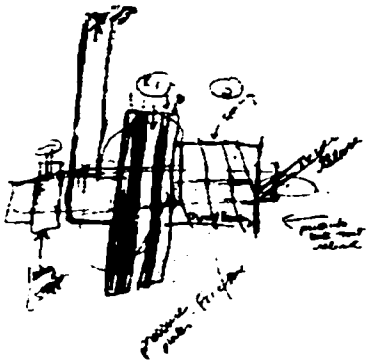


figure 71: Friction experimentation.

Foot Release

When the leg for the drafting table evolves from a peg to a mounted component, using it as a release mechanism is nullified. Now that the design requires the entire leg move with the table attached, a release mechanism is needed to bring the table out of the cabinet. Early in the research, it is determined that a release that automatically locks when not in use, is the most effective and safe concept for this element. This directive evolves from the fact that small children could be around the workstation, and frustration experienced with existing drafting table mechanisms that were prone to drop on the user. It is thought that the foot release mechanism when pushed would release the table and if the user's foot slipped, the table would automatically lock. (figure 72)

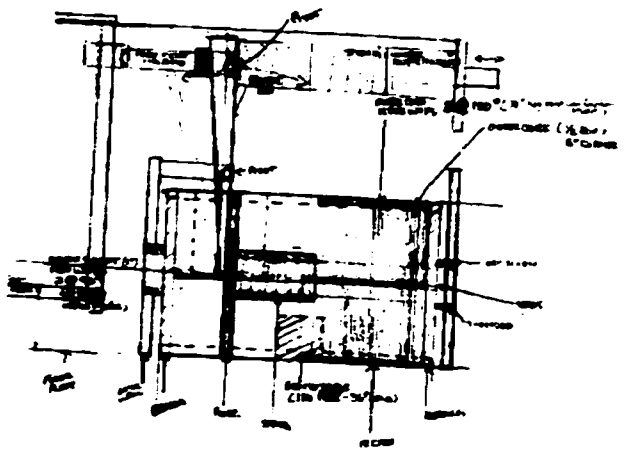


figure 72: Automatic lock in friction system by a foot release.

Experimentation in having the release incorporated into the ball joint handle or as a separate handle on the table's surface is done, but these directions are dropped as a foot release is deemed more effective in terms of construction and usability. Biomechanical research shows the act of opening the table suggests the user have both hands occupied in flipping the table and the foot is the logical choice for releasing and controlling the table during these movements. Experimentation then focuses on attaining an optimum foot release pressure. The pressure requirement used to unlock the mechanism is influenced by safety concerns, especially the presence of small children in the working environment and a diverse user population. Experimentation focuses on material selection, spring tension, linkage system, foot petal, manufacturing and binding problems.

Lock Drafting Table to Cabinet

Initial table movements and mechanisms required the development of a locking device to secure the table to the cabinet in the stored position. As the table's leg and leg release mechanism alters during the design process, the need for a locking mechanism vanishes. Since the leg works on a foot release that is always locked, the need for a table to cabinet locking mechanism is deemed redundant.

Slider to Move Drafting Table from Cabinet

It is first thought that the large (drafting) table with a central mounted leg, needs a slide mechanism to bring the table away from the stored position in order to clear the cabinet when flipping. (figure 73)

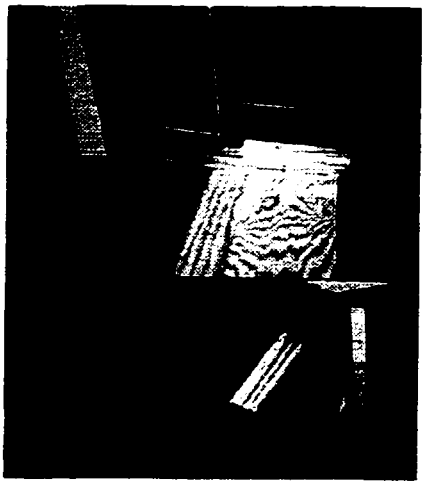


figure 73: Slider to bring table in and out of cabinet.

Experimentation focuses on slider size, width, strength and durability, as well as a moveable floor that the table and leg is mounted to. As it is realized that the adjustment in the table's leg angle allows the table to clear the cabinet, design of this feature is stopped.

Computer Table

The computer table mechanisms go through a series of exploration in the design process. The following; ball-joint, laptop locking mechanism, laptop height mechanism, printer sliding drawer mechanism and printer locking mechanism are discussed below.

Computer Table – Ball-Joint

When it is concluded that the ball-joint is the optimum direction for the large table movement, this mechanism is experimented with in the movement of the computer table. (figure 74)

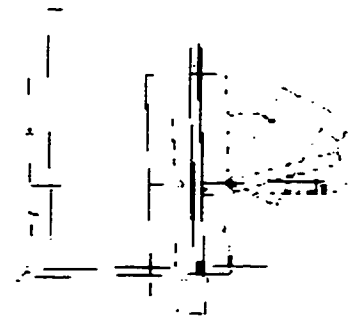


figure 74: Ball-joint to open computer table.

Size of the ball, ball covers, materials, angles, location within the table and mounting, are all experimented with during this stage. As the computer table evolves, the location of the ball-joint becomes more certain. (figure 75)

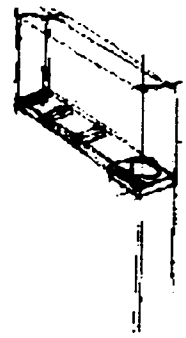


figure 75: Joint placement.

Consideration, in terms of hiding the mechanism and making the movement of the table from a stored to a working position simple, is very important during this process.

Computer Table- Locking Mechanisms Laptop

As the laptop is conceived as being an internal component of the computer table, concepts that secure it within the desk are scrutinized. Exploration is conducted that develops ideas for an internal secure placement mechanism and an external table locking mechanism.

Computer Table -Laptop Height Mechanism

Since the laptop is to be an internal component of the computer table when stored, a mechanism to bring it to the working surface height is needed. Experimentation at this stage analyzes ideas; that fit within the confines of the table size, is easily manipulated, is connected to the outer face of the table surface so that the motion of opening the surface brings up the laptop, is connected to the internal security mechanism that secures the laptop's position and manufacturing concerns and material uses. (figure 76)

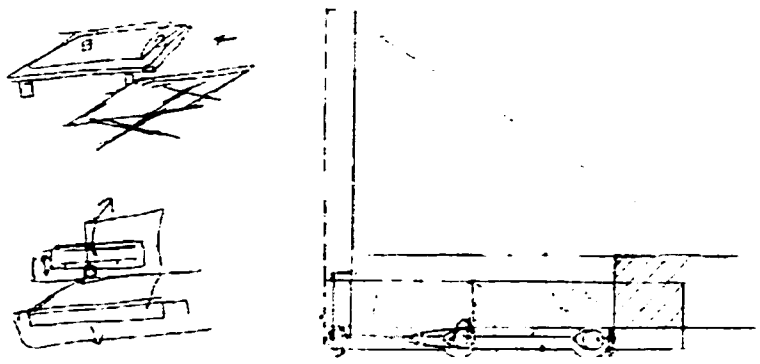


figure 76: Lifting laptop exploration.

Computer Table - Printer Sliding Drawer Mechanism

The printer it is decided early in the design should be inside the computer table, providing easy and close access for the user. Research on printer/scanner equipment

illustrates that a false drawer design best suits the printer and its use. Experimentation focuses on bringing the drawer out simply and effectively, stabilizing it when out because of the weight of possible printers. As well, consideration is given to providing a stop for the drawer, an internal mechanism that keeps the printer level at all times. Material for this drawer is examined for its strength, thickness (as the table's depth is minimal and the design requires the most space possible to allow for different printer heights), slide effectiveness and reparability.

Conclusions: Design Process

The design process is the act of evolving and expanding initial design concepts into a final format that fulfills the project's objectives. Throughout this process much experimentation, research, conceptual development and decision making, determines the final design direction. The final design direction is as follows:

The workstation is a transformational structure that blends into the 'home' environment when not in use and alters the perception of this environment when used. In use, the workstation provides a professional setting yet preserves a sense of privacy when closed. The overall design must be such that the station can be located in any room of the home. The large working surface (drafting table) acts as a structural component, as well as a working surface. Work must be able to be left in progress and the table easily stored. The main table working surface constraint is 900 x 1200 mm (3'x 4'). A computer table that stores a laptop and printer is included in the design. The computer table is transformational in design like the main table. Storage is conceived as daily storage and provided for within the confines of the 400 mm (16") maximum depth of the workstation. Lighting is incorporated into the design and wiring is provided for, although wireless technology for computer equipment is encouraged. Space is a prime concern of the design. Mechanisms are tools used to make the workstation's components and overall design successful. These decisions control the final design concepts.

Part Three: Final Design

Introduction

The design process conclusion illustrates a final design direction. (See Part Two, Section Two: Conclusions.) The design of the final workstation is based on these findings and is described in this section. This part is divided into the following sections; user, recommended computer equipment, product description, function and use, ergonomic suggestions for a chair, material and manufacturing, and raw costs. This part ends with a project summary and final recommendations.

Section One: User

It is expected that the main users will be individual(s) in the 25-40 age bracket, male or female, professional, artist or service oriented, entrepreneur or contract worker, with or without children, living in either their own home or rental property. The user runs a business from home or studio, full or part time and is not satisfied with present furniture abilities and resident workplace situations. A specific leaning towards the fields of industrial design, architecture, graphic arts, computer graphics and engineering is evident.

Section Two: Recommended Computer Equipment

In the world of computers and computer technology it is impossible to state an exact computer, printer or scanner for use in the workstation, as technology is changing so fast society can not keep up. One trend that seems to be popular with the home office and other workers is the tendency towards laptop and away from desktops. It is thought that this direction is due to: technological advances in laptop sizes, screen dimensions, color and output, flat screen technology, decreasing costs for computer types, increases in demand, market competition and the increasing use of one computer in the home, office, hotel, on the plane, in the car and so forth. International Data Corporation states people telecommute more than ever and predict a 24.2 percent growth in portable computer sales, compared to 12 – 14 percent growth in desktops.(Anderson, 1996.)

Desktops, although holding ground, are not as mobile as laptops and are losing technological advances over the laptop. Laptop chips are better and faster than before, can provide comparable Random Access Memory (RAM) and hardware sizes, have improved their abilities to run programs, and increased screen sizes and color resolution. For example the Eurocom 8500M laptop is marketed as a desktop replacement, boasting its 15.1" screen, RAM and hard disk drive, upgrade ability and processor (Sankey, 1988). For these reasons, the workstation from conception is designed to house only laptop or flat screen (and slim hard drive) technology. This decision is in keeping with space concerns, as well as the influence of the user's buying choices. When spending for home office equipment, the ability to have one computer for home and away from home, is a cost factor influence for many small businesses.

In terms of printers, scanners and fax machine, one compartment is provided for these components in the computer table although the storage area of the workstation body can house other relevant equipment. (See Part Three, Section Four, Function and Use: Computer Table) This decision is based on market research, which shows

portable printers capable of being scanners, faxes and copiers all in one, at exceptional quality, output and price. The computer market is recognizing the home office and small business entrepreneur and providing quality, quantity and value in smaller combination products for the user's money. It also appears that wireless technology is becoming more affordable, capable and acceptable to the user. (PC Portables, 1998.) Because of this, the computer table housing provides for conventional wiring, but the designer encourages the implementation of wireless technology.

Conclusions

Technology is changing everyday. Specific computer equipment is not stated. Rather decisions to design the workstation to house laptop and flat screen technology are explained in terms of home office usage and computer technology advances. Consideration is also given to the market, competition, use and abilities of this type of equipment.

Section Three: Product Description

The workstation is a transformational structure and can be located in any room of the home. Space is a prime concern of the design. In it's closed state it affords privacy and blends into the environment. In it's opening and open state, it alters the perception of the environment providing the ritual of 'going to work' (opening) and a professional setting for productive work (opened). (figure 77, 78, 79)

The workstation's overall dimensions are 1800 x 1000 x 400 mm (72"x 40"x 16"). It has four sides; front, back, right and left. All four corners of the station are cut at 45 degrees and fit together to form a rectangle. The station can be mounted in a room from the right (thin) side as well as from the back. The front side of the workstation is considered the one with the large (drafting) table set into the main body of the product. This maple table is 1200 x 900 x 87.5 mm (48" x 36"x 3 ½") in size, and is supported and moved by an attached brushed steel leg. The metal leg is composed of a post- in which a circular face, ball joint and adjuster are set into, covered by a rectangular, slightly tapered, brushed steel form. This metal leg is centered into the back face of the large (drafting) table and is mounted 125 mm (5") from the floor on the inside of the workstation.

The large (drafting) table when mounted with the leg rests 50 mm (2") from the top of the workstation. Two maple panels and a kick cover the last portion of this side. The back of the workstation is considered the side opposite to the large (drafting) table. Fabricated of a 18.75 mm (¾") maple board, this side acts as a support wall and can be used to mount the station. When facing the front of the station, the right side is considered the second mounting side and is composed of a 18.75 mm (¾") maple board. The left side is the one with the computer table and support positioned inside it. This table is 75 mm (3") in depth and mounted 375 mm (1.5") from the back wall. When closed the workstation appears as a wall or divider.

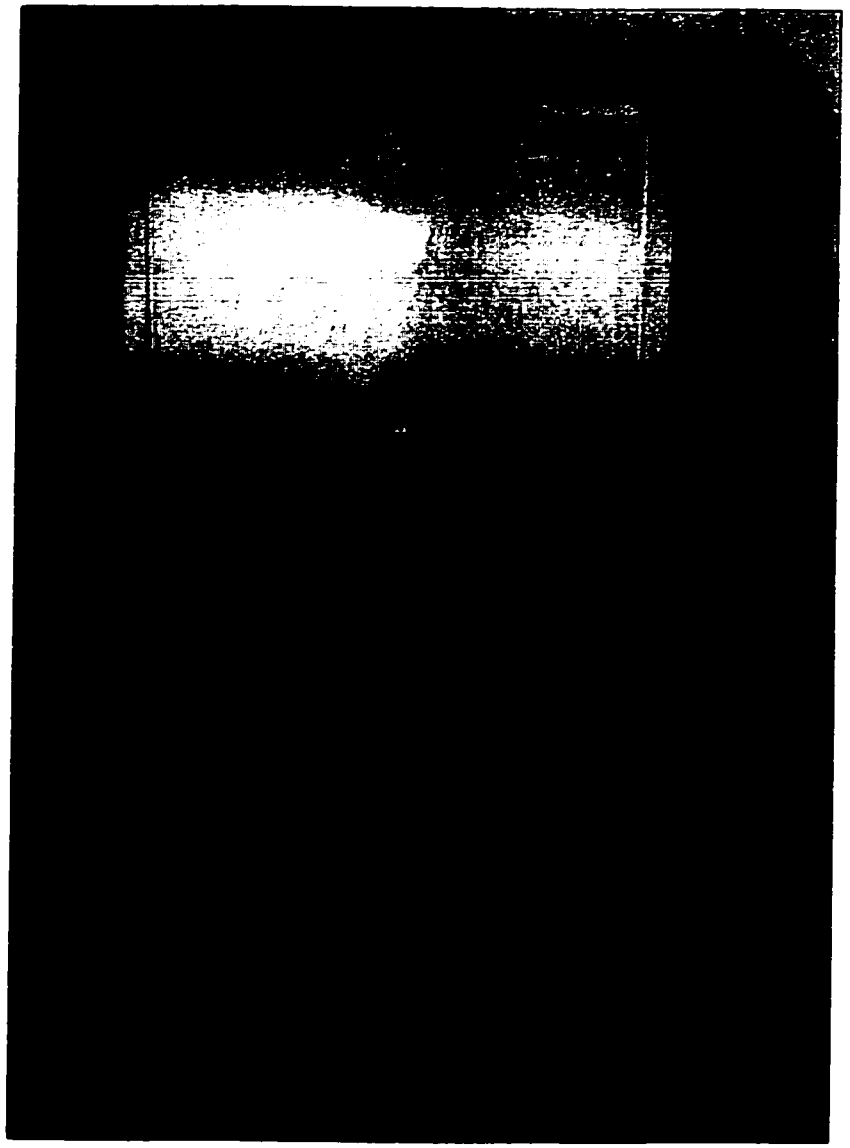


figure 77: Workstation closed.

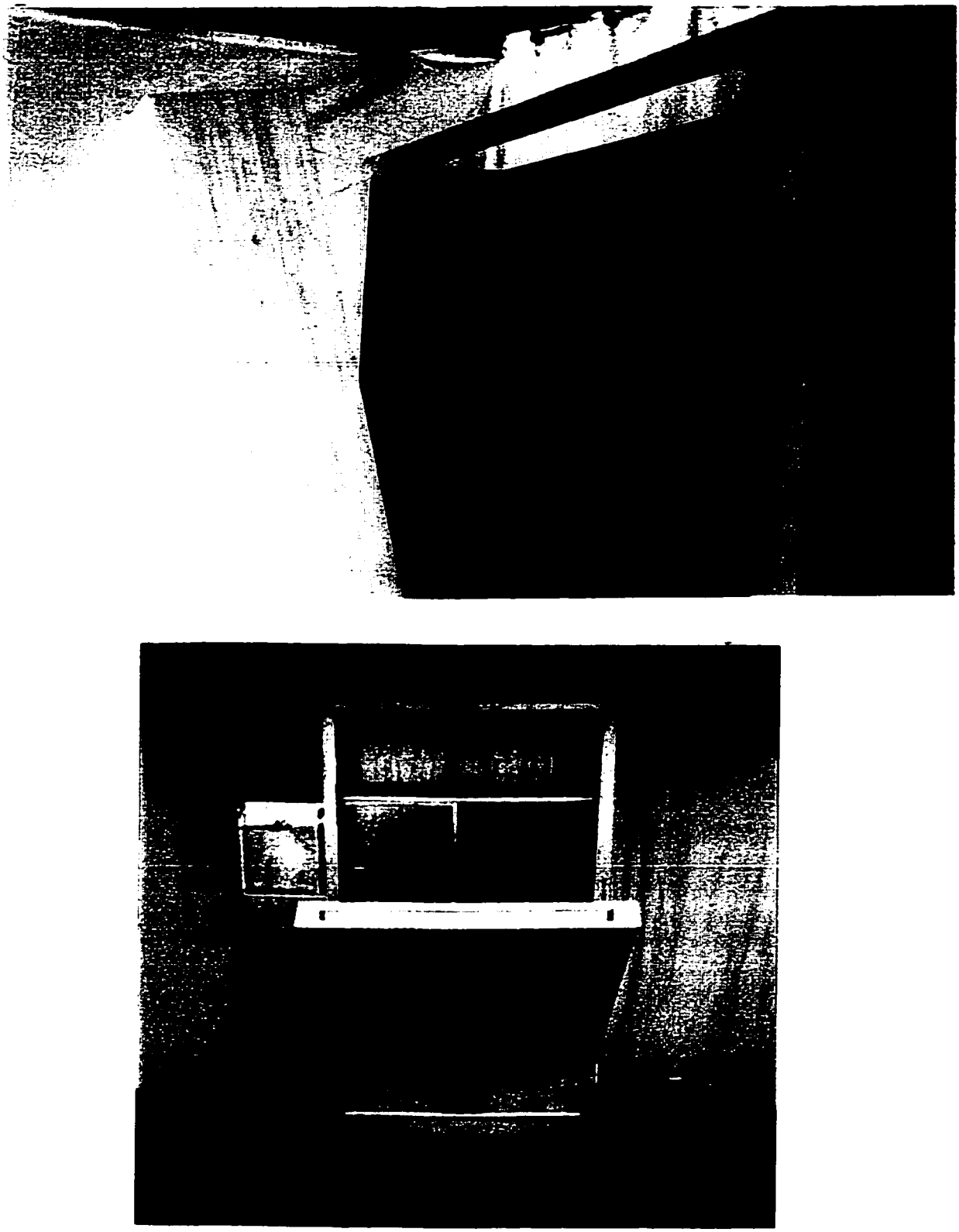


figure 78: Opening.

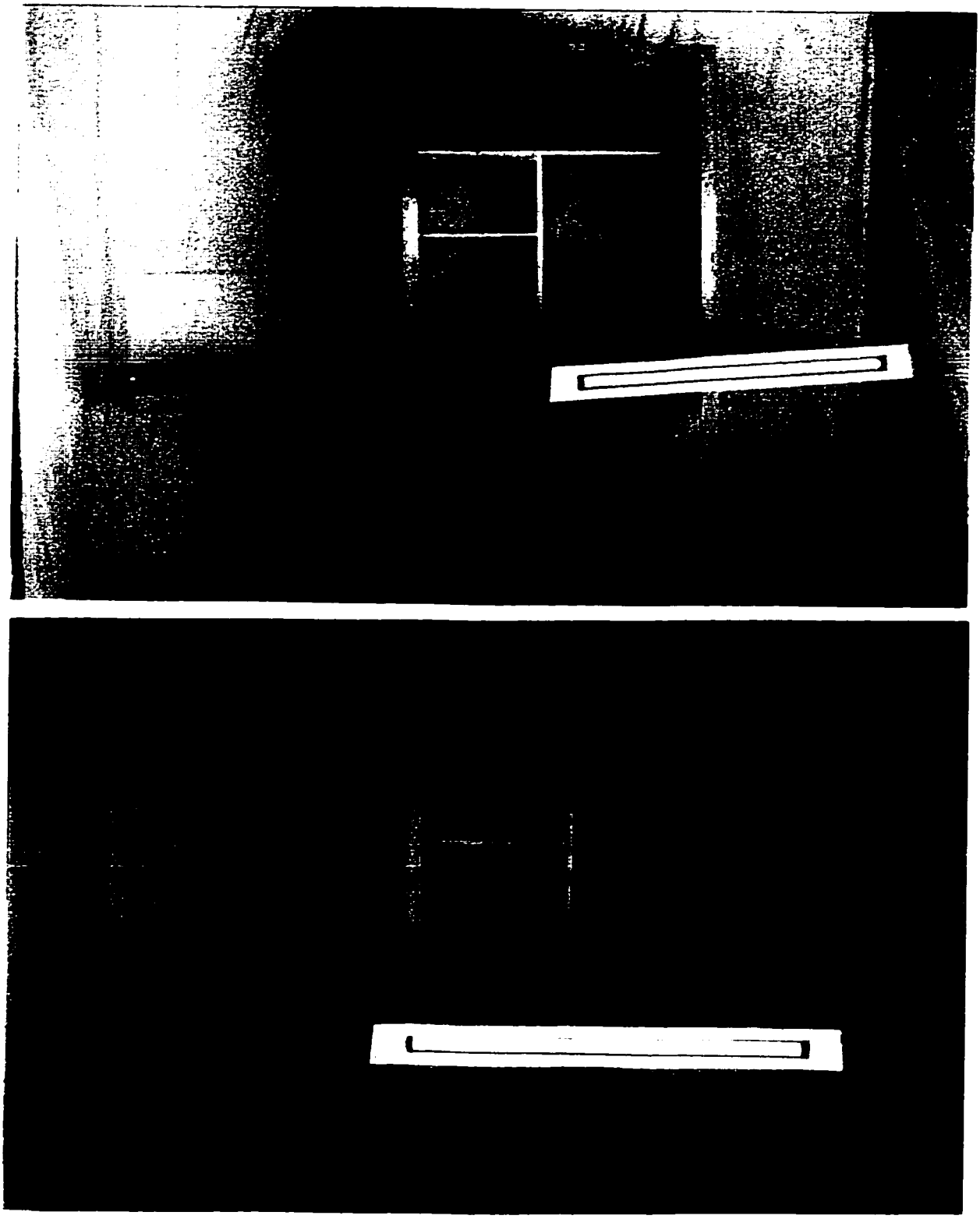


figure 79: Opened.

When the large (drafting) table is opened, the storage area is assessable and lighting can be turned on. A compact florescent light is mounted inside the top of the cabinet and faces the ceiling for ambient lighting. (See Part Three, Section Four, Function and Use: Lighting) This light is hidden from the front opening. Below this is a large shelf meant for book or large storage. On the bottom of this shelf another compact florescent light is mounted for interior lighting. Below this shelf on the right hand side is a slot for large drawings or paper storage. The back left-hand space is a hollow box that houses the computer table in its closed position. This table houses a laptop and printer/scanner, and moves from inside the cabinet to its working position by a ball-joint and slider. (figure 80, and 81)

1406.25 mm (56 ¼") from the floor a shelf runs across the width of the open cabinet. On the left side of this board is a three-level storage compartment which can be used for disks, CDs, paper and other essentials. (figure 82) Small boxes can be placed in these compartments for pens, pencils and other utensils. The right 490.63 mm (19 5/8") of the board is left open in order to access the large drawing storage area. Below this board is a space and two storage compartments rest here. This area is meant for extra paper and other storage. Underneath this storage is housed the foot release and leg mechanism and below that is the kick.

The workstation can be mounted from either the right or back side and used in an L-shape configuration. (figure 83) This configuration has the user sitting facing the 1200 mm (48") of the large (drafting) table with the computer table to the left. This arrangement provides privacy by the presence of the cabinet and allows the user to have the use of natural lighting for the large table. The computer table is protected from direct sunlight behind the cabinet body. With a back mount, the large (drafting) table can be turned so the user faces the cabinet body while working. In this arrangement the user can stand at the drafting table and rotate the table to the desired angle. (figure 84, 85, 86,and 87)

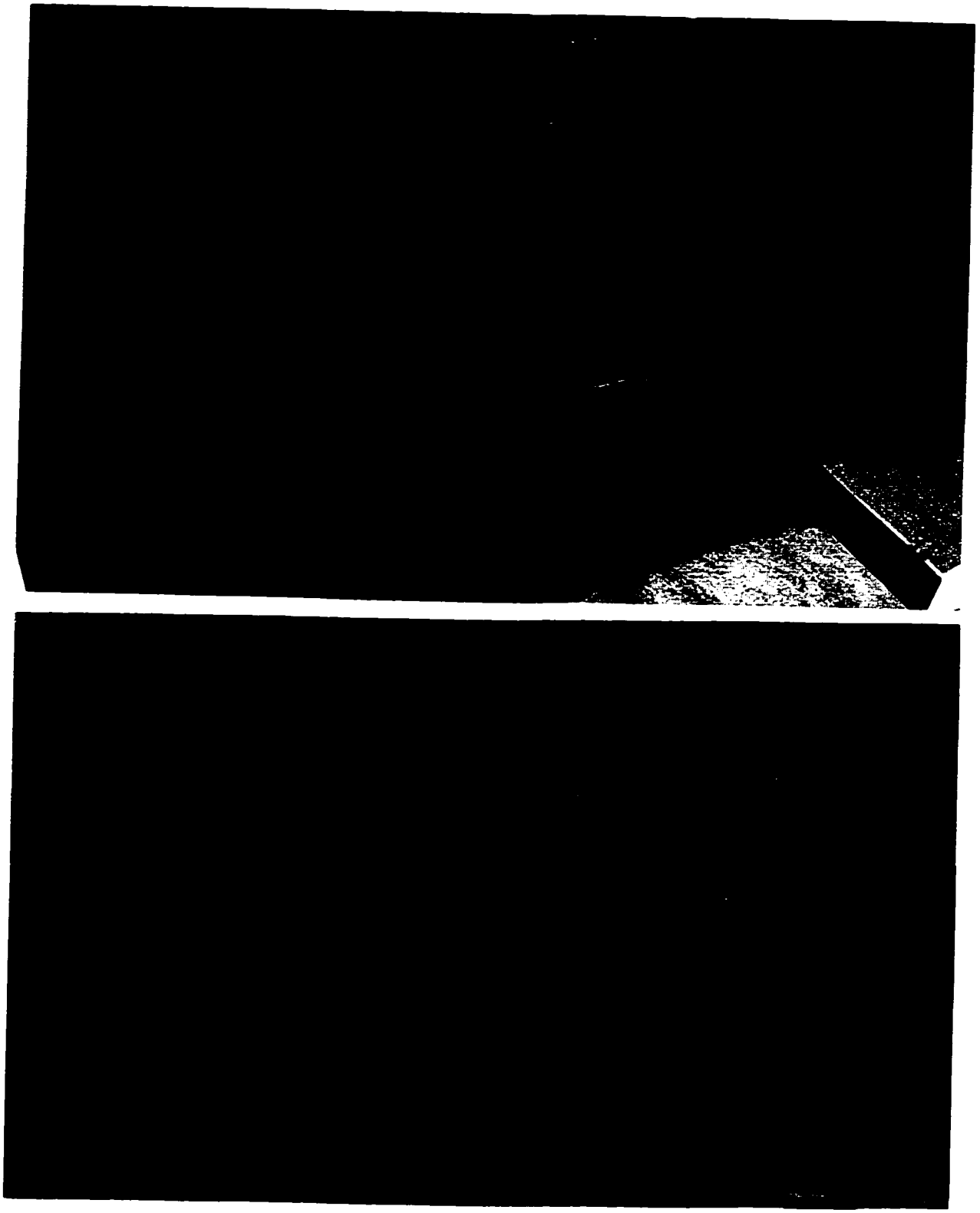


figure 80: Computer Table.

figure 81: Place for laptop and printer.

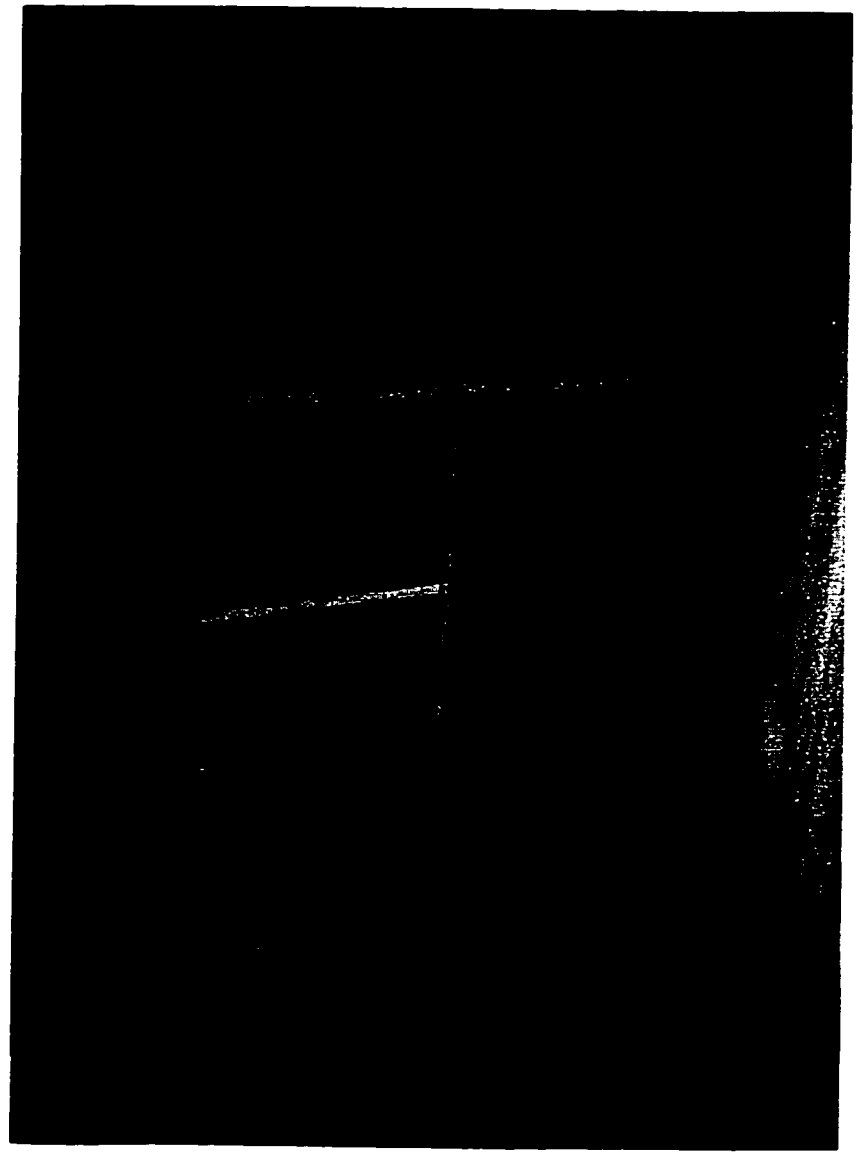


figure 82: Storage

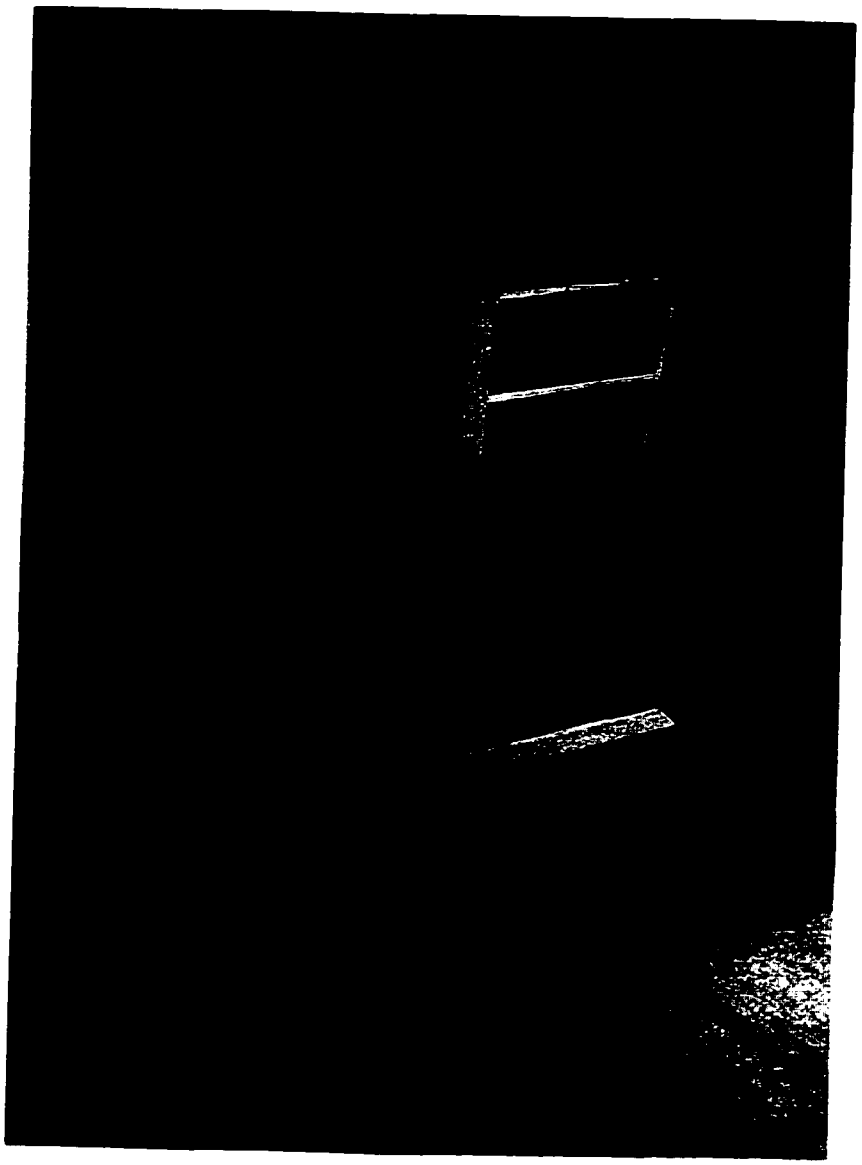


figure 83: Used in L-shape configuration.

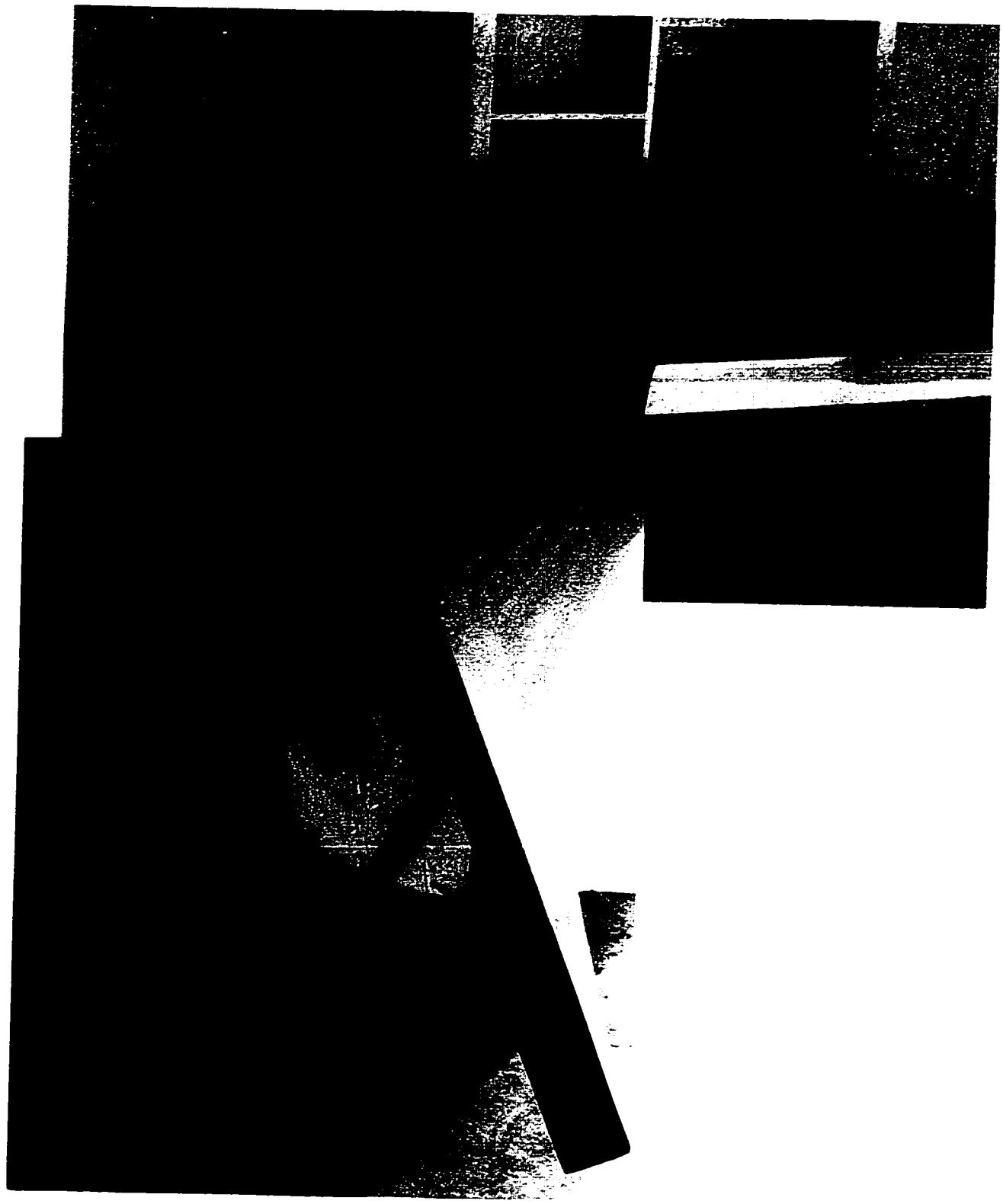


figure 84 and 85: Using table - second arrangement.

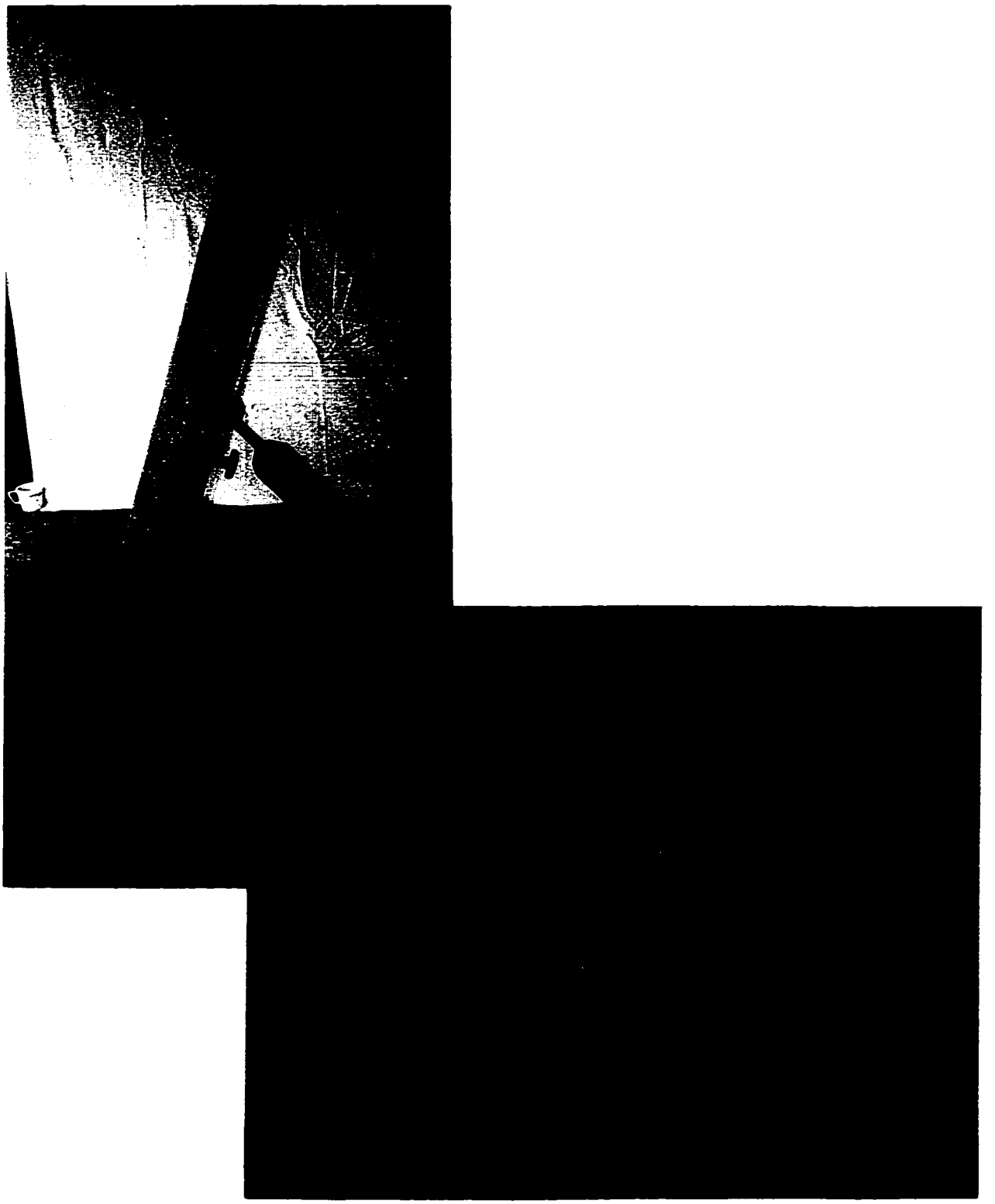


Figure 86 and 87: Using table standing - second arrangement.

Conclusions

The workstation design meets the project objectives by addressing users needs and providing functional solutions to problems occurring in the home office residence. The workstation maximizes space and facilitates the means to optimize the entire workplace residence environment. It provides the means to increase productivity by letting the user leave work in progress, and presents both a professional and private aesthetic that is transformational and conducive to many decors. The workstation bestows a sense that the home is separate from work yet can share the same physical footage. It supplies the ritual of 'going' to as well as 'leaving' the office by negating or presenting the physical presence of the work when the occupant desires.

The three main elements of the workstation – the large (drafting) table, the computer table and the storage area, provide the necessary components of a fully functional office, as well as supplies a L-shaped office layout that is considered a productive, efficient and practical arrangement.

Section Four: Function and Use

Final components of the workstation are described in detail below. Their intended use and function are explained.

Maximizing Space

The workstation in comparison to a conventional drafting table, computer station, and storage fulfills its desired objective of maximizing space. A 900 x 1200 mm (36"x 48") drafting table requires 1.6 square meter (17.25 sq. ft) in use or not and commonly a computer station needs 1.48 square meter (15.9 sq. ft.) of floor space. A comparable storage cabinet requires 0.44 square meter (4.7 sq. ft.) closed and 0.87 square meter (9.4 sq. ft.) opened. For the three components with a chair (.84 sq.m./ 9 sq.ft.) 4.78 square meter (51.5 sq. ft.) of floor space is required.(figure 88 and figure 89) The workstation design when closed uses 0.41 square meter (4.43sq.ft) of floor space. When fully opened the design (with chair) uses 2.96 square meter (31.88 sq. ft.) of floor space. (figure 90 and 91)

The workstation's dimensions are chosen according to specific needs. These dimensions maximize space in the following way: 400 mm (16") is the smallest depth the station can be, while providing an appropriate working surface for the computer table (See Part Three, Section Four, Function and Use: Computer Table), 1000 mm (40") is the smallest width that accommodates the 900 x 1200 mm (36"x 48") large (drafting) table while providing support for the cabinet structure. This dimension is also important in terms of wall space and mounting considerations in a room. 1800 mm (72") accommodates the center placing of the drafting table leg and required adjustable height ranges, while making sure the workstation fits through a standard door. 750 x 2000 mm (2'.6" X 6'.8") (See Part Three, Section Four, Function and Use: Drafting Leg) The workstation's dimensions provide a sense of thinness, in comparison to the average shelving unit found in a living room, and an opportunity to fit numerous walls due to it's width and dual mounting ability.

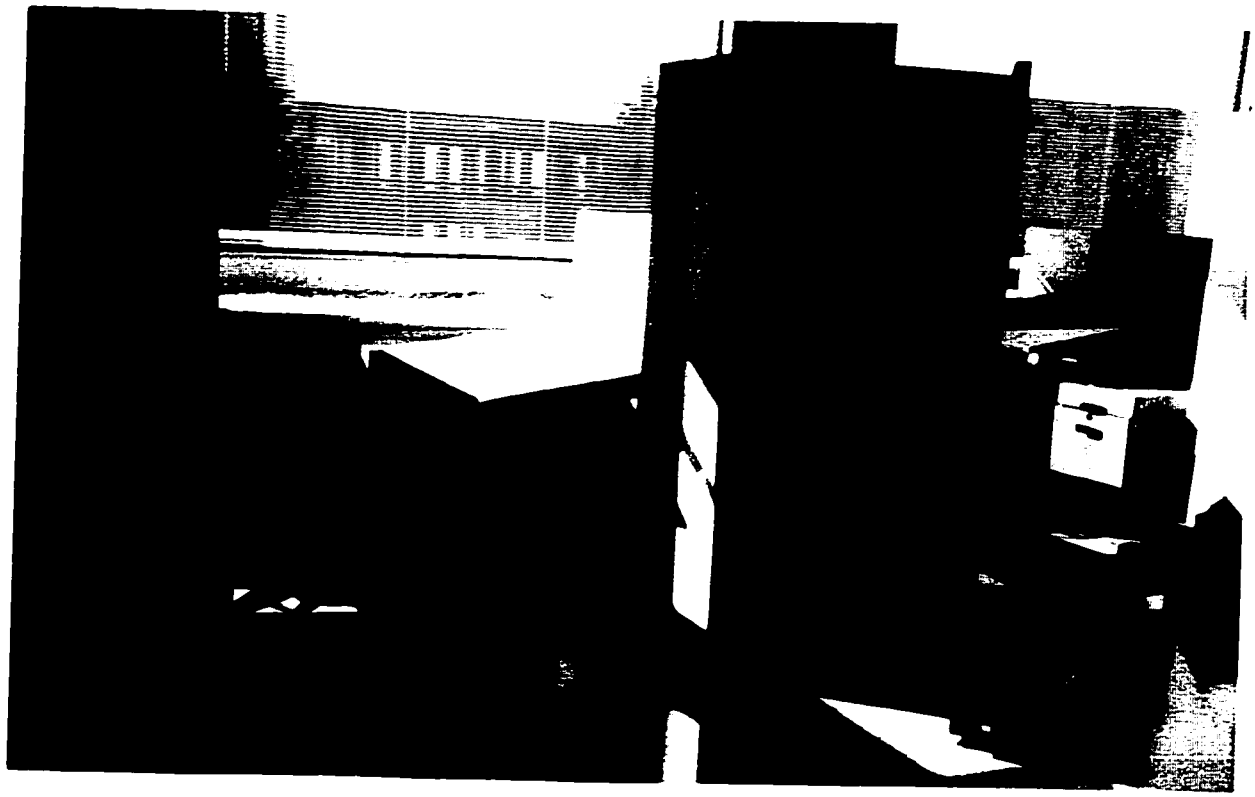


figure 88 and 89:Use of floor space – conventional furniture.

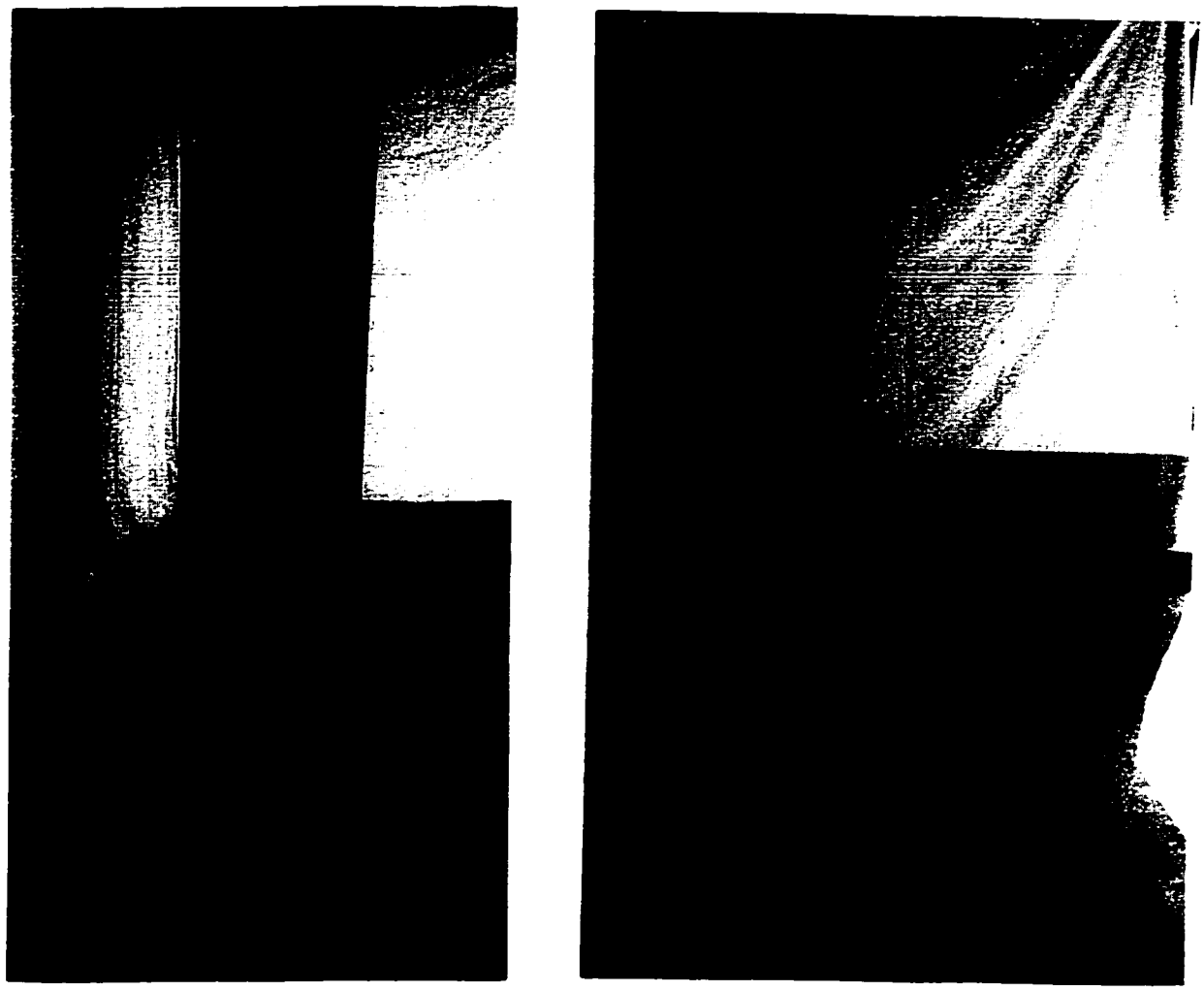


figure 90 and 91: Use of floor space- workstation opened and closed.

Appearance

The workstation's appearance is simple. At first glance (closed), the workstation's purpose is ambiguous. The workstation's plain rectangular aesthetics allows it to be unobtrusive, as it's material construction and shape are conducive to a 'home' environment and furnishings usually found within this environment. The transformation to the working position alters the perception of the workstation, now the design states: professional, practical and functional. The 'home' environment becomes an 'office' by this act. A perceived separation between work and living arrangements is created.

Professionalism

Creating a strong sense of professionalism, while maintaining the privacy and intimacy of the home, is a complicated objective. Making the workstation transformational attains a sense of privacy, (closed), and as well provides a professional environment (opened). The large (drafting) table's opening signifies a change, as this ritual conditions the user, family and clients to accept the home office's professional status and different usage for that space.

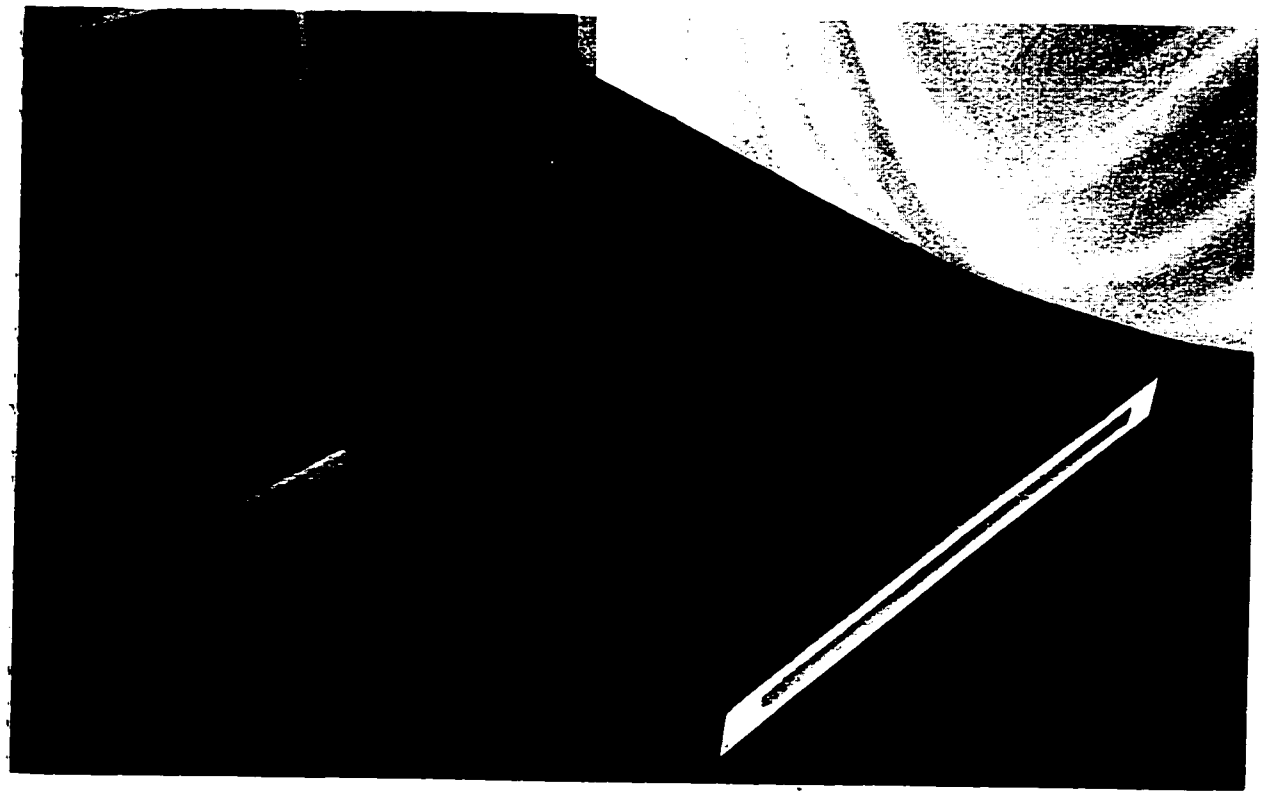
A Working Surface - Large (drafting) Table

The large working surface acts as a structural component as well as a working surface. The main working surface is 1200 x 900 x 87.5 mm (48"x 36"x 3.5"). The surface dimensions provide for the use of A1/A0 size paper (594 x 841 mm / 841 x 1189 mm). This size is considered an appropriate paper size for specific user occupations. (See Part Three, Section One: User) (figure 92 and 93)

The large table can be set at 90 degrees as well as any angle between 90 and 123 degrees for the side configuration, and 90-180 degrees for the back configuration. The table can be used in a long rectangular position (1200 x 900 mm /48"x36") or

can be fully rotated and used in a short rectangular position (900 x 1200 mm / 36"x 48"). (figure 94 and 95) The table's height can be adjusted between 700 – 900mm (28"- 36'') accommodating the smallest and largest user (5^{th}-95^{th} percentile). (figure 96 and 97)

The table's edges are slightly tapered from the top (working) surface, to assist the user in positioning the table simply and accurately within the cabinet. The table is composed of a pine frame with internal pine beams covered by a maple sheet on each outer surface. A pine crossbeam runs inside the width of the table along the top of the ball joint block. A second pine crossbeam runs on either side of the leg beams. The leg beams are also pine and run from the bottom of the ball joint block to the bottom of the table. Pine is used for the internal beams and frame, as this wood is cost efficient, local, and strong yet light in weight.



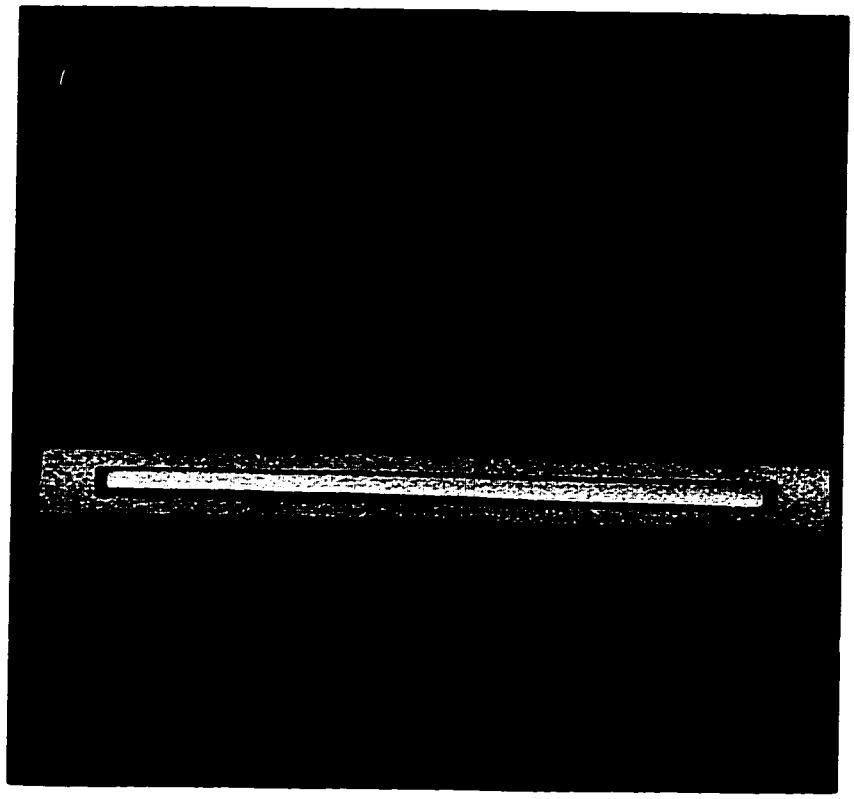


figure 92 and 93: Large (drafting) table.

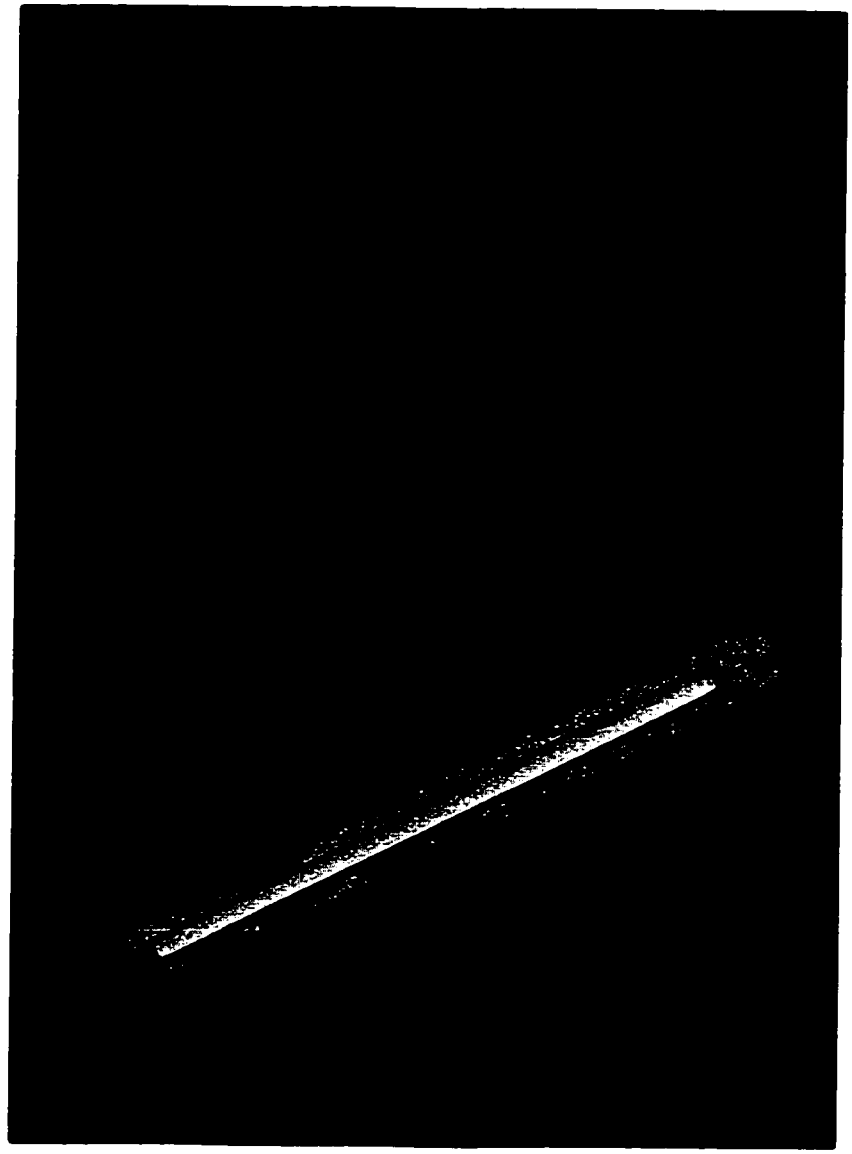


figure 94: Large (drafting)table angle (left).

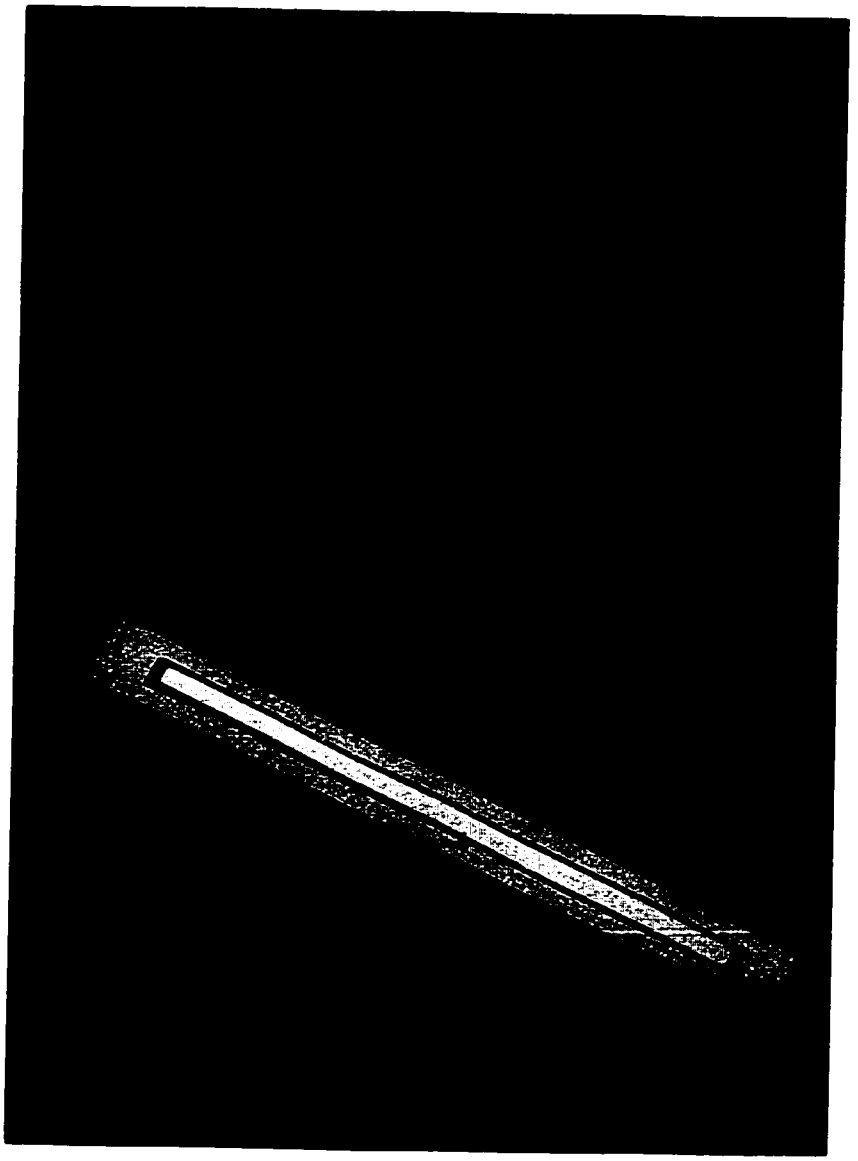


figure 95: Large (drafting) table angle (right).

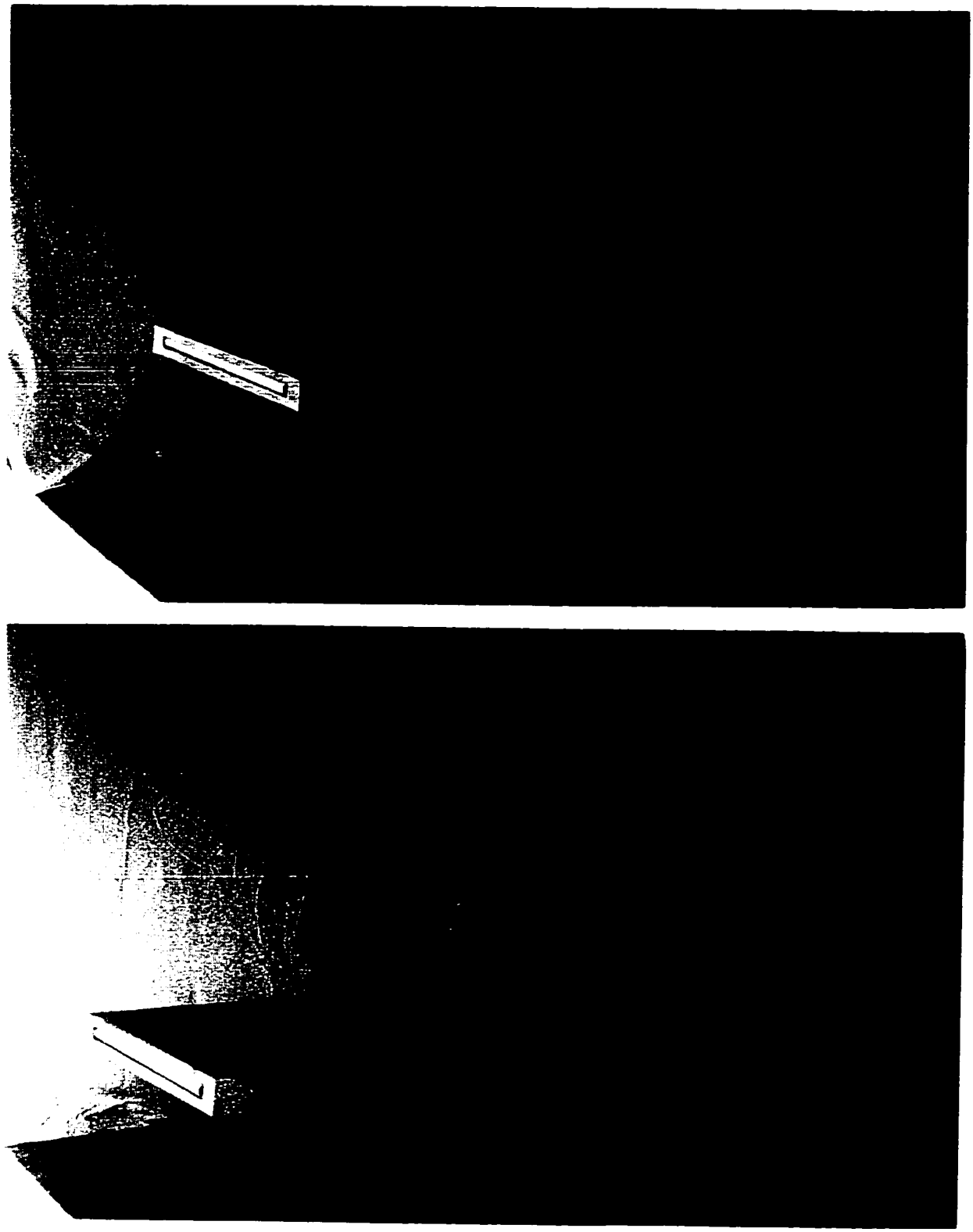


figure 96 and 97: Large (drafting) table heights.

Final Components of Large (drafting) Table

The large (drafting) table has two main components; a work in progress protector and the leg. They are more fully discussed below.

Work in Progress Protector

The work in progress protector is located at the top end of the1200 mm (48") length of the table, opposite the leg placement. (figure 98 and 99) The protector is accessed through a slot from the top surface. It is intended that the user reach over, pull the protector across the drawing and clip it into position. Two clips on the anterior end of the table are used to hold the protector in position. The fit is snug so the work in progress will not move when the table is being stored.

The protector is composed of a light plastic/rubber/cork material that rolls easily out of the compartment and over the drawing. This material adheres lightly and temporarily to the drawing and will not damage or mark the work in progress.

Leg Mounting Within the Table

The table leg and ball-joint are housed within the large (drafting) table. This provides a flush front when the table is closed and prevents possible hazards to persons going by the desk. (figure 100 and 101)

The ball-joint is attached inside the table's surface, by its faceplates, to a solid fir block. This block is glued to the table. The table's leg is mounted to the ball joint and lies down the length of the table within a fitted frame. This frame is composed of pine beams that run the length of the table marking the angle of the leg's cover and providing structure for the table itself.

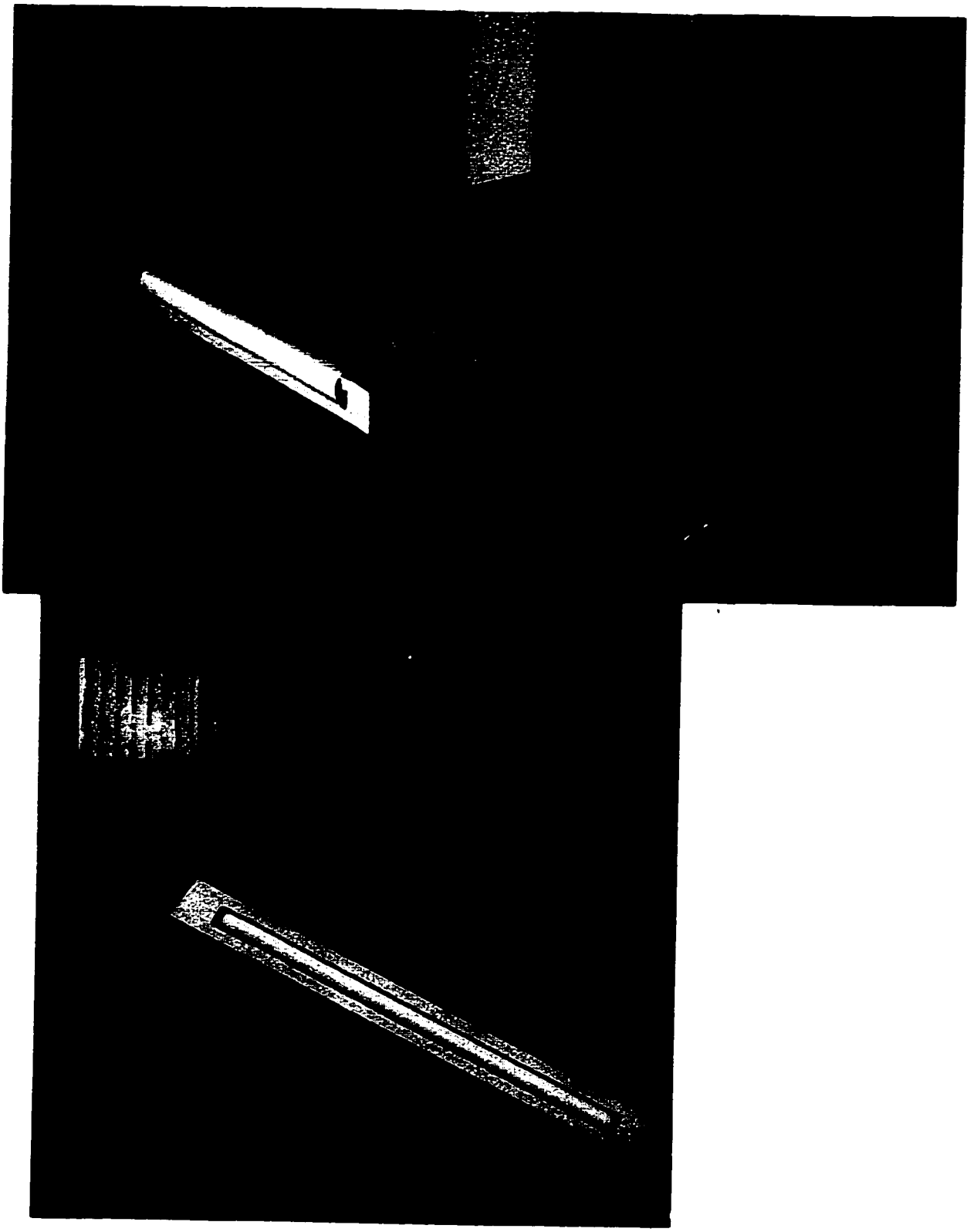


figure 98 and 99: Work-in-progress protector.

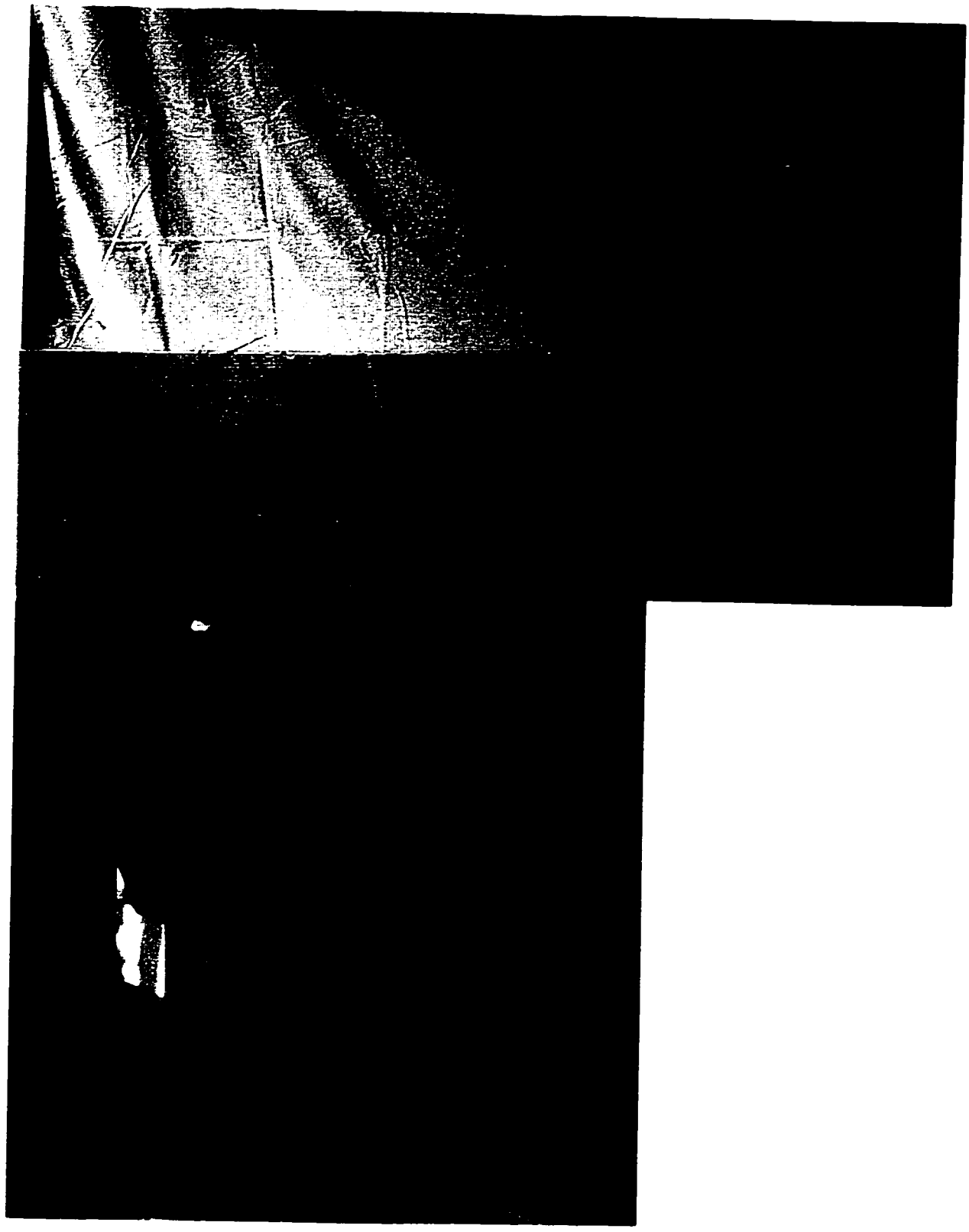


figure 100 and 101: Leg mounted within table.

Wiring

Wiring for the workstation runs from a central shaft 456.25 mm (18 ¼") from the right side of the cabinet. This wiring is protected in a hollow frame structure that runs the length of the cabinet. In the bottom of the cabinet a transformer is mounted for the compact fluorescent lights used in the cabinet. The plug for the station runs from the central post to a plate mounted on the left side of the cabinet.

Although wireless technology for computer equipment is encouraged and preferred, placement for wiring is provided for within the computer table and through to the cabinet system. (See: Part Four, Drawings: Wiring)

Storage

Storage is conceived as daily storage. (See Part Three, Section Three, Product Description) Within the cabinet, storage is designed as empty containers for optimum use. All stationary shelves are made from 18.75 mm (¾") maple boards. (figure 102 and 103) There are three stationary shelves in the cabinet located at 325 mm (13"), 656.25 mm (26 ¼"), and 1406.25 mm (56 ¼") from the top. Compartmentalized movable shelves are constructed from 18.75 mm (¾") boards for the sides with 6.25 mm (¼") maple for the shelves. These shelves are set loosely into the internal structure of the cabinet. All storage must remain 100 mm (4") from the front of the cabinet to prevent binding or damage to the large (drafting) table or its' housing. (figure 104) A large drawing storage area built into the back left side of the cabinet is a designated storage area and easily accessed by the user. (figure 105)

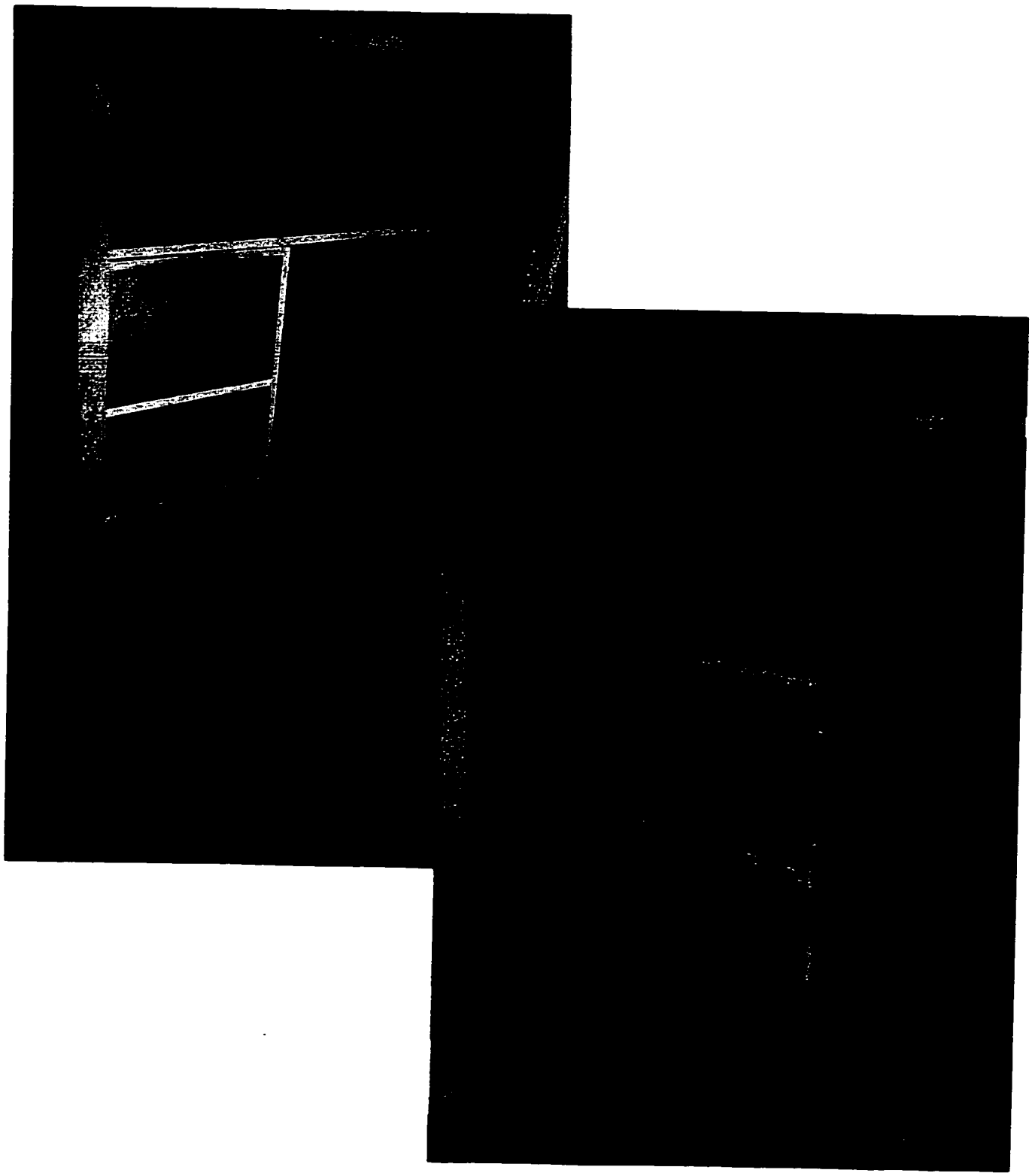


Figure 102 and 103: Empty containers for optimum use.

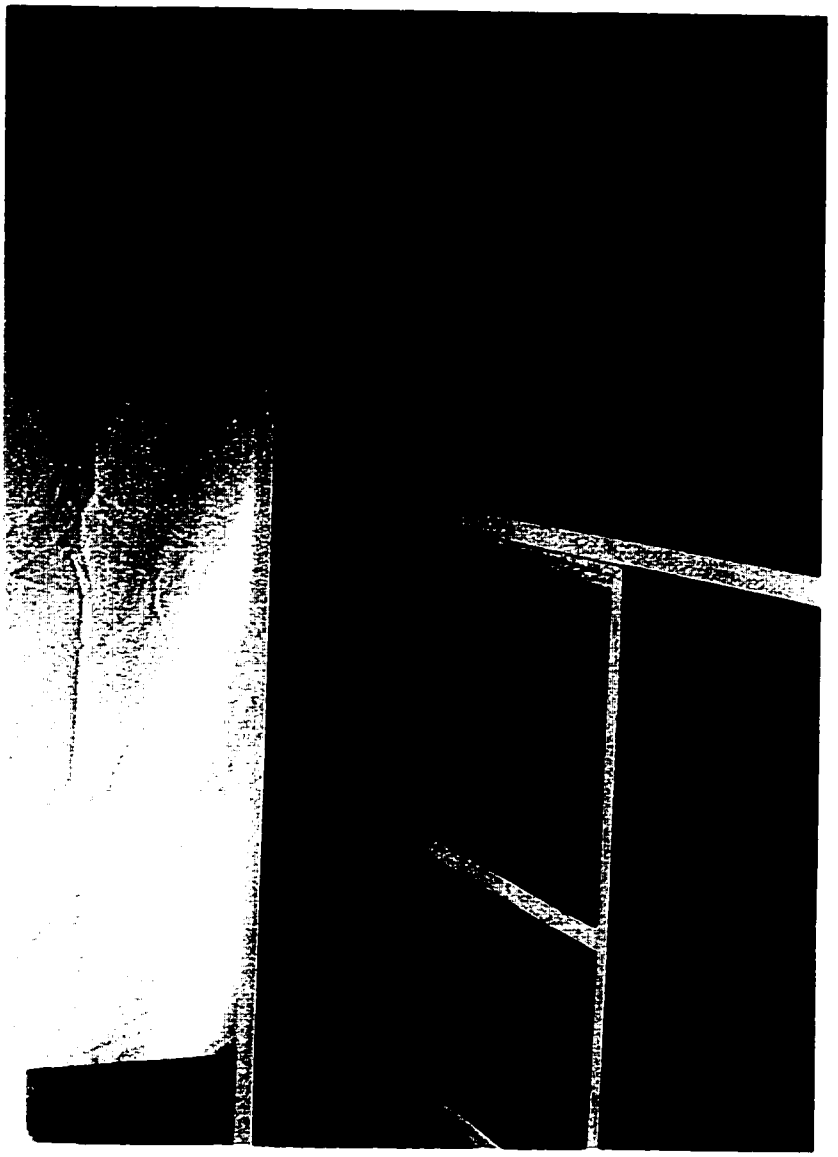


figure 104: Prevent binding.

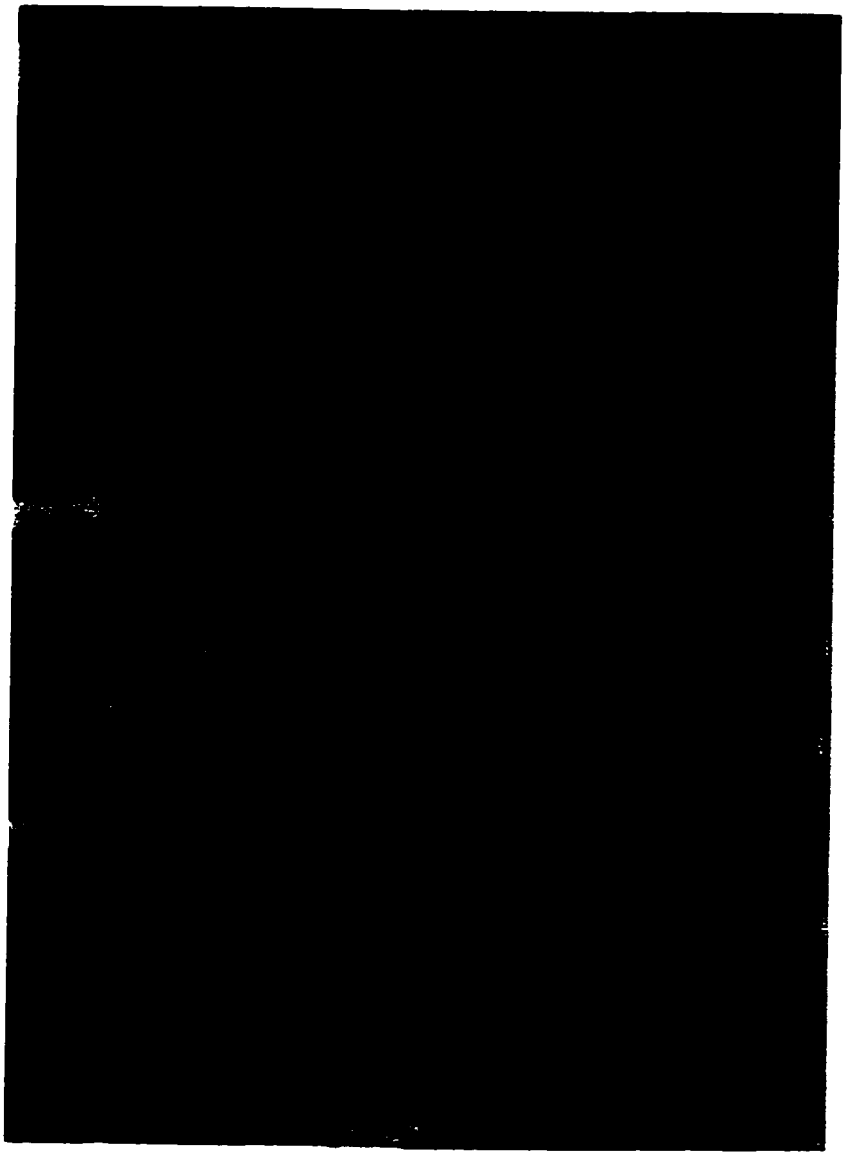
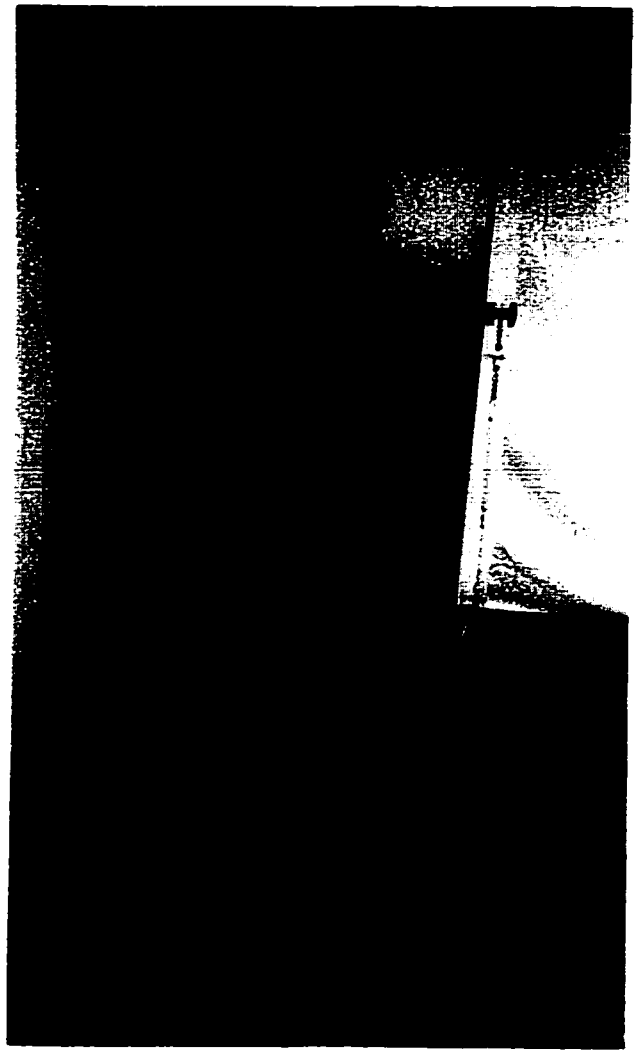


figure 105: Large drawing storage.

Computer Table

A computer table that stores a laptop and printer is located in the back and left side of the cabinet. When stored this table and its support occupies 453 x 76.6 x 1378 mm (18 1/8" x 3 1/16" x 55 1/8") within the cabinet. The computer table, like the main table, moves out of the body of the cabinet. (figure 106 and 107) A ball-joint attaches the table to a support box whose sliders bring the table in and out of its stored location. The user rotates the table and places it down to rest on the support box when in its' used position. (figure 108)

A homing pin on the bottom side of the computer table slips into the location-mounting slot on the left side of the cabinet completing the positioning action. This pin helps the user position the table correctly and adds support to its working structure. A second location-mounting slot is situated on the topside of the support box. This slot houses the homing pin in its stored position, securing the computer table to the support box and helps the user correctly guide the table in and out of the cabinet. This pin also safeguards the user from accidentally dropping the table when first opening. (figure 109) The user accesses the computer table by a slot in the printer drawer on the front face of the table. (figure 110)



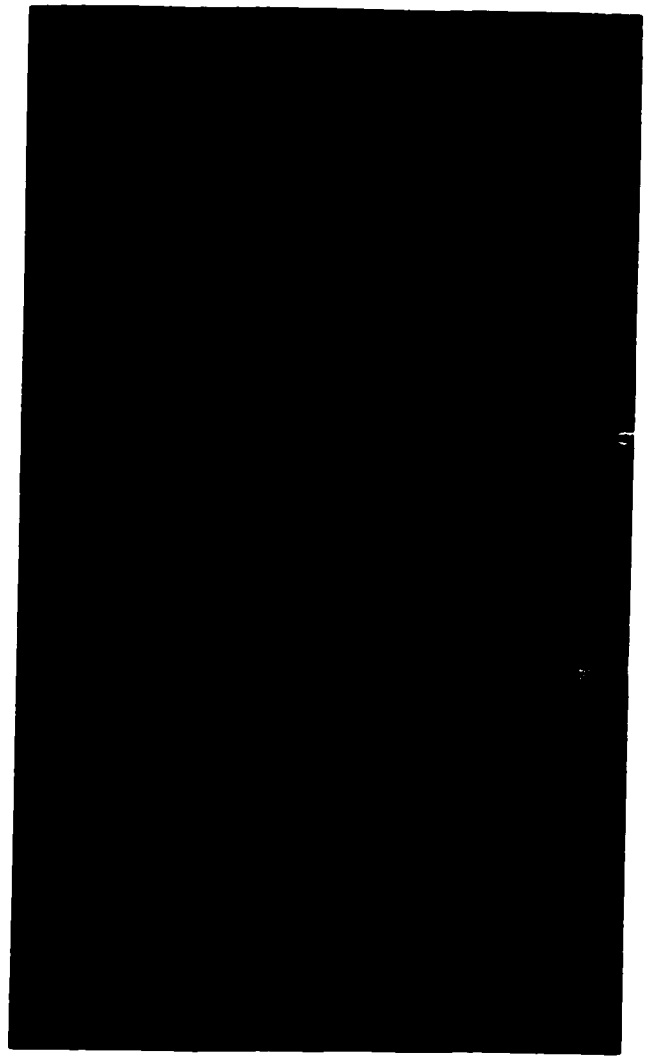


figure 106 and 107: Computer table moves out.

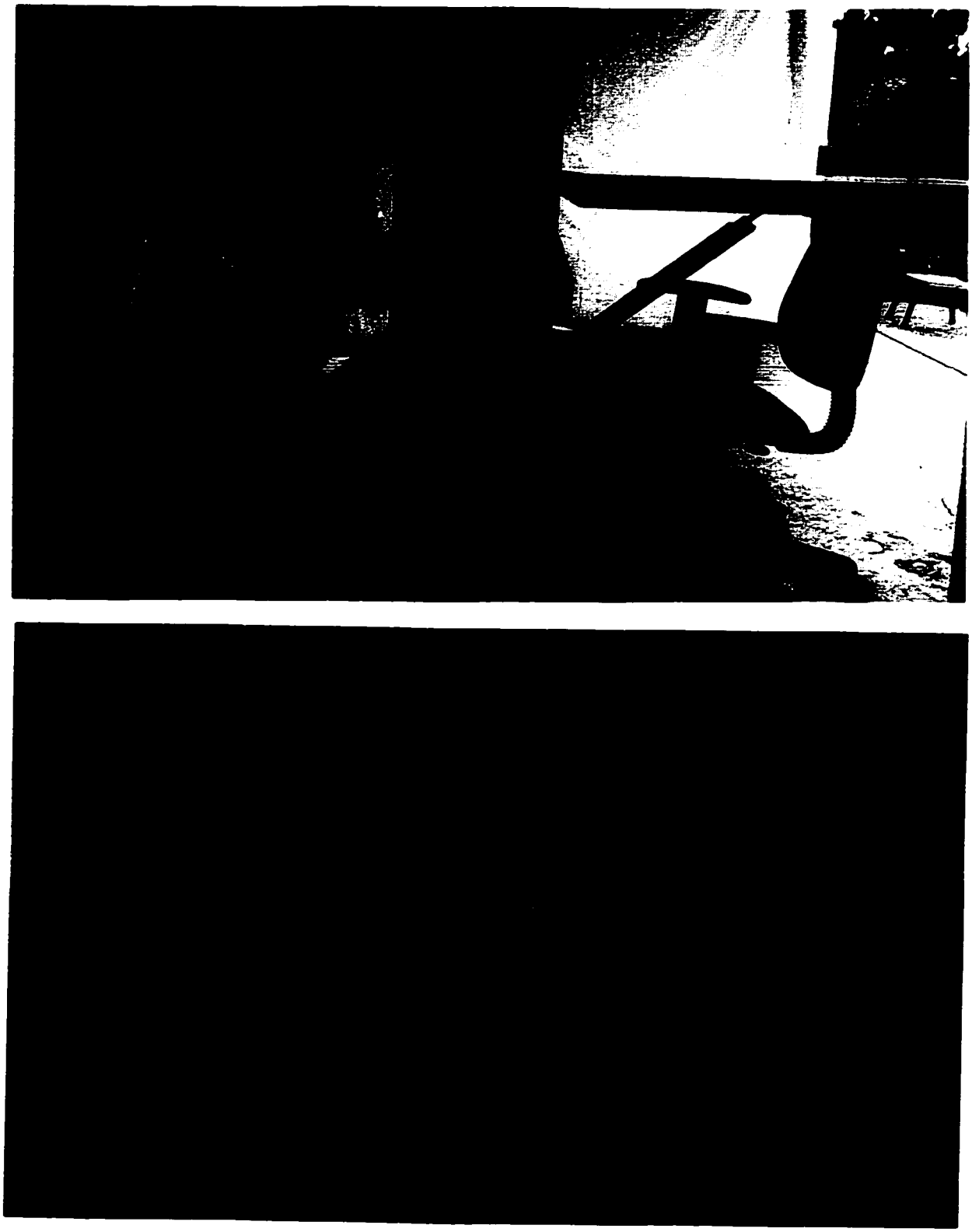
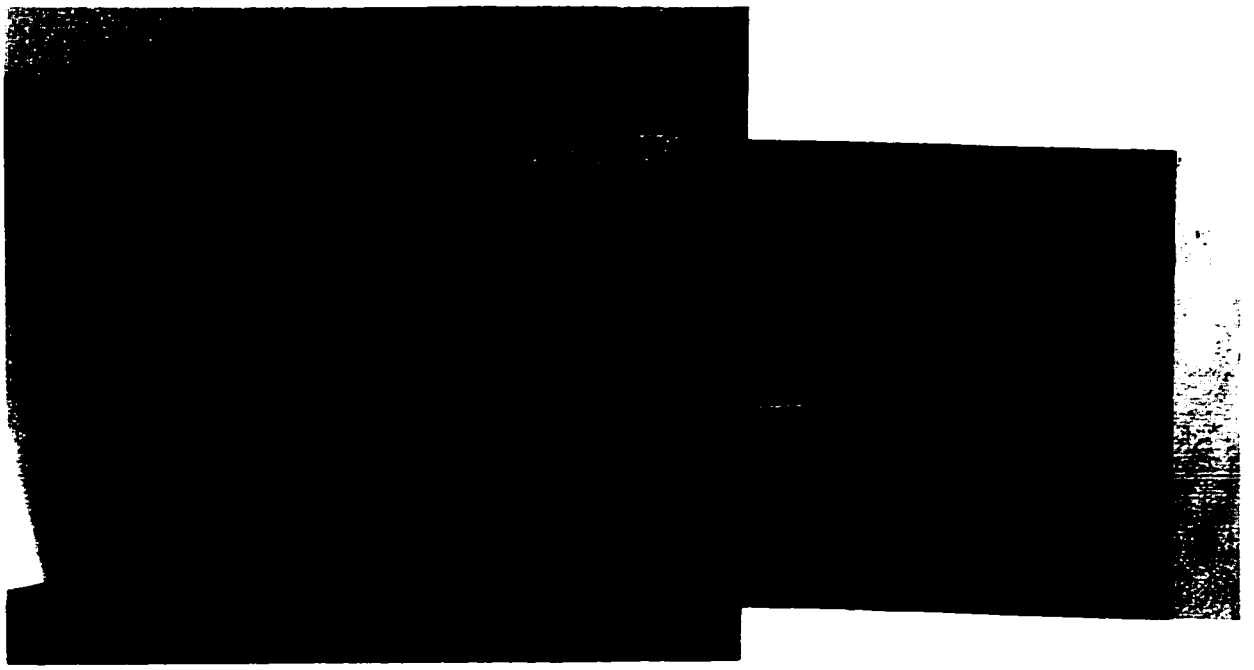


figure 108: Working position.



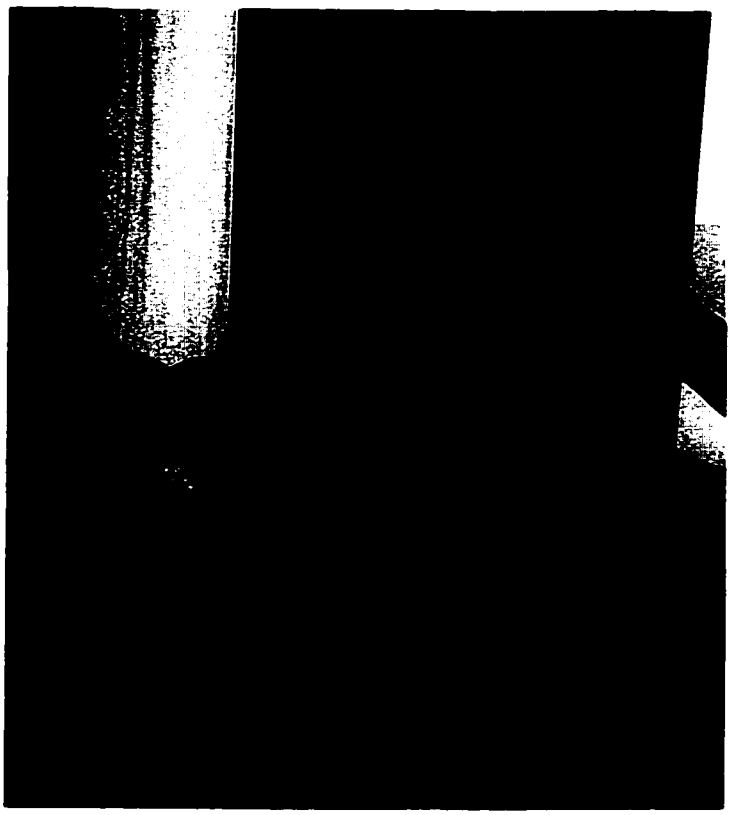


figure 109: Homing pin and slot.

figure 110: Access to computer table.

The computer table has four main components: a computer table, a support box, the housing within the cabinet and its mechanisms – ball-joint, sliders, wheel, and stopper. The first three components are discussed in further detail below. The computer table's mechanisms will be discussed in complete detail later in the mechanism portion of this section. (See Part Three, Section Four, Function and Use, Mechanisms: Computer Table) Any discussion of the computer table's mechanisms in the following paragraphs serves only to help explain the first three components.

The Computer Table Component

This table is composed of a pine frame with internal crossbeams running center at 412.5 mm (16.5") and 612 mm (24.5") from the left side of table. (See: Part Four, Drawings: Computer Table Plan View). A pine beam runs the length of the table, 37.5mm (1 ½") from the back frame providing support for the frame as well as providing space for possible wiring. From a plan view, the right frame of the table is reinforced by a 400 x 75 x 43.75 mm (16"x 3"x 1 ¾") board. This board provides structure and housing for the ball-joint mechanism. The ball-joint is mounted into the top right corner of this wall. (See Part Three, Section Four, Function and Use, Mechanisms: Computer Table- Ball Joint)

The rotational shaft extends out of the table into the support box below. This joint placement positions the computer table flush with the cabinet's width when in its working position. The ball-joint's housing allows the ball-joint and computer table to move in and out of storage without binding with the support box below.

The computer table is designed to house a laptop and a printer/scanner. (See Part Three, Section Two: Required Equipment) The first (far-left) slot houses the laptop and is accessed through a top-lifting hatch. This means of access allows the utilization of the entire length of the computer table surface when the laptop is not required. (figure 111 and 112)

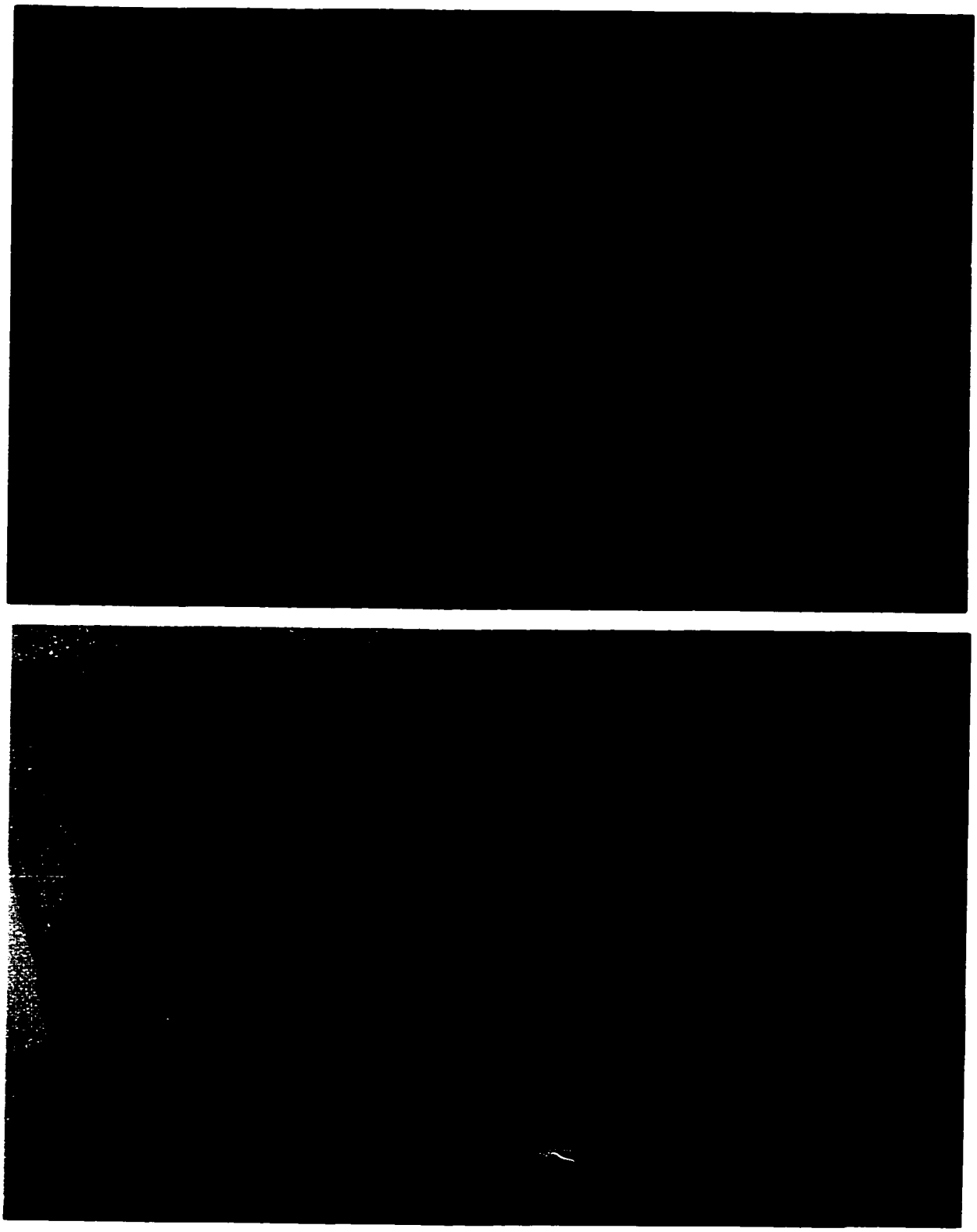


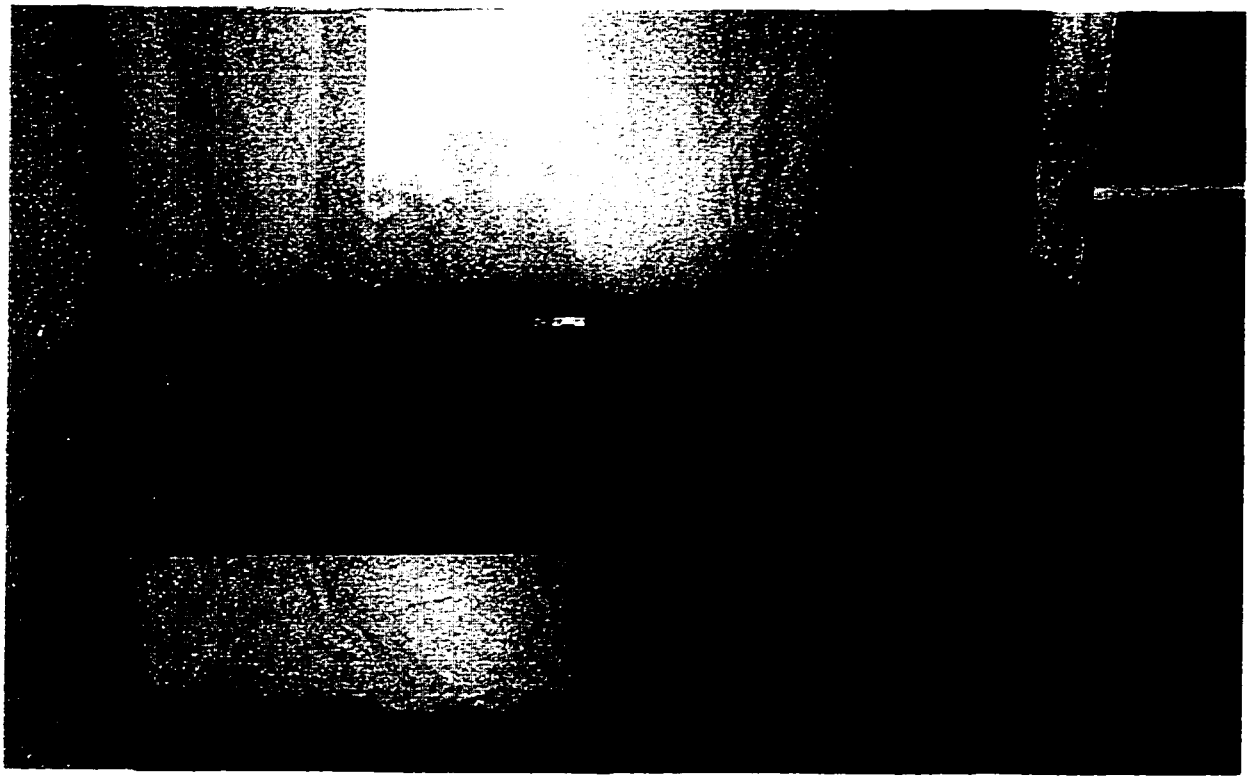
figure 111 and 112: Laptop compartment.

The second slot houses the printer/scanner and is accessed through a front sliding drawer. (figure 113) This access allows the user to sit in front of the laptop and pull the printer drawer open when needed, thus providing approximately 375 mm (15") of table surface for paper and other utensils while using the laptop. The laptop/printer configuration also provides the user clear foot room, as the support box ends under the printer. This table set up allows the user to swing from the computer table to the main (drafting) table when using both tables. (figure 114)

The Support Box Component (possible hard drive box)

The support box has four functions; it supports the computer table in its stored and working positions, it brings the computer table out of storage, it houses the hard drive if a flat screen/keyboard configuration is mounted in the computer table, and it secures the ball joint providing access to this mechanism for maintenance or removal. (figure 115) The support box is constructed of a pine 75 x 37.5mm (3"x 1.5") frame covered by 6.25 mm (¼") maple plywood on each side set into the frame. The support box dimensions are 531 x 400 x 75 mm (23 3/8" x 16"x 3"). The 531 mm (23 3/8") length sets the computer table at the required fixed ergonomic height when the table is set into its' working position (ANSI/HFS-100, 1988). Three sliders are attached to the bottom frame of the box reinforced by a 75 x 40.63 mm (3"x 1 5/8") pine board that extends past the length of the box. (total length 981.25 mm /39 ¼"). (figure 116)

A false front hides the sliders from view. Three sliders are mounted on the bottom side of this board for a smooth and secure sliding motion. At the far end of this board a 50 mm (2") wheel is mounted face up to stop the table from tipping forward when it comes out of the stored position. This wheel runs the length of the bottom of the large drawing storage and is stopped before it reaches its end.



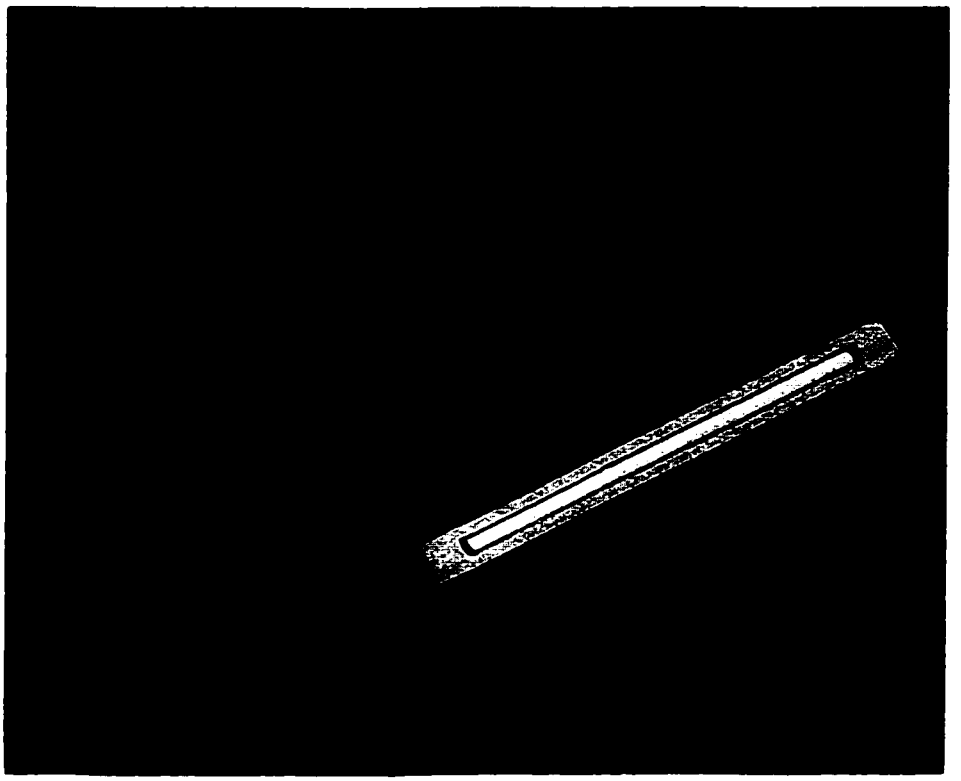


figure 113: Printer/scanner compartment.

figure 114: Using both tables.

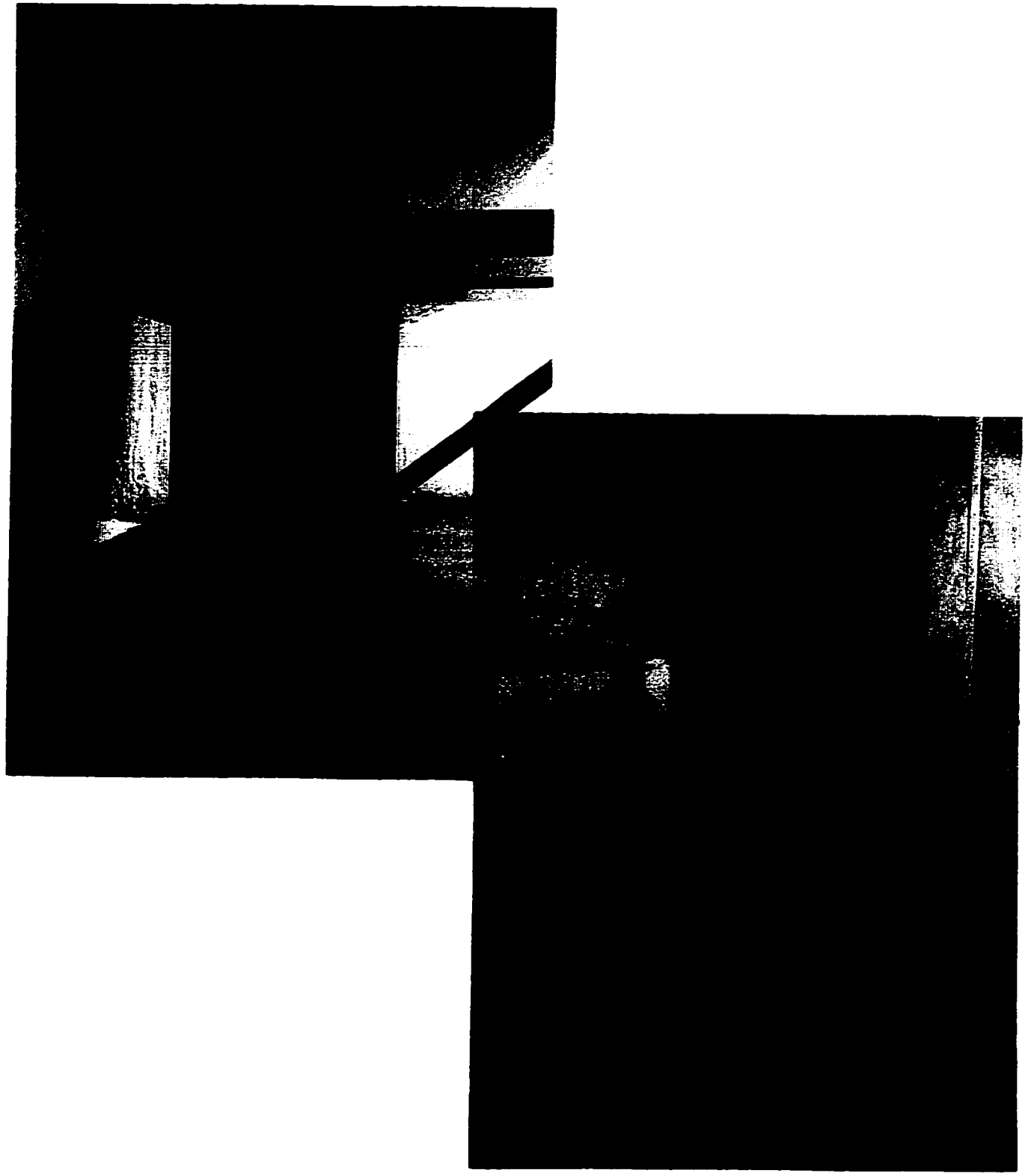


figure 115: Computer table support box.

figure 116: Sliders and board.

The Computer Table Housing within the Cabinet

The storage compartment for the computer table is located 37.5 mm (1.5") from the back wall and measures 1378 x 453 x 76.6 mm (55 1/8"x 18 1/8"x 3 1/16). (figure 117) A 78 x 18.75 mm (3 1/8" x ¾") maple board runs the length of the cabinet and is attached to the top storage shelf completing the compartment. Under the lengthwise board there is a 140.6 mm (5 5/8 ") gap from the floor to allow the computer table's running board to run freely through the cabinet. Three 100 mm (4") maple boards are attached to the back wall of the cabinet (top, middle and bottom) running its' width. These boards act as guides for the computer table and support. A stop chain is located on the backside of the support box and is attached to the central wall. This feature stops the support box from coming completely out of the cabinet by catching the wheel. This chain can be unhooked so that the computer table can be removed from the cabinet.

Lighting

Lighting is incorporated in the workstation and is achieved through the use of compact fluorescent lighting. This type of lighting is chosen for the following reasons: it uses a low amperage -13 amps to a comparable incandescent 60 amp bulb, has a longer life span - four years to the four month average for incandescent, comes in a variety of colors - emulating incandescent or natural lighting (blue and yellow hues). The workstation has two permanent lights housed within; a ceiling faced ambient light and an internal cabinet light. The ceiling faced ambient light's purpose is to provide permanent ambient lighting for the workstation. This solves lighting limitations of a given room and opens the placement possibilities for the workstation. The internal cabinet light provides lighting for the large table surface, the storage area and the computer table. Both lights can be turned on and off by the user. It is suggested a movable ready-made task light be purchased and kept in the storage compartment for use with the workstation as well. If needed various clip on lighting products are available on the market for use with a laptop.

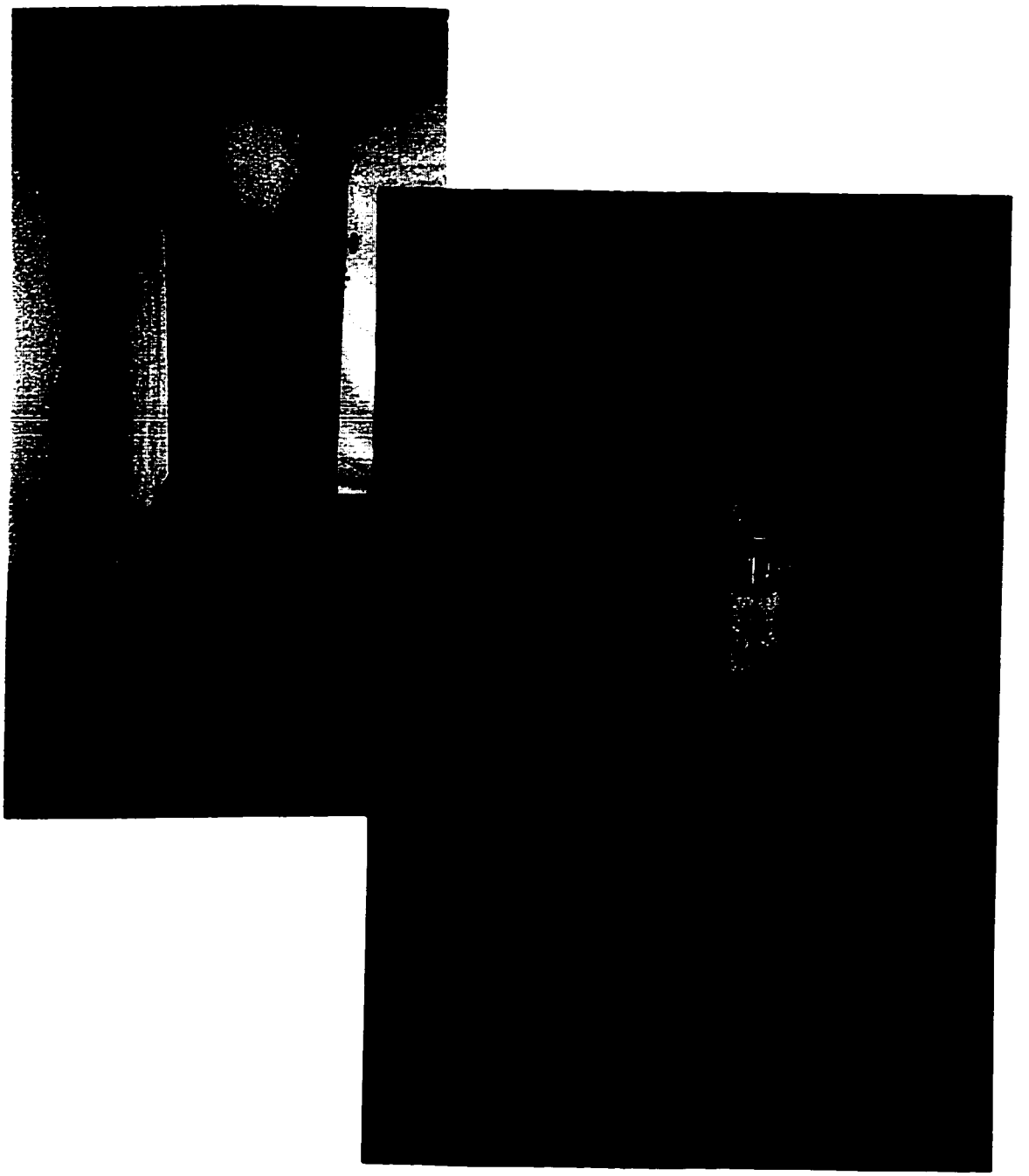


figure 117: Housing computer table in workstation body.

Mechanisms

Mechanisms are tools that make the workstation's individual components and overall design successful. Below each mechanism's function is described.

Large (drafting) Table Ball-Joint (ball, shaft and covers)

The large (drafting) table ball-joint functions to bring the large (drafting) table in and out of storage, allowing the user to attain the desired angle when manipulating and rotating the table in both working positions. (figure 118) This joint is chosen for it's flexibility and the above stated movements and is thought to be the most efficient and cost effective means of completing these tasks.

Large (drafting) Table Ball Joint Adjuster Handle

The ball-joint adjuster handle allows the user to effectively tighten and loosen the ball joint for movement of the large (drafting) table and securing its' position. (figure118)

Large (drafting) Table Leg

The table leg is composed of a shaft mounted to a clutch pack assembly (outsourced) and tied to a release linkage system and foot pedal. This mechanism allows the user to; bring the large (drafting) table from a stored to working position in conjunction with the ball joint and its' adjuster, act as a height adjuster for the table, allowing the user to position it's at any height between 700 mm – 900 mm (28"-36"). (figure 119, 120 and 121, 122) The height adjustment is extremely important given the possible user variety. Another important feature of this mechanism is that it keeps the table in a locked position. The user must use the foot pedal to release the table, helping to prevent accidents both to user and table, as the mechanism locks automatically when pressure on the foot pedal is released.

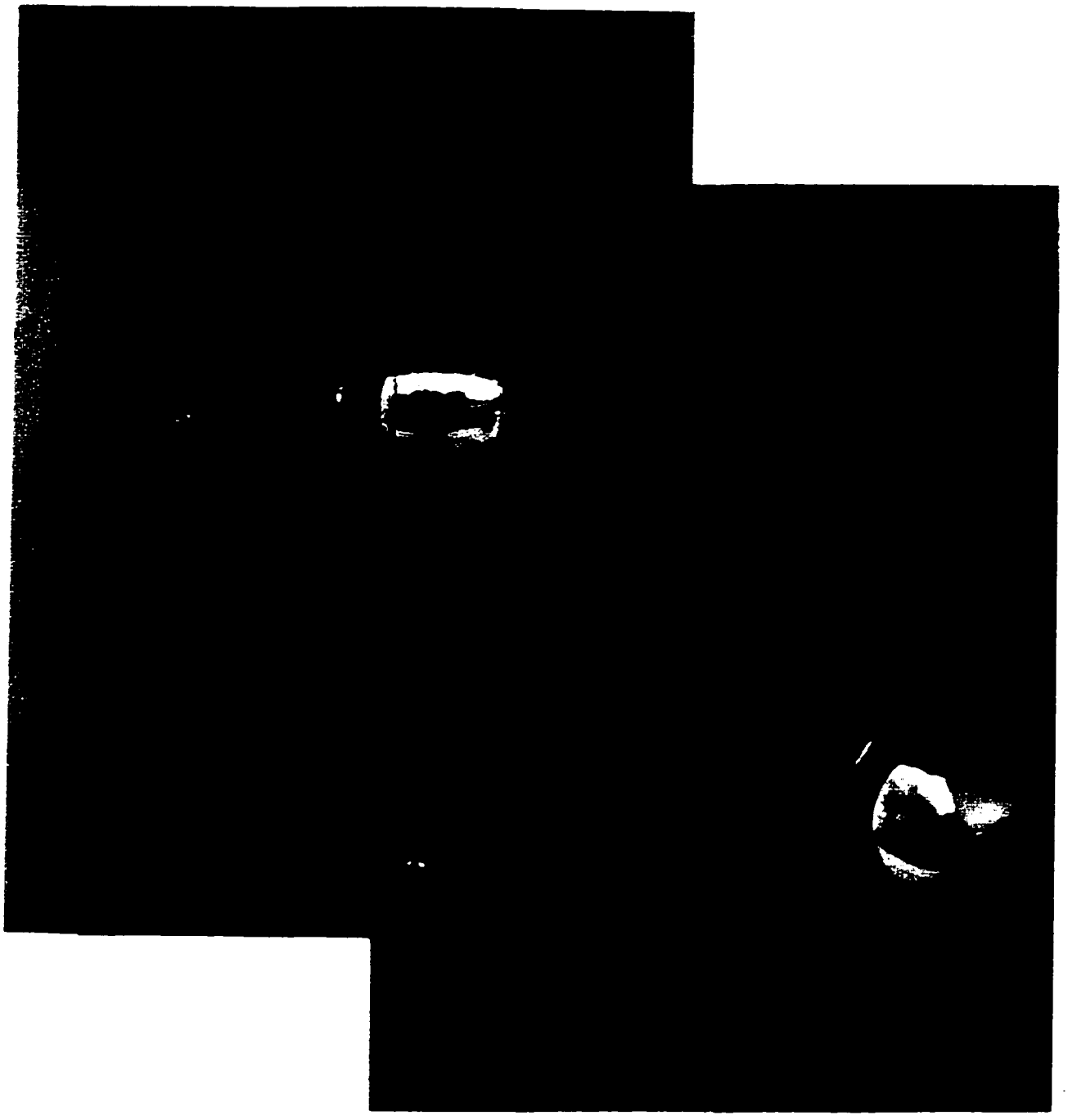


figure 118: Large (drafting) table ball-joint and adjuster handle.

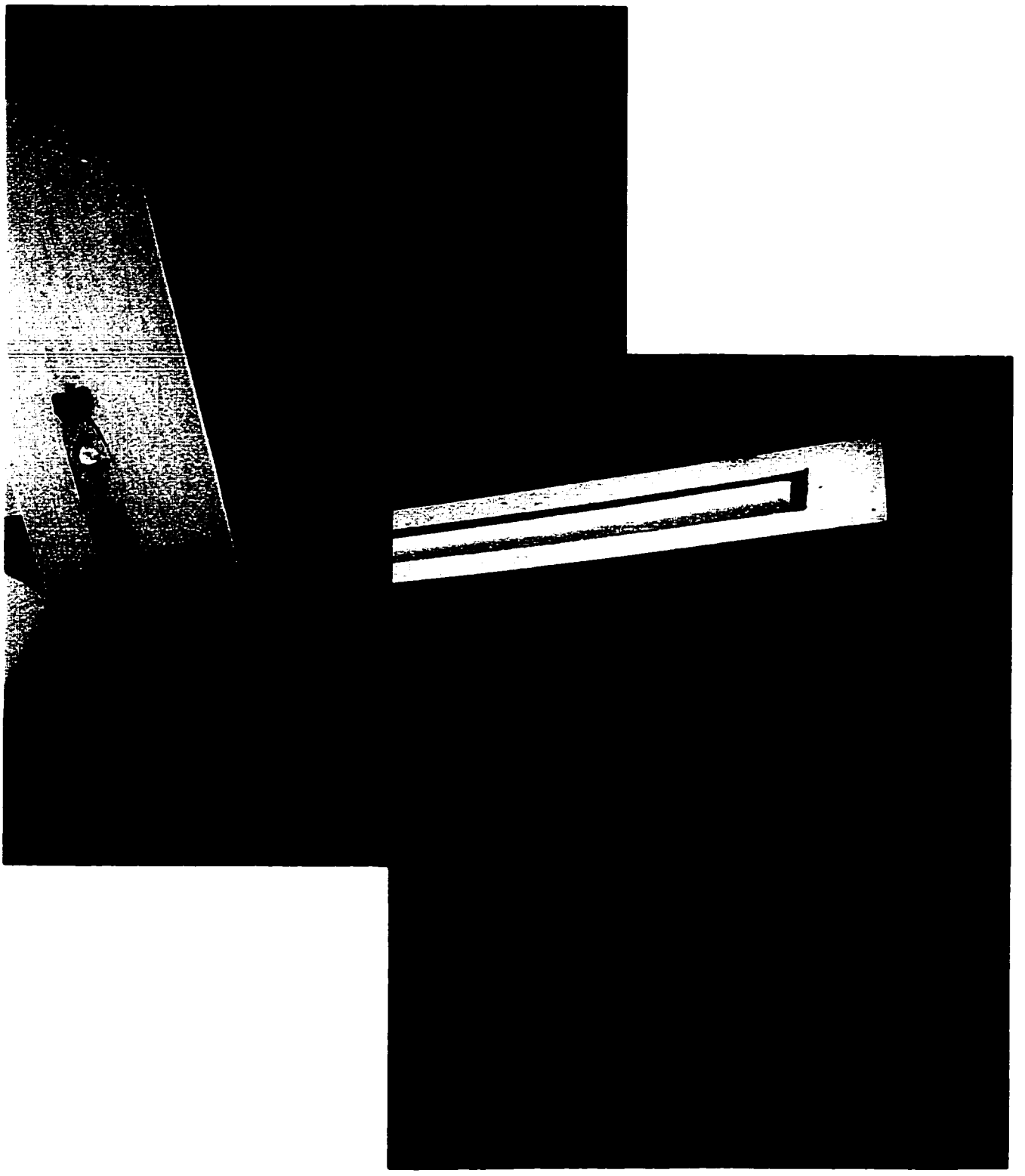


figure 119 and 120: Leg functioning - opening, closing and working table.

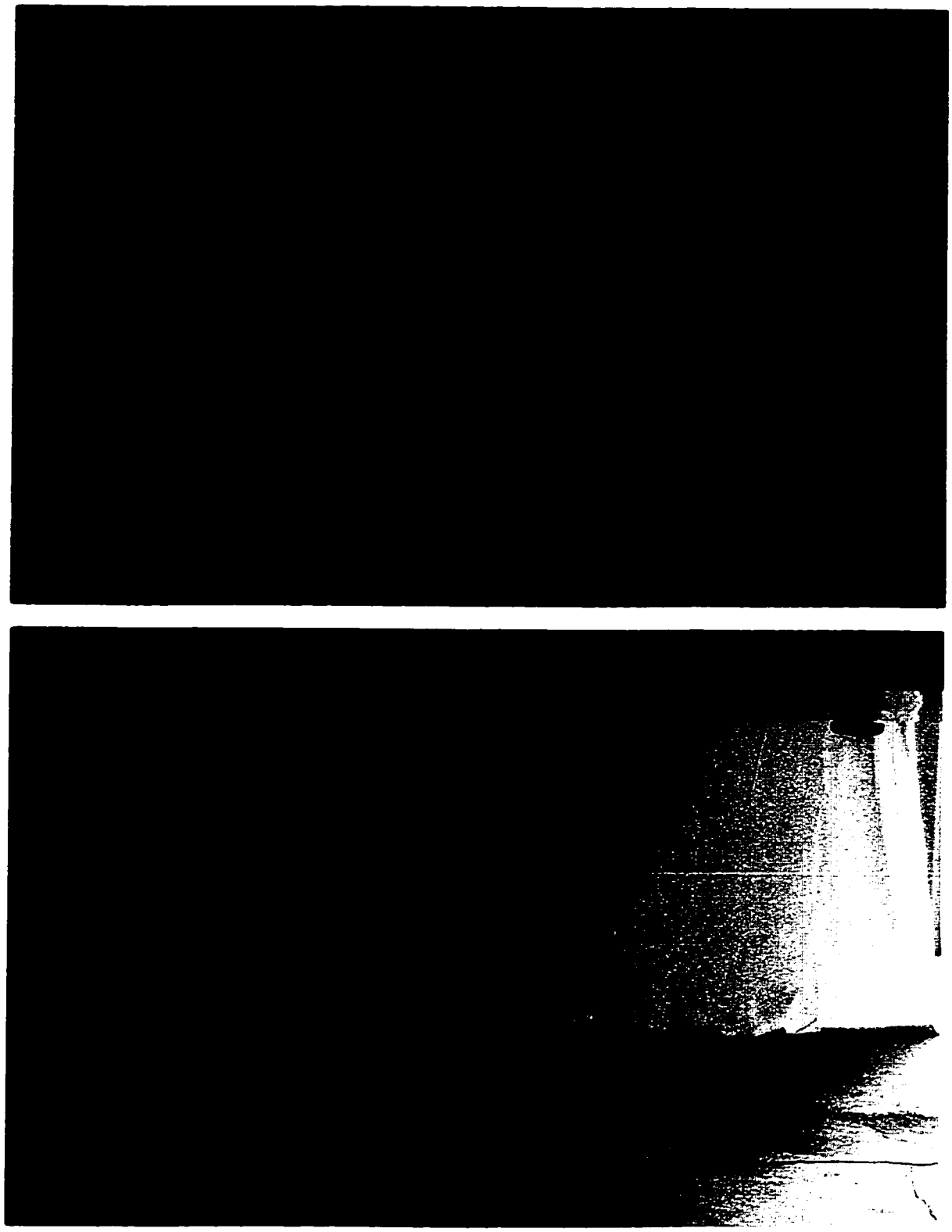


figure 121 and 122: Large (drafting) table leg..

Large (drafting) Table Foot Release and Linkage System

The foot release and linkage system is part of the action of both height adjustment and table moving from storage to working position. (figure 123) These mechanisms are connected by links and fastened to create a system of movement easily manipulated by the user. The foot release is tight to hinder small children from accidentally releasing this mechanism, but is easily used by intended users. The foot release and linkage system also controls the automatic locking of the clutch pack assemblage, a safety feature.

Large (drafting) Table Magnetic Catches

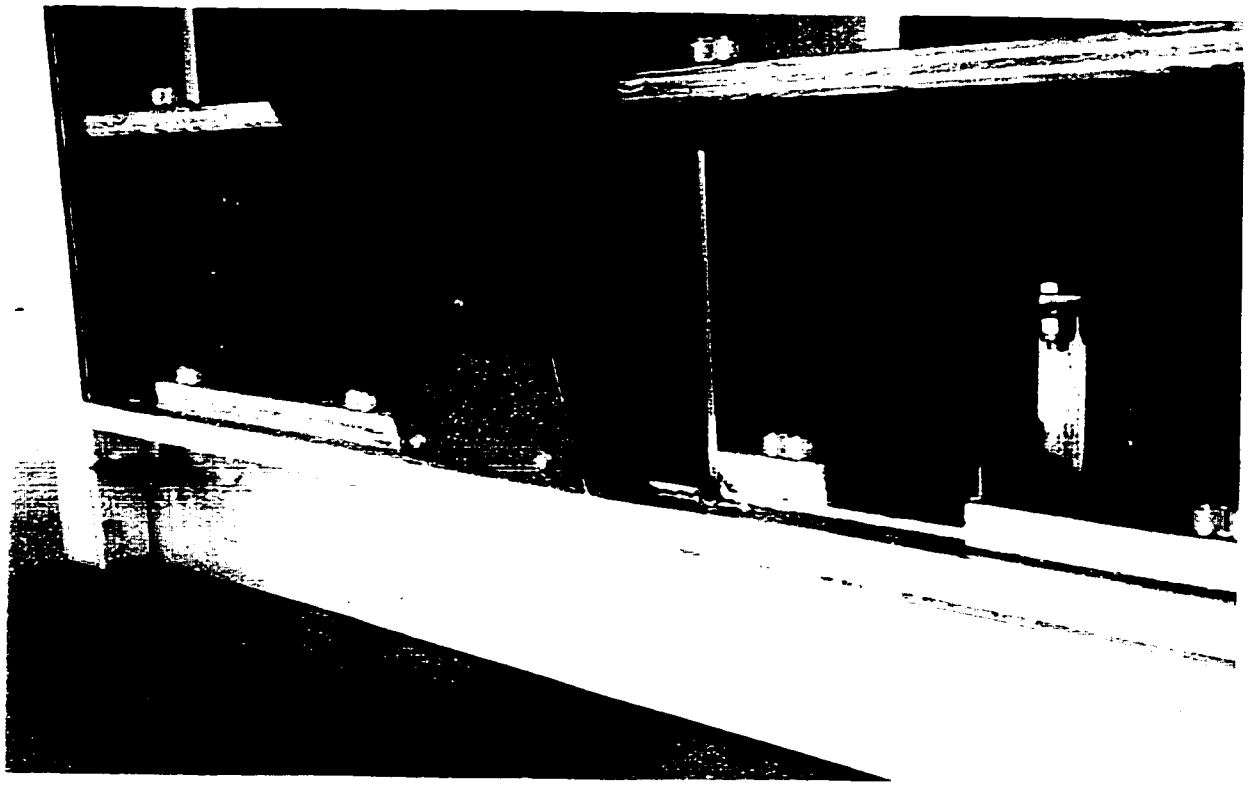
Two magnetic catches are mounted into the face of the table and the upper shelf of the workstation. These catches function to provide added security to the table when stored and helps the user open the table by a pushing action.

Front Panel Clips

The front panel clips are attached to the bottom front panels of the workstation. These clips provide a secure mounting of face panels while allowing access to the clutch pack, foot release and linkage mechanisms for maintenance and repair.

Computer Table Ball-Joint and Covers

The computer table ball-joint and covers are mounted into the back corner of the computer table. This joint provides the swivel and twisting action required to bring the computer table from the stored position to the working position and then back again. The ball joint is a nylon ball housed in steel covers that allow it to swivel and turn. (figure 124)



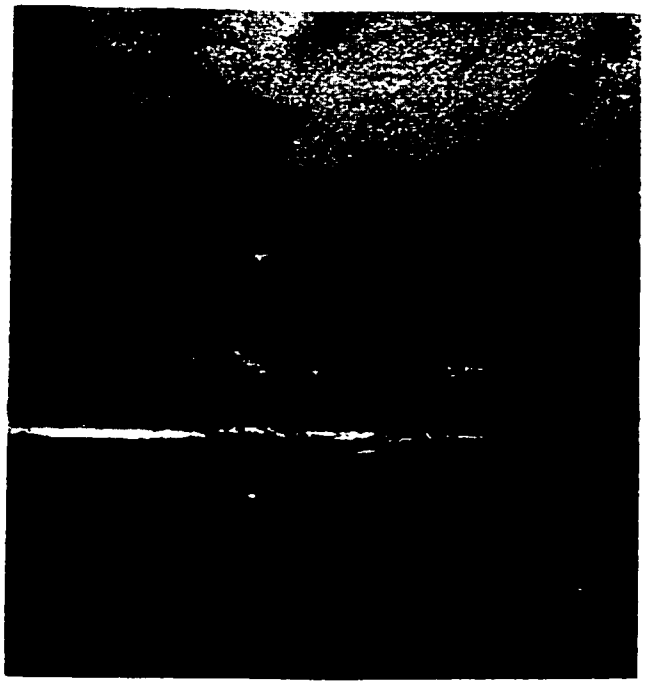


figure 123: Foot release and linkage system.

figure 124: Computer table ball joint and covers.

Computer Table Support Slider

The support slider is mounted to the bottom of the support box. This slider allows the entire computer table and support box to be brought out of the stored position to where the ball joint can begin lowering the computer table component. The slider provides an easy, safe and guided vehicle for the user to manipulate and control the computer table action.

Computer Table Stopper

This device acts to stop the computer table and support from coming out too far from the workstation body, tells the user to stop pulling the slider and begin twisting the ball joint to position the computer table. This feature is also installed for safety, so that the table cannot come out and hurt someone.

Computer Table Laptop Lift and latch

The laptop lift functions to bring the laptop out of the computer table frame and to the table surface height for use by the user. The latch keeps the laptop secured within the table frame in conjunction with securing material when not in use and in storage.

Computer Table Printer Drawer (slider, stopper, and drawer).

The computer table printer drawer functions to bring the printer in and out of the computer table easily and effectively. The printer is secured within the table frame with securing material when not in use and in storage.

Homing Pin and Slots

A homing pin is mounted center in the bottom of the computer table frame. There are two homing slots; one mounted center in the top of the support box and the other mounted close to the front edge of the left side wall of the workstation. This pin and slot functions to help the user manipulate the computer table placement more easily and to provide added support when the table is in it's working position

Conclusions

Each component is described in terms of its functioning within the product. All components help the workstation maximize space, provide a simple appearance conducive to both the home and office environment, create a sense of professionalism while preserving privacy and give the user a transformational and productive desk.

Section Five: Ergonomic Guidelines for a Chair.

It is stated that a chair will not be designed for this project, rather ergonomic recommendations for a readily available product would be suggested. (See: Part One, Section One, Introduction) In the following section biomechanical and anthropometric considerations are discussed and suggestions are made for an appropriate chair design.

Background

As discussed in the history section of this project, a chair is not always considered for its ergonomic value. Through the years, the design of a chair has been influenced and evaluated by a variety of things. A chair has often been viewed as a status symbol and not until the late nineteenth century did comfort and ergonomics become influential factors in chair design. (See: Part One, Section Two, Historical Overview-The Nature of Domestic living) In the twentieth century the computer has revolutionized our working lives and as such has demanded a closer look at the furniture we use with them. An average person spends many hours in front of their computers and 65-73% of people use a computer at home or at work (Bureau Census, 1993). The increasing use of computers has caused an explosion in back problems, fatigue, muscle strain and a whole list of CTD (Cumulative Trauma Disorder) syndromes related to the improper and dysfunctional design of furniture. Poor habits of posture when sitting are directly affected by the design of a chair and many problems stem from poor fitting chairs (Messenger and Griffin, 1990, Armbuster, 1991). Home office workers, like other workers, must pay more attention to the physical and physiological needs of their furnishings when considering the acceptability of their home office furniture, just as they would in any normal office setting. The 'kitchen chair' is not appropriate for the long hours and repetitive work the home office worker faces each day. The 'kitchen chair' philosophy will eventually harm the individual's well being and workability. (figure125)

figure 125: 'Kitchen' chair philosophy.
(IBM Ad.)

In this computer age, ergonomic considerations must be continually applied when considering a chair and/or workstation design. This section discusses ergonomic principles in relation to chair design, followed by a list of suggested criteria for a sound chair design.

Principles

This section is structured into two components, biomechanical and anthropometric considerations.

Biomechanical Considerations

The design requirements of a workstation and chair depend largely on the tasks that are performed while the user is seated, as well as the posture required while performing these tasks. The workstation user performs various tasks at the station,

including; writing, drawing, sketching, imputing, typing, research and searches (online), reading and emailing. These tasks require the user to attain both upward and or forward positions for work activities, as well as a reclined position for leisure type activities.

In chair design, it is especially important that the designer encourage two primary ergonomic principles as the user performs the required tasks; preserve the natural curve of the spine and distribute the body's weight evenly. A properly designed chair enhances the benefits of the seated position while a poorly designed chair causes undue pain and back problems. A well-designed chair encourages good posture by maintaining the natural shape of the spine. (figure 126)

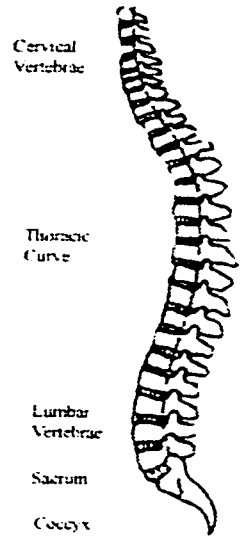


figure 126: Natural shape of spine

(Anthropometrics and Workstation Design in Environmental Factors & their Application.)

These two principles are the critical aims of the chair and workstation function and affect the criteria of comfort. Oxford (1969) states that if the user is aware of the chair and workstation while performing his/her task then the design is not meeting the comfort needs of this person, the primary goal of the chair's purpose. Pheasant

(1986) states to " provide support in a posture which is (i) comfortable over a period of time; (ii) physiologically satisfactory; (iii) appropriate to the tasks or activity that is being performed" is the aim of comfort (p. 181).

The Spine

The spine consists of; vertebrae and disks that provide structure to the spine and muscles and ligaments that provide rigidity and flexibility. The spinal column has four regions; the cervical, thoracic, lumbar and sacrum. As a whole, these regions act as a flexible column allowing for movement in directions such as flexion, bending and twisting. The sacrum is the most fixed, the cervical region next in immobility, while the thoracic and lumbar regions are the most flexible. These regions of the spine form the three curves of the natural form; the cervical lordosis curve, the thoracic kyphosis curve and lastly the lumbar lordosis curve. (figure 127)

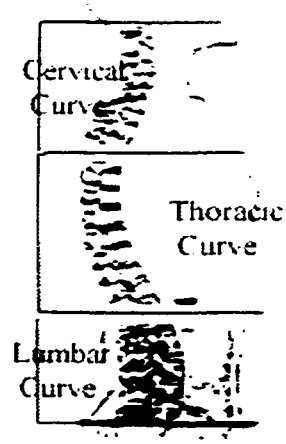


figure 127: Three curves of the spine.
(Cornell, 1988.)

For seating, the lumbar curve is especially important as this region can assume two postures; the lordotic curve (when the back curves forward) which is closest to the natural shape of the spine or the kyphotic curve (when the lower back curves outward). (figure 128)

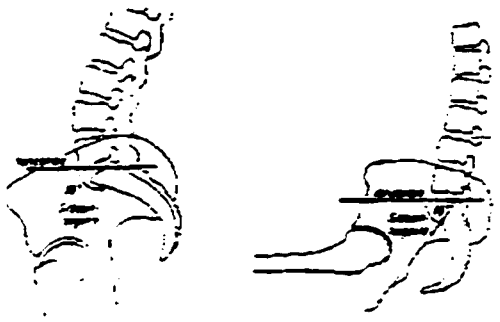


figure 128: Lordotic and Kyphotic posture.
(Schoberth, 1962.)

When a person stands the spine is in its natural curve. " The normal curve pattern of the spine is believed to have evolved as a result from man's ability to stand and walk in an upright position" (MTI. How Does My Back Work, *Medical Dictionary*, p. 1. medicaltraining.com/ dictnry.htr). Standing, weight is distributed evenly throughout the body's support structure. When a person sits, the spine's natural form alters and weight distribution changes.

The Alteration of the Spine's Natural Curve

In the sitting position, the body changes from a 180-degree position to a 90-degree position, altering the shape of the spine and the lumbar tends toward kyphosis. This tendency towards a kyphotic posture is also due to pelvic rotation as the body compensates for the change in the body trunk angle. (figure 129)

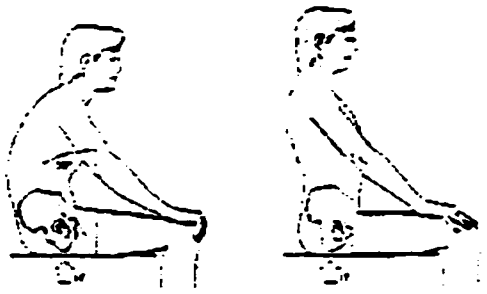


figure 129: Pelvic Rotation.
(Pheasant, 1986.)

In order to regain lordosis, muscular tension is required to counter the tension in the hamstring and rotate the pelvis. This causes strain on the back and abdominal muscles, as well as the ligaments that support the vertebrae as they try to maintain the natural lordosis posture. Lumbar support as stated by Chaffin and Andersson (1984), is more important than the back rest angle or the height of the back rest support, in terms of effective seat design.

Two physiological problems result from the alteration of the natural spine; intervertebral disc pressure and muscle strain. Intervertebral disc pressure stems from the fact the spine, standing or sitting bears a majority of the body weight (Chaffin and Andersson, 1984). When seated, disc pressure increases due to "increase in the trunk load movement when the pelvis is rotated backward and the lumbar spine and torso are rotated forward as well as the deformation of the disc itself caused by lumbar spine flattening" (Chaffin and Andersson, 1984, p. 303). Muscle strain occurs if a user is required to sit for extended periods without or poor, back support. Slouching is the result of muscle fatigue and can lead to further spinal problems. Seat depth also influences the occurrence of slouching. A seat depth that is too long forces the user to move forward in the seat, away from the back support and eventually the user succumbs to slouching as fatigue takes over.

Suggestions

The chair must have lumbar support, as this feature will encourage a lordosis posture. The ability to adjust the lumbar support height is preferred, as the chair may be used by a variety of users who over time need to adjust this support. Most effective and cost efficient seat designs presently have this adjustable support.

Phesant (1986) suggests that the backrest support " begin at a level which clears the major protuberance of the buttocks, should have its minimum prominence in the mid-lumbar region and should conclude below the level of the shoulder blade to

allow freedom of movement " (p. 183). The presence of thoracic support is important to provide upper back support. A chair should have a high seat back to provide support to both the lumbar and thoracic regions. This type of back rest provides the user the ability to adopt a relaxed posture leaning backward and forward, as well as resting the back and shoulder muscles.

An adjustable back rest is recommended. Adjustment of the backrest height allows the user to position the rest at his/her appropriate height. A fixed rest will cause problems for different users, restricting their upper arm and shoulder movement, or positioning the lumbar support in the thoracic region.

Also important in encouraging a lordosis posture is the seat's back rest rake. The seat's back rest rake is the backrest angle relative to the horizontal plane. Backrest rakes as little as 10 degrees will decrease pressure as well as reduce pelvic rotation, which in turn reduces kyphosis. (Andersson and Ortegren, 1974) A back rest rake also reduces body weight from the buttocks to the backrest. A moveable rake is preferred.

An inclined backrest, use of arm rests and adequate lumbar support reduces intervertebral disc pressure. Muscle stain can be alleviated by proper lumbar support, which reduces slouching. As the chair is a separate entity from the workstation's table the user can position it at the appropriate distance. The seat pan width should be a minimum of 440.6 mm (17 5/8"). It is recommended the seat pan depth be between 372.8 - 421.8 mm (4 7/8"-16 7/8") to reduce the tendency to move forward in the seat. The 5^{th} percentile female thigh length determines this measurement.

Postural stress caused by sitting in the same position for a long period of time has been associated with lower back pain (Reynolds, 1993). To minimize stress, seating must be dynamic rather than be fixed in a 'predetermined best' position. Ideally, the user should have the ability to move the seat back independent of tilting the seat.

Change in distribution of body's weight and pressure points.

Weight distribution also effects the acceptability of a seat's design. The spinal column holds the majority of the weight bearing burden of the body. "The lumbar vertebrae are the largest vertebrae because they carry and direct the body's weight". (MTI. *How Does My back Work –Medical Dictionary*, p. 3. medicaltraining. com/dictnry. htr.) When the lumbar curve is in the lumbar lordosis posture the least amount of pressure is placed on the discs between the lumbar vertebrae.

When a person sits the body's weight distribution alters and the compressive force tends to concentrate on the lumbar vertebrae This strain cause lower back problems for the user and weakens the abdominal muscles generating weak intra-abdominal pressure (IAP) which normally helps support the spine and maintain its natural curve (Armbuster, 1991, Oxford, 1969).

" Lower back pain is one of the most frequent problems treated by orthopedic surgeons. Nearly 80 percent of adults will experience significant low back pain sometime during their lifetimes. After the common cold, problems caused by the lower back are the most frequent cause of lost work days in adults under the age of 45."(*UK HealthCare*, p. 1. www. Ukhealthcare.uky.edu/disease/spine/lowback.htr). A lack of adequate lumbar support will cause uneven intervertebral disc pressure, chronic back pain, herniated discs and pinched nerves to occur (Chaffin and Andersson, 1984).

When seated other problems occur due to changes in weight distribution, as weight is transferred to the feet, backrest and buttocks to help support the body. The majority of the weight supported by the buttocks is placed on two bony structures called the ischial tuberosities or sitting bones (Cornell, 1989). (figure 130)

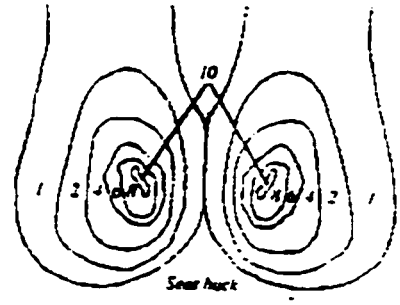


figure 130: Pressure points.
(Cornell, 1989.)

A well designed seat strives to relieve the ischial tuberosities and the body's spine from some of it's weight burden by redistributing the body's weight evenly amongst the support segments and avoiding possible pressure points. The areas that surround the ischial tuberosities in the buttocks have very little protection and are prone to pain. If the seat's design does not distribute the body's weight over the entire buttocks the person will experience pressure point pain, feel uncomfortable in the seat, move excessively and cause strain.

Further problems can occur for the user in relation to the depth, width and length of the seat pan. The seat pan plays a vital role in avoiding pressure under the thigh, behind the knee and the sacrum. (figure 131)

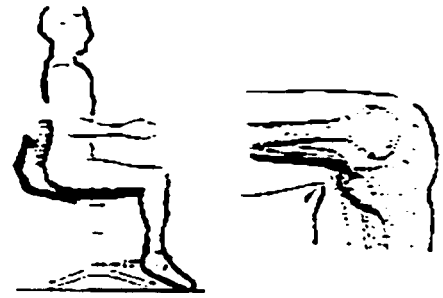


figure 131: Avoid pressure.
(Jonsson and Andersson, 1978.)

The areas under the thigh and behind the knee are particularly sensitive and prone to problems. Improper fit of the seat pan can cause pressure and circulation problems, as well as pinched nerves for these areas. As mentioned a seat pan that is too long causes the user to move away from the backrest resulting in a kyphotic posture, muscle fatigue and slouching. (See: Chapter Three, Section Five, Ergonomic Guidelines for a Chair: Alteration of the Spine). The user moves away from the backrest to alleviate pain and pressure he/she is experiencing behind the knee because of the improper seat pan length. In terms of the sacrum, it is as sensitive a pressure point as it is rigid in form. The seat pan must contain a convex contour to accommodate this area or the user will experience pain.

An adjustable seat pan height is another important design feature. A seat height that is adjustable enables the user to rest his/her feet on the floor with minimal pressure behind the thigh. A stationary seat height restricts circulation in the legs, pinching the sciatic nerve if the seat is too high (the user's popliteal length is too short), and if the height is too low (the popliteal length is too long), weight is shifted to the buttocks from the legs and pelvic rotation occurs, forcing the lumbar into kyphosis.

Lastly, reasonable ingress and egress of the seat in relation to the table is important. An adjustable and tilting back rest and casters, help the user get in and out of the seat.

Suggestions

Ribiffe (1969) suggests a seat design should distribute the body's weight over the entire buttocks with the pressure decreasing from the ischial tuberosities to the periphery of the buttocks to reduce possible problems.

The seat pan should be slightly concave front to back and side to side. This design will distribute the body's weight over the entire buttocks with pressure decreasing from the sitting bones out to the periphery of the buttocks. A concave seat pan

stabilizes the body in the seat and cushioning helps alleviate possible pressure point pain.

A rounded front or waterfall edge is also recommended for the seat pan design as this reduces pressure on the underside of the thighs and lessens the restriction of blood flow to the legs and feet. Both Pheasant (1986) and Oxford (1969) recommend this feature. The seat pan's width should be wide enough that the user can make slight shifts from side to side to avoid static postures and accommodate a large user population.

ANSI/HFS-100 (1988) suggests the seat pan width should be a minimum of 440.6 mm (17 5/8") and the depth between 371.8-421.8 mm (14 7/8"- 16 7/8). Again the seat pan depth should be set by the smallest thigh length of the user population, in this case the 5^{th} percentile female. The seat pan should also be padded. A properly padded seat pan compression rate should compress about 12.5-25 mm (½"- 1") when a person sits (Smith and Cohen, 1997) Lastly it is suggested that the seat pan angle itself should be adjustable, and easily manipulated in a seated position.

In regards to the sacrum, Cornell (1989) states that a slight and gentle upward curve at the back of the pan would rotate the pelvis forward encouraging lordosis as well as lessening pressure on the sacrum. Cornell (1989) also suggests a gentle side to side contour within the backrest to help stabilize the body in the chair as well as redistribute the body's weight. The curve of this feature is important, as too great a curve will cause the shoulders to round. Diffrient et al (1974) suggests a radius of 1020 mm not be exceeded.

The user should easily manipulate the seat pan adjustment. A gas-pressured system commonly used in current computer chairs is an effective feature. To lower the seat the user sits on the seat and pulls the handle up. To raise the seat the user stands and pulls up the handle which causes the seat to automatically rise until he/she lets go of the lever.

In terms of ingress and egress, it is recommended that the chair design incorporate an adjustable and tilting backrest, have casters and be supported by five legs. These features make it easy to move the chair, facilitate postural adjustments and support the chair evenly.

Other Factors

Armrests have been argued for and against in many ergonomic documents (Smith and Cohen, 1997). Armrests can provide support and relaxation for the arms, but can also be in the way of a fixed table height, as well as pinch fingers. Armrests should be moveable and height adjustable as well as fully removable if used. (figure 132)

figure 132: Armrests- adjustable and removeable.
(Smith and Cohen, 1997.)

As the chair is used by a variety of people a footrest is also recommended. A footrest provides for the smallest user to properly engage both chair support and table height, as well as accommodate the thigh clearance of the largest person when a table height is fixed, as in the case of the workstation's computer. (figure 133)

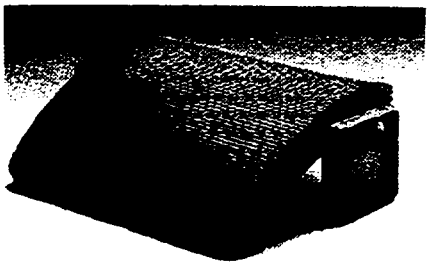


figure 133: Footrest - adjustable and separate.
(Rosenbaum, 1995.)

Rest periods are an important component of any successful working arrangement. More and more corporations are recognizing the need for rest and stretch breaks for its employees. The benefits of these programs are a reduction of medical complaints. " No matter how high-tech or expensive the chair, no one should sit for an extended period" (Marshall, 1996, p. 1. www.colorado.edu/CNS?Digit?julyaug96/seats.htn.).

A swivel chair is valuable if the user is moving from one table to another when working. Casters are also an aid in this movement. Both casters and a swivel, aid in the ingress and egress of the chair to table. It is recommended that a five-leg system support the chair pan for even and adequate strength (Smith and Cohen, 1997).

Suggestions

Armrests if present must be moveable and adjustable. A separate and adjustable footrest is recommended. The user must take rests breaks and develop a stretching routine. A chair that swivels, has caster and a five-leg support system of the seat, is recommended.

Anthropometric Considerations

As the intended user of the workstation and chair is from a varied population, anthropometrics play an important role in evaluating the chair's design. (See Part Three, Section One: User) The appropriate fit of a chair is defined by the user's anthropometric data in relation to the dimensions of the chair and workstation.

Anthropometric data needed to determine an appropriate fit includes the individual's: height, abdominal depth, sitting eye height, knee height, popliteal height, sitting elbow height, buttocks to popliteal length, thigh thickness and hip breath (Pheasant, 1986, Armbuster, 1991, Reynolds, 1993, Rogan, 1990, Jergens, 1980, Mark 1984). In this project the user population is both female and male, varying in age, size, weight, nationality and height. These variables require that the chair's acceptability be based partly on how effectively it adjusts to accommodate the different user's body dimensions.

A user needs to examine his/her individual body dimensions in comparison to a chair's flexibility. These dimensions can greatly hinder or enhance the suitability of the intended chair. For example, in terms of the seat, the popliteal height plays an important role in the fit of the chair. " A chair satisfies postural requirements when (a person) is able to sit against the back rest and the height of the seat is the same as the individual's popliteal height" (Oxford, 1969, p. 153). When an individual sits on a seat that is too low the user slouches, pushes his/her feet forward and develops bad postural habits. When the chair is too high, the individual is forced to perch on the front of the seat, sacrificing the comfort and support of the backrest, leaning and hunching over the table and developing bad posture.

Suggestions

Acquire a fully adjustable chair, to fit different individuals, rather than a chair for a set user. To avoid a person slouching or perching, a chair design whose seat height

has infinite adjustments is recommended. It is also important to consider if the chair is to be used for more than one worker. Again, a fully adjustable chair is recommended allowing for differences in body measurements.

Seat depth is important in terms of the user using the backrest appropriately and preventing pressure behind the knee. A seat depth between 371.8 - 421.8 mm (14 7/8"- 16 7/8") is recommended, based on the 5th percentile female user.

As the chair is a separate entity this stops any possible problems with ingress and egress of the chair to either table. A fixed combination can cause users to bend over their work if the person is too big, or perch on the seat edge if they are too small.

Conclusions

Based on the problems associated with a poorly designed chair, it is recommended that the following list be a guide for the user when purchasing a chair for the workstation. A well-designed chair will meet the following criteria:

- Seat back must have lumbar support.
- Seat back must have thoracic support.
- Back rest height adjustable.
- Back rest angle free tilting or adjustable.
- Back rest rake angle adjustment of 110-130 degree.
- Recommend back rest width of 300 – 325 mm (12"-13") to allow for upper arm swing.
- Seat pan height must be adjustable between 400 – 512 mm (16"- 20 1/2").
- Recommend a gas release seat adjustment mechanism for seat height
- Compressed seat rate of 12.5-25 mm (½" - 1") when person sits.
- Seat pan angle adjustments up or down in front (5-degree minimum).
- Seat pan width of 440.6 mm (17 5/8").

- Seat pan depth of 371.8-421.8 mm (14 7/8"- 16 7/8").
- Concave seat pan.
- Waterfall edge on front of seat pan.
- To aid ingress and egress casters and swivel present.
- Casters – provide convenience in moving from one table location to another.
- Swivel - useful for working at L-shaped consoles.
- Five-leg support system for improved safety.
- Footrest included but as a separate product.
- Footrest must be inclined upward slightly (5-15 degrees), have a nonskid surface, be heavy enough not to slide easily, large enough for feet to be firmly planted on it, portable and height adjustable.
- User must engage in rest breaks and a stretch exercise routine.
- Armrest if present are moveable, height adjustable, and fully removable.

Section Six : Materials and Manufacturing

In this section materials and manufacturing processes are discussed in regard to the workstation design.

Material Choice

Material consideration and selection is an important component of design. Material selection effects the cost, value, selling price, appearance, structural integrity, weight, durability, quality, performance and safety of the final product. These factors influence the marketability of the product, the actual manufacturing possibilities, as well as end user selection. Material consideration must begin early in the design stages and be continually re-evaluated throughout the design process. In this section, material selection of the workstation is discussed. Consideration of cost, appearance, surface textures, corrosion resistance, availability and ease of manufacturing influence the material choice. The workstation is composed mainly of two types of material; steel components- cold rolled sheet, plate, tubing, rod and flat stock and wooden components- mainly maple and pine. The use of other materials; for example, brass, aluminum and chrome plating are minimal and discussed in one heading.

Steel

Sheet metal is implored in the workstation design for the following reasons:
it is easily machined, bent and formed, as it is a malleable and ductile material that is available in a variety of thickness, shapes and forms (bar, tubing and flat stock) which affects weight, strength, safety and durability for the workstation's mechanical devices. Steel is easily and locally available, cost effective and provides the opportunity for a variety of surface finishes. This material is also recyclable and durable, easily repaired and has low maintenance properties. Although prone to rusting, simple coating and finishing processes can resolve this issue.

Wood

A large percent of the workstation is composed of wood. Local and readily available, this material has been a favorite choice for furniture making for many centuries. It is a renewable source, comes in a variety of thickness, grades and ply and is cost considerate. Wood is continually used in a variety of structural and decorative products. Primarily two woods are used in the construction of the workstation: maple, a hardwood and pine, a softwood. Selection of these woods is based on the following; weight, strength, durability, color and appearance which affects acceptance in the home office environment, texture, cost, local availability and finishing qualities. The maple is chosen for its grain, color and strength, as well as being considered a quality wood used in fine furniture. Pine is also chosen for its color, being a slight contrast to maple, is lightweight, easily cut or carved and a wood used in both construction and furniture. Because of these characteristics these woods are often favored when used with metal for a single product.

Other Materials

In the workstation, brass, aluminum and chrome plating are also used. The selection of these materials is determined mainly for their functioning within the workstation design, as well as their compatibility with the major materials. These materials are locally available, but used with discretion, as limiting material variety is an important manufacturing consideration for a less complicated end product. Brass is used mainly in possible friction situations or for latches, as it complements the light grain of the woods selected. Aluminum is used in the clutch pack assembly, which is a ready-made product. Chrome plating is used on the ball for the large (drafting) table ball-joint to provide an effective friction barrier between the ball and it's cover plates. This material limits friction and wear between steel on steel and is a more desirable material choice than the use of a powder or oil, as this mechanism is housed within a wooden table and leakage would cause damage to both the table and possibly the user's work.

Fir is also used in the workstation for the inner support housing of the large table ball–joint. This material is chosen for its' mounting strength and to provide structure to the table itself.

Other Material Choices

The workstation can be manufactured in a variety of woods along with a variety of metals. The possibility for a workstation with an aluminum leg for example is reasonable, as is the idea of the station being built in a dark wood such as walnut or mahogany. The designer, user and manufacturer determine these choices, although present material selection is deemed most effective and desirable by the designer.

Manufacturing

"Manufacturing is the making of products from raw materials using various processes and following an organized plan for all aspects involved " (Walker, 1994, p. 1.2). It is a responsibility of the designer to consider manufacturing throughout the design stages. From conception, manufacturing of the workstation is thought to implore (as much as possible) simple manufacturing, such as sheet and simple forming processes. These processes are ideal for the following reasons: to keep costs down, to make the assembly process simple and effective, to keep tooling reasonable and easily adaptable, to keep set up time low and allow flexibility in production run numbers - so that going from small runs to large runs is a simple process. As well, disassembly, repair and maintenance issues continually influence manufacturing decisions. The idea of locally sourced materials and their manufacturing qualities also affects construction and design.

Although a series of assemblies and subassemblies dictate the order of construction, the manufacturing processes themselves can be altered dependant on the manufacturer's discretion if the alterations provide simpler, faster, more productive and cost effective means. For example if the manufacturer is already set up to punch

they can replace drilling operations as long as the same out put is achieved. The designer accepts and condones these methods only if the integrity, safety, quality, durability, reassembly, repair and low maintenance of the product is not compromised.

Assembly is a large and dictated component of the workstation's manufacturing. Individual forming processes for each component must be kept simple and cost effective to keep the assembly process reasonable. In this section the metal production methods and wood production methods are separated into two parts .

Metal Production Methods

Metal production for the workstation uses a series of sheet metal operations; shearing, blanking, punching, bending, press brake forming, hemming, drawing and coating, metal cutting processes; turning, drilling, thread cutting, tapping, filing, sawing and milling and joining processes; mechanical joining and welding. These production methods are chosen because they are simple processes that help reduce cost, tooling and set up, as well as make assembly, disassembly, repair and maintenance, easier. Using these forming processes provides the manufacturing company the ability to simply and cost effectively expand production at a later date, while initiating with smaller runs.

Metal Assemblies and Subassemblies

Large (drafting) Table Ball Joint

- Uses simple manufacturing, is cost effective and easily produced in large quantities.

Ball (outsourced)

- Uses a 75 mm (3") hollow steel ball with 6.25 mm (¼") wall thickness that is chrome plated.
- Ball is drilled, threaded, welded and machine bolted to shaft.

Shaft

- Uses a 18.75 mm (¾") cold rolled steel rod, 300 mm (12") in length.
- Top 6.25 mm (¼") is turned and threaded to 12.5 mm (½") diameter, bottom 168.75 mm (6 ¾") are threaded to diameter.

Pressure Cover Plates

- A component that requires two manufacturing processes; milling and drawing, which can initially raise production costs. Once this process is tooled and set up, manufacturing is simple and effective.
- Costs and production of this component is reduced by the fact both the front and back plates can be drawn and partially drilled from the same die, then turned into front/back distinction in the next machining process. This factor makes repair and maintenance more cost effective.
- As well, these components can be alternatively pressed by a hydraulic press if this process is more available to the manufacture.

Front Plate

- Is drawn to 50% of ball diameter from a 300 x 300 x 1.6 mm (12"/12"x1/16") steel blank
- Is drilled, front milled to drawing specifics and cut to fit large table plate dimensions.

Back Plate

- Is also drawn to 50% of ball diameter from a 300 x 300 x 1.6 mm (12" x12" 1/16") steel blank, (same plate) then drilled.
- This component is ready for assembly to large (drafting) table ball/joint mounting.

Face Plate

- 20-gauge sheet blank punched to form.
- Glued to 18.75 mm (¾") wooded backing and drilled.
- Is ready for mounting to front plate in large (drafting) table ball / joint assembly.

Large (drafting) Leg

- Uses simple manufacturing processes, cutting, drilling and welding. Strength and weight issues play key rolls in choice of tubing and material thickness.

Square Shaft

- Uses a 31.25 mm (1 ¼") square tube with 12.5 mm (1/8") wall thickness.
- Material is easily cut, front drilled and welded.
- Three securing nuts for ball shaft are positioned at the top, middle and bottom of shaft length in tubing for ball shaft to be threaded through.

Leg Cover

- Uses 20-gauge sheet metal sheared from a 900 x 300 mm (36" x 12") blank.
- Front and back panels are initially sheared in the same process reducing cost, set up and tooling.

- Edges are punched 6.25 mm (¼") from side at 100 mm (4)" spacing.

Front Panel

- Front panel has four holes punched in the center of the sheet, at 237.5 mm (9 ½") spacing.
- The top of the panel is cut then press-brake bent to 67 degree angle.
- Panel is polished, clear coated and ready for final assembly.

Back Panel

- Back panel is sheered to dimensions then press-brake bent to 23 degree angle.
- Is polished, clear coated and ready for final assembly.

Rivets (outsourced)

- Used to join front and back cover panel to large (drafting) table leg shaft, after clutch assembly is welded.

Nuts(outsourced)

- Used to mount front panel to leg shaft after final placement within table structure.

Bottom Face Cover

- Uses simple manufacturing processes with readily available hardware.
- This cover functions to finish flush face of leg on the front of workstation.

Cover

- A 20-gauge sheet blank cut to dimensions, punched for hinge assembly and 6.25 mm (¼") of side bent for spring assembly.

Springs

- Two springs ready made, attached to cover and workstation mounting plate.

Hinge

- 12.5 mm (1/2") hinge attached to cover and workstation floor. Assembly line production.

Clutch Pack Assembly (Outsourced)

- Comprised of two main materials; steel and aluminum.
- It is recommended that this component be outsourced as it is locally available at a cost-effective price. Manufacturing would entail tooling, set up and assembly costs that can be avoided in the simple modification of mounting the ready-made product to the design specifications.
- As well an outsourced component will have mechanical, technical and safety approval.
- All components of the clutch pack are left untouched except for the welding of a support structure to the outer steel housing to mount the leg shaft and the replacement of the inner push rod with a 300 mm (2") cold rolled (3.75 mm/ 1/8") rod.
- Of course extreme care is exercised in the welding process, as heat damage would alter the integrity of the outer structure and aluminum key housing.

Mounting Plate

- The mounting plate uses simple processes, again cost effective and easily produced.
- The 6.25 mm (¼") steel plate is chosen for its structural abilities and strength, as well as keeping weight in mind.

Bottom Plate

- Cut to dimension, drilled or punched for mounting bolts.
- Structural walls and linkage housing are welded after formation.

Clutch Pack-leg Walls

- 6.25 mm (¼") steel plate cut to dimension, drilled or pressed for clutch plate shaft mounting, edges filed and rounded, then welded to bottom plate facing north and south running parallel to one another using back edge as guide.
- Clutch pack/leg shaft is assembled through holes and welded.

Central Pivot Rod Housing

- A 25 mm (1") hollow tube with a 3.125 mm (1/8") wall thickness cut to length, with an internal nut at bottom of tube, covered by a top and bottom sheet that is previously drilled/ punched.
- Is welded to the bottom plate 100 mm (4") from front edge of plate on the right side.

Release Swing Walls

- Two 6.25 mm (1/4") walls cut to dimension, drilled /pushed with a hole 87.5 mm (3 ½") from floor, then welded to the bottom plate on left side, facing east and west running parallel to one another.
- A brass insert is assembled into the hole of each wall for the swing rod.

Nuts

- Outsourced hardware for assembly linkage and mounting plate.

Release Linkage/Components

- Steel components, cut, drilled and welded to form the release linkage system.
- Chosen for strength and weight considerations, as well as ease of manufacturing and assembly.
- This system is comprised of :
  - *a swing*- 18.75 mm (3/4") rod whose ends are turned 6.25 mm (¼") and has a pusher bar and release arm welded to it. This component is assembled into the release swing walls.
  - *back pusher link* - A 25 x 3.125 mm (1"x 1/8") steel flat bar cut, drilled and welded to form linkage. This component attaches to the pusher bar of the swing via a flat bar link.
  - *central pivot link* – a 25 x 3.125 mm (1"x 1/8") flat bar with two holes drilled/punched and assembled to end of back pusher link and internal pusher link.
  - *internal pusher link* – 3.125 mm (1/8") flat bar, one hole for attachment to central pivot link, with replaced pusher rod welded to it.
  - *Nuts* – ready-made used as pivot pins in linkage system.

Foot Pedal

- A simple 3.125 m (1/8") flat bar cut to length, bent and welded to a 1.56 mm (1/16") cover plate.
- A single hole is drilled/punched to attach foot to swing linkage.

Work in Progress Protector (outsourced)

- Outsourced component whose cover is replaced by specified material.

Pins and Roller

- Outsourced hardware locally available, must fit 762.5 x 12.5 x 37.5 mm (30 ½"x 1 ½") dimensions.

Cover

- Plastic with thin cork layer glued or sewn to existing roller.

Computer Table Ball-Joint

- Either a readily available product or component manufactured by drawing, milling, punching, drilling, threading and fastening processes.
- The same manufacturer of the large table ball-joint can make this component although different dimensions would require tooling variances.
- Because this joint has lower strength and stress requirements, cheaper and easily formed materials can be used for its' manufacture.

Ball and Shaft

- 50 mm (2") nylon ball drilled or punched for shaft.
- Depending on ball material, ball is set screwed or welded to shaft.
- Shaft is 8.125 mm (3/8") threaded rod mounted into and through ball.

Ball Cover Plates

- 16 gauge sheet blanks drawn or pressed to fit 50 mm (2") ball.
- Drilled or punched for assembly over ball and within computer table housing.
- Clear coated.

Nuts

- Available hardware to fit shaft size and punch/drill holes.

Homing Pins (outsourced)

- Available hardware, brass pins and sleeve assembled into computer table components and side wall of workstation.

Sliders

- Available hardware attached to bottom of support box by screws.
- This component has plastic rollers and housing that can be adjusted to fit length of support floor.

Stopper and Floor Roller

- Readily available products attached to support floor.

Laptop Mechanism

- Uses both available products (hardware) and simple manufacturing processes.

Hinge

- Available product assembled to wooden tabletop.

Plate

- 22-gauge sheet blank sheared with 3.125 mm (1/8") square bar spot welded or punched and riveted to four edges of sheet.

Securing

- Available product glued to plate top surface. (Velcro)

Latch

- Available hardware assembled.

Printer Mechanism

- Uses simple metal and plastic cutting processes and assembled into table surface.

Slider

- 5 mm (3/16") acrylic sheet cut to length, then two slots cut into surface. Glued to printer drawer floor.

Slider Plate

- 22-gauge sheet sheared and edged rounded and filed.
- Two 3.125 mm (1/8") square rods spot welded or drilled/punched and riveted/pinned to bottom of plate.
- Assembled into slider.

Stopper/guide

- 22-gauge sheet sheared bent and spot welded to top surface of slider plate.

Securing

- Available product glued to slider plate surface.

Mounting Plates for Workstation (outsourced)

- Available product comes loose with workstation.

Wood Production Methods

Wood production methods for the workstation uses a series of cutting operations; cutting, rabbeting, routering, finishing operations; planing, sanding, and finishing and fastening operations: gluing, nailing and screwing. These production methods are chosen, as they are simple processes that help reduce cost, tooling and set up. They also help in assembly, disassembly, repair and maintenance. The workstation's material and design allows for the use of simple forming processes, providing the manufacturing company flexibility in terms of production rates.

Wood Assemblies and Subassemblies

Workstation Body

- The workstation body is composed mainly of maple plywood and uses simple cutting finishing and fastening methods.
- These methods are cost efficient, easily tooled and flexible for production numbers.

Right side and back mounting walls

- Cut to size and edges mitered to 45 degree.
- Slots for shelves rabbeted, then shelves glued and nailed to side wall.
- All walls sanded.
- Back wall left off for finally assembly.

Large (drafting) table housing (front)

- Front wall side pieces cut and back edges mitered to 45 degrees.
- Front edges sanded flush for drafting table fit.
- Glued and nailed to side walls.

Front mechanism panels and top cover

- Cut to fit, sanded and top cover glued and nailed.
- Mechanism panels clips screwed in and left for finally assembly.

Computer table housing (left side wall))

- Cut to size, mitered to 45 degrees, slotted for shelves (completed with operations of right side wall).

- Slot table for computer opening, cut and sanded.

Storage

- Pieces cut to size sanded, glued and nailed.
- Moveable storage containers cut to size, shelves rabbeted, glued and nailed.

Large (drafting) Table

- Uses simple cutting and joining processes.
- A combination of a pine framework (18.75 mm / ¾" 1 by 4 cut to size) with 6.25 mm (¼") maple plywood G1S (good one side) inserted into frame.
- Framework is mitered, 6.25 mm (¼") rabitted to house maple ply, then glued and nailed.
- Bottom frame is first slotted in center to house leg. Maple plywood is cut, sanded and back wall is glued and nailed to frame.
- Within frame work two 18.75 mm (¾") 1 by 4s are ripped to size, glued and nailed to back wall and frame sides to create leg walls.
- In center of back 6.25 mm (¼") plywood fir block is cut, routered for ball mounting, then glued and ball back cover plate screwed into place.
- In front 6.25 mm (¼") plywood leg and ball joint shape is cut and sanded, glued and nailed into place.

Computer Table

- Uses simple processes, cutting, mitering, rabbeting, sanding, drilling, boring, gluing, and nailing.
- Composed of two boxes, cut and mitered from 37.5 mm (1 ½") pine 2 by 4" ripped to size.

- Holes are drilled and computer table box's hole is bored to size for ball joint housing.
- Slot for printer drawer is routered into front frame of computer table box. Framework is then rabbeted 6.25 mm (¼") glued and nailed.
- Support frames for laptop and printer components cut, drilled, glued and nailed.
- Then 6.25 mm (¼") maple plywood G1S, is attached to both sides of support box and back side of computer box, glued and nailed.
- Top 6.25 mm (¼") plywood of computer table is cut and hinged to frame for laptop component, the rest of the top panel is then assembled, glued and nailed.
- Runner is attached to support box, and sliders are screw mounted to runner.

Wood Finishing

- All wood components are sanded and readied for finishing during the manufacturing process.
- The three main components of the workstation, the body, the large (drafting) table, and the computer table and support are separately clear coated and put together once final parts are fitting exactly.

Other Manufacturing

Wiring and Lighting

- Wiring and lighting components of the workstation use outsourced products and assembled to safety standards.
- A framework is built into the back of the storage compartment to protect the wiring.
- Lighting is assembled by screw mounting.
- Wiring in the computer table runs in a channel frame mounted in the back 37.5 mm (1 ½") of the computer table box.

Conclusions

Generally material and manufacturing processes focus on the issues of designing a product that is cost effective, user friendly, locally sourced and constructed, and considers quality, integrity, durability, safety, maintenance and repair. Material and manufacturing considerations are continually evaluated throughout the design stages as it is extremely important that the workstation be a product that is easily manufactured and cost effective, or it will end at the prototype stage. This product is an assemblage of parts made as separate units. This design lowers the manufacturing costs by using simple processes which increases the ease of assembly, is convenient to transport and cost effective. Assembly order and joining processes are critical to the product's success and integrity and must follow the direction of the designer. From this direction suggestions from other professionals, such as mechanical engineers and manufacturers, can only increase the product's success.

Section Seven: Raw Costs

A raw cost estimation for the workstation per unit is $ 501.00 (Canadian funds) A retail pricing for the workstation would fall between $2000.00- 2500.00. The following table lists a breakdown of raw material costs used in the workstation.

Table: Raw material and costs per unit used for workstation. *

MATERIAL	UNIT	PRICE
¾" (1.88 cm)Maple plywood	2	55.00/sht (18.53/ sqm.)
¼"(.63 cm) Maple Plywood	2	20.00/sht (6.74/ sqm.)
Pine 1 ½" (3.75cm) 1x 6	18" (45 cm)	1.29/ft (4.18/ meter)
Pine 1 ½" (3.75 cm) 1 x 6	5	.90/ft (2.92/ meter)
Fir 2 x 12	1	4.00
¾" (1.87 cm) Steel Rod	13" (32.5 cm)	.90/ft (2.92/ meter)
Sheet 20 G	6 sq.ft.(77.4 cm)	1.44/sq.ft (1.55/ sqm.)
Sheet 22 G	1 sq.ft (12.9 cm)	1.20/sq.ft (12.92sqm.)
Sheet 16 G	4 sq.ft. (51.6 cm)	2.44/sq.ft (26.26/ sqm.)
Steel Ball	1	8.00/per
¼" (.63 cm) Steel Plate	12	25/sq.ft
1/8" x 1" (.31 x 2.5 cm)Flat Bar	30" (75 cm)	.54/ft (1.75/ meter)
1¼"x1/8"(3.1 x .31 cm) Sq. Tube	3' (90 cm)	1.80/ft (5.83/ meter)
½"(1.25 cm) Hollow Tube	12 ½" (31.25cm)	.13/inch (.005/ cm)
Nylon Ball	1	4.00
Latches	2	2.82/per
Lock	2	4.99/per
Hinge (cut)	1	4.97
Lid Support	2	5.57
Compact Light	2	22.00/per
Switch	1	5.39
Wires	20 ft.	.20/ft (.65/ meter)
Electric Box	1	.86
Receptacle	1	.49
Plate	1	.16

* Units are given in imperial measurements as they are purchased in this system.

Table cont.: Raw material and costs per unit used for workstation. *

MATERIAL	UNIT	PRICE
3/8" (.94 cm) Threaded Rod	5 ½"(13.75cm)	.12/inch (.005/ cm)
1/8" (.31cm) Steel Rod	13" (32.5 cm)	.15/ft (.49/ meter)
1"x 1/16"(2.5 x 15.5 cm) Sq. Tube	3" (7.5 cm)	1.00/ft (3.24 / meter)
Clutch Pack	1	60.00
Fridge Roller	2	10.00
Roller and Clips	1	10.00
Material Roller	1	5.00/yard (5.42/ meter)
Clips Front Panels	12	.80/per
Homing Pin /Slots	1	2.83
Chain	18" (45 cm)	.55/inch (.22 / cm)
¾" (1.86cm)Acrylic Rod	4" (1.88 cm)	.33/inch (.12 cm)
½" (1.25 cm)Acrylic Rod	1" (2.5 cm)	.30/inch (.13 / cm)
3/16" (.16 cm)Acrylic Sheet	Several	.03/inch (.012/ cm)
Plastic	1	5.00
Nuts	Several	1.16/pack
Bolts	Several	.33/per
Washers	Several	.06/per
Screws	Several	4.00/box
Nails	Several	1.80/box
Glue	1	3.87
Sandpaper	Several	1.15/per
Steel Wool	Several	.35/ pad
Clear Coat	1	20.00
Magnet Catch	2	.99/per
Chrome Plating	1	10.00

* Units are given in imperial measurements as they are purchased in this system.

Section Eight: Project Summary and Recommendations

This project's intention is to explore relationships between the consumer, furniture and society via the home office and limited living space. The problem exists that as home offices are being used more and more everyday, the mixture of furniture and 'kitchen chair' arrangements previously acceptable are no longer meeting user's need. Furniture designed to overcome problems occurring in the home office environment, such as providing a distinction between the home and office, are crucial to the home office worker's productivity and success. This philosophy in design also works for the small living space, as this area needs activity and environment distinction. Furniture must be multidimensional and designed for work place residence issues.

History illustrates that furniture adapts to the needs of the user. As a designer, a comprehensive understanding of these needs can be established through the examination of the social, psychological, technology, economic and cultural influences that effect society. From this examination, problems and issues are clearly illustrated as in the case of the home office and design objectives can be established.

The design objectives of this project; to create, a perceived distinction between environments, a sense of professionalism while preserving privacy and the ability to leave work in progress increasing user productivity, are well established and evolved in the design solution. The primary objectives: to demonstrate a design response to the lifestyle needs of the workplace residence, maximize the mental well being of the workplace resident and provide an opportunity to use optimal space of the workplace residence, are also substantiated in the workstation solution.

The workstation is a multidimensional desk that has a large (drafting) table, computer table and storage area combined into a unit that transforms the space in which it is placed from a home to a working environment. The workstation provides the user with the ability; to separate his activities, giving more than one sense to any

room, be productive by leaving work in progress and provide a design response to a growing lifestyle.

The user population for the workstation is both male and female, with or without children, either owns his/her own home or is a renter, has a home business full or part time and may or may not be limited by space. Suggestions for considering space differently are meant to help the user create a positive perception of the workplace or small living space residence. Ergonomic considerations for the workstation's design are followed throughout the design process and suggestions for a ready-made chair are stated. Manufacturing and material concerns focus on making a marketable, easily produced, yet quality and safe product.

The present workstation has taken both design and primary objectives into the initial prototype stages. Potential for further development of a series or family of products exists. Recommendations for the continuation of this product into the next prototype stage and final manufacturing are the following:

- Interviews and testing of product with focus groups. These procedures will determine reaction to the design in respect to function, aesthetics, ease of use and acceptance.

- Manufacturing and engineering analysis conducted to improve manufacturing processes and clarify design details or revisions.

- Ergonomic testing and analysis by expert evaluation, performance testing and user/ field-testing.

The above mentioned recommendations will provide insight and understanding into both the design's success and where there is need for further development. These recommendations will move the project closer to a marketable product.

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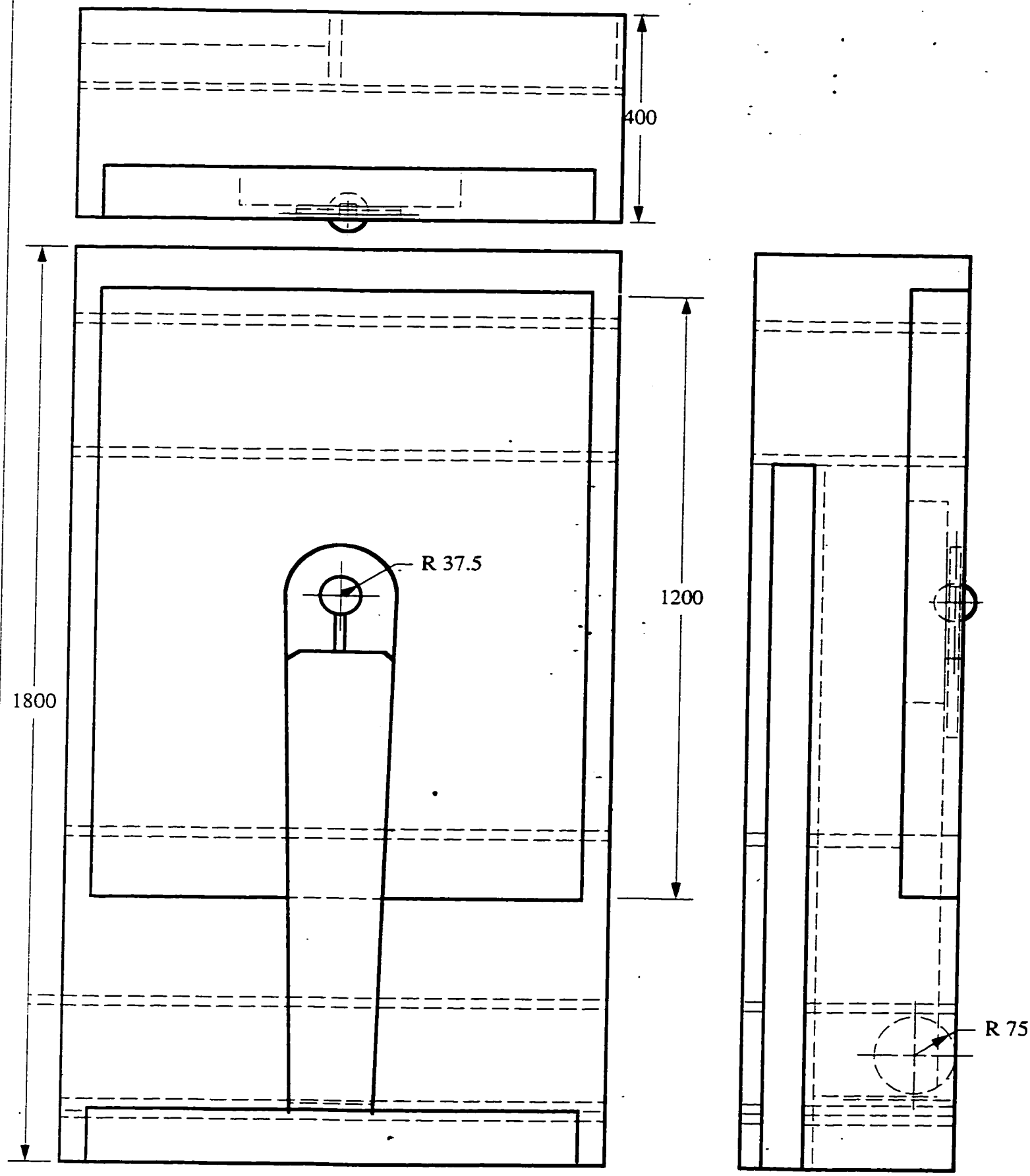
Technical Drawings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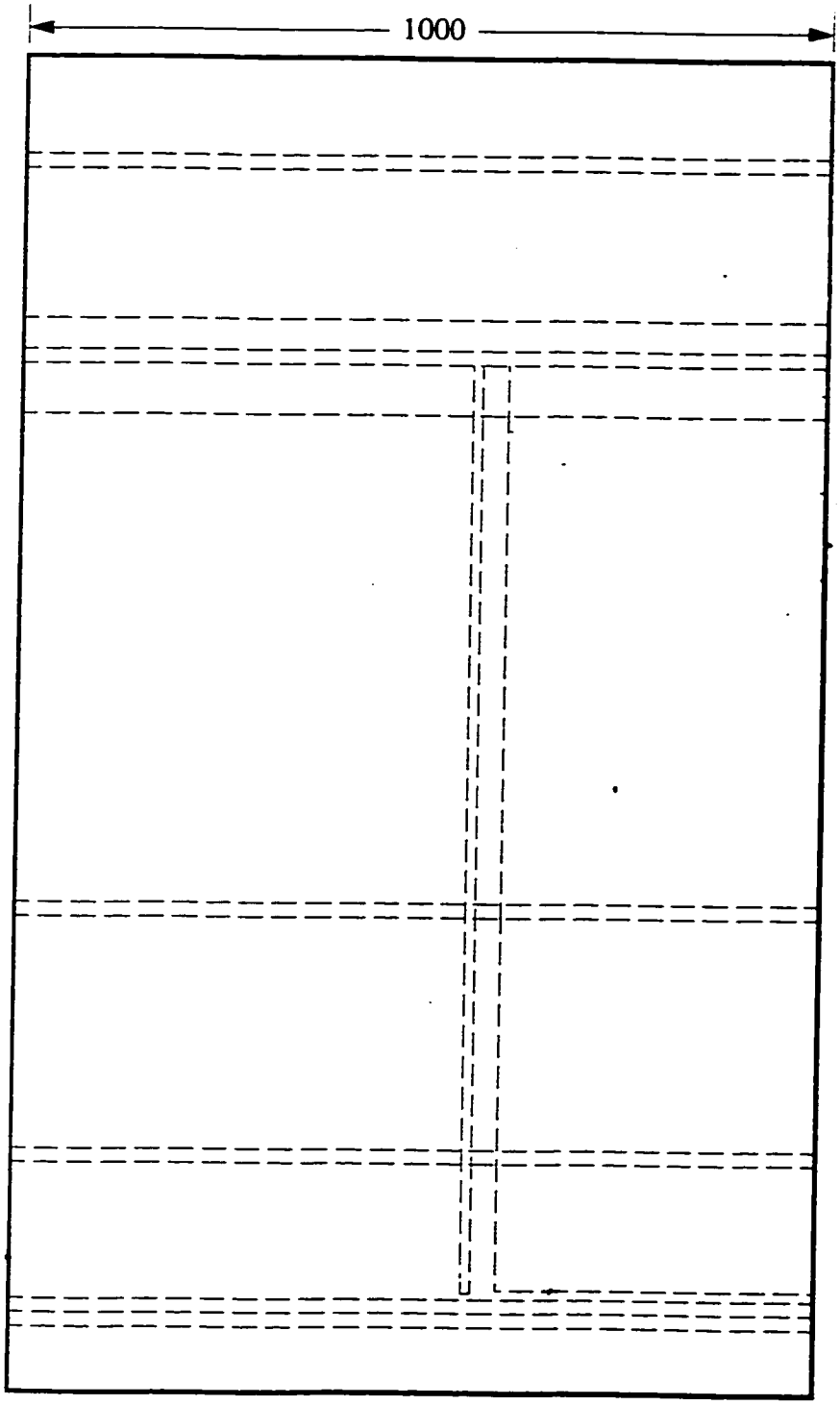

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PROJECT: WORKSTATION FOR HOME OFFICE AND SMALL LIVING SPACE		
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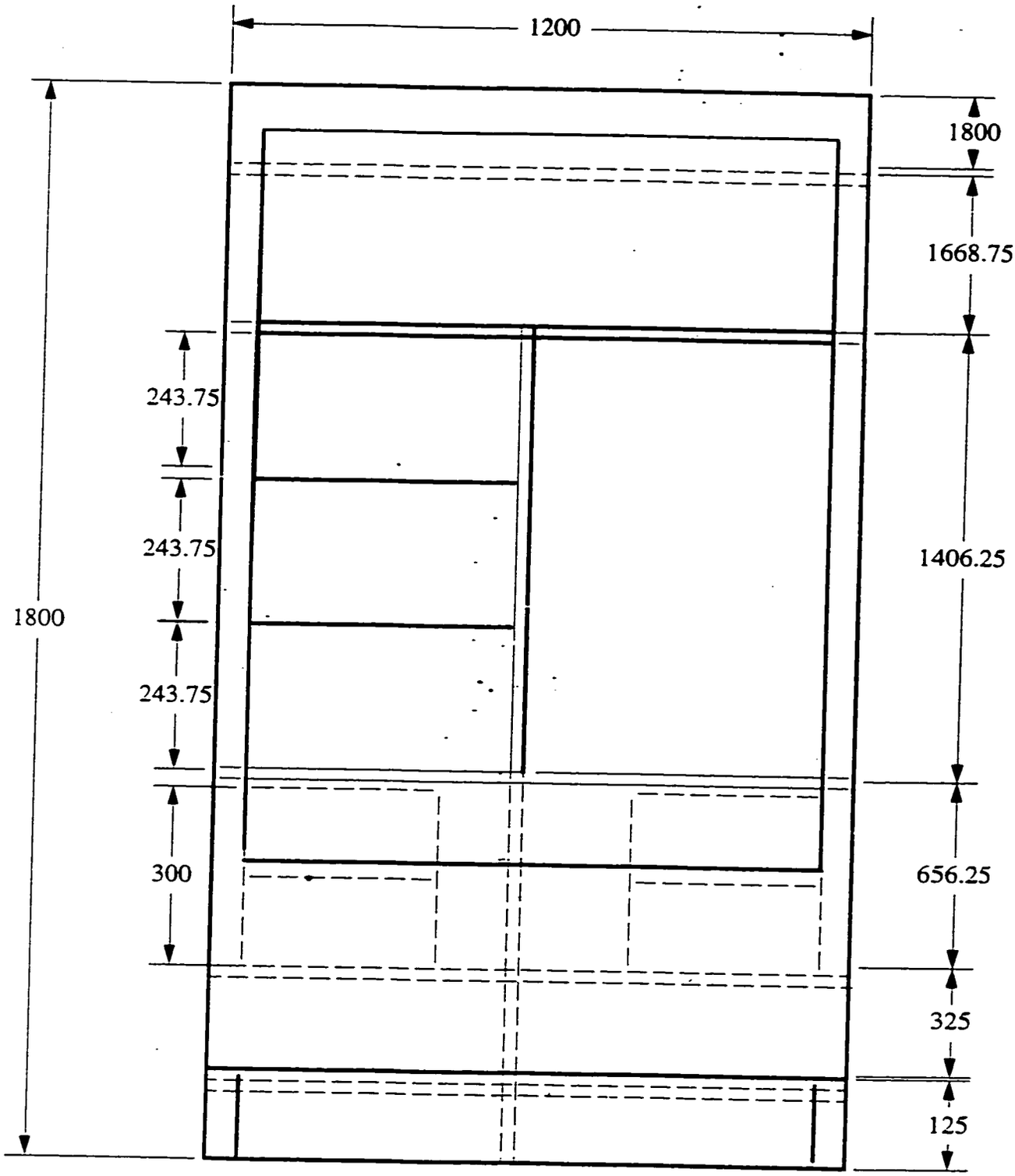
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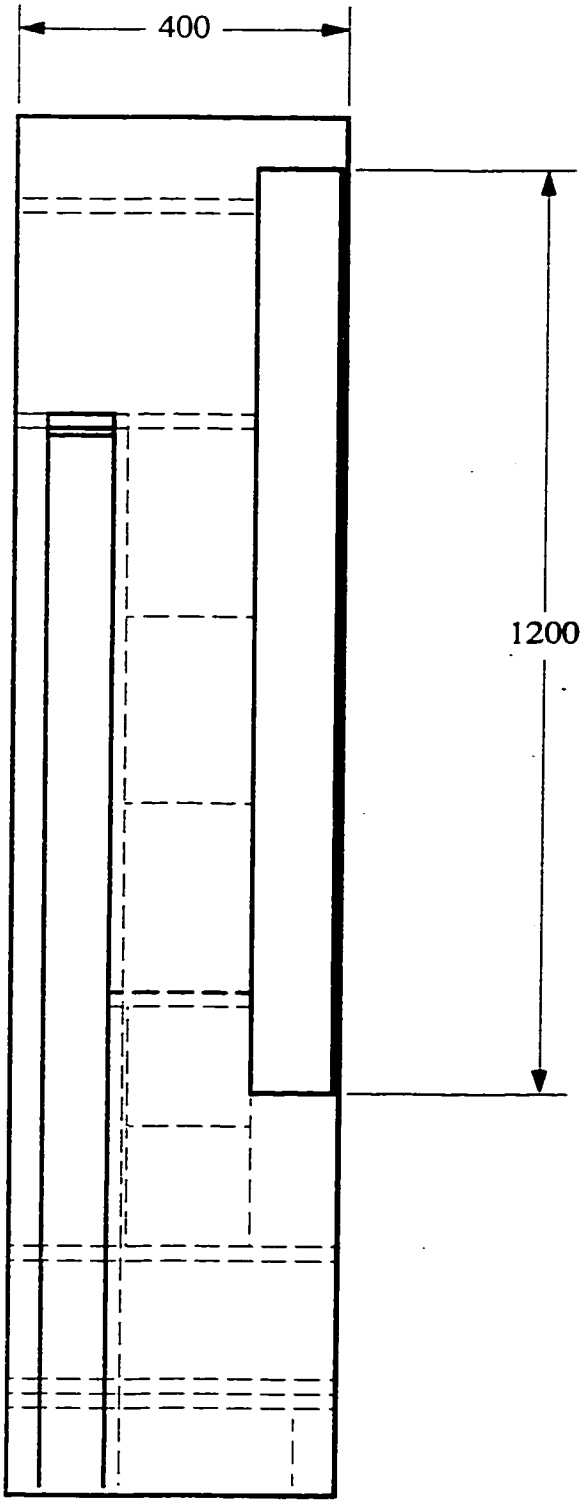

PROJECT: WORKSTATION FOR HOME OFFICE AND SMALL LIVING SPACE

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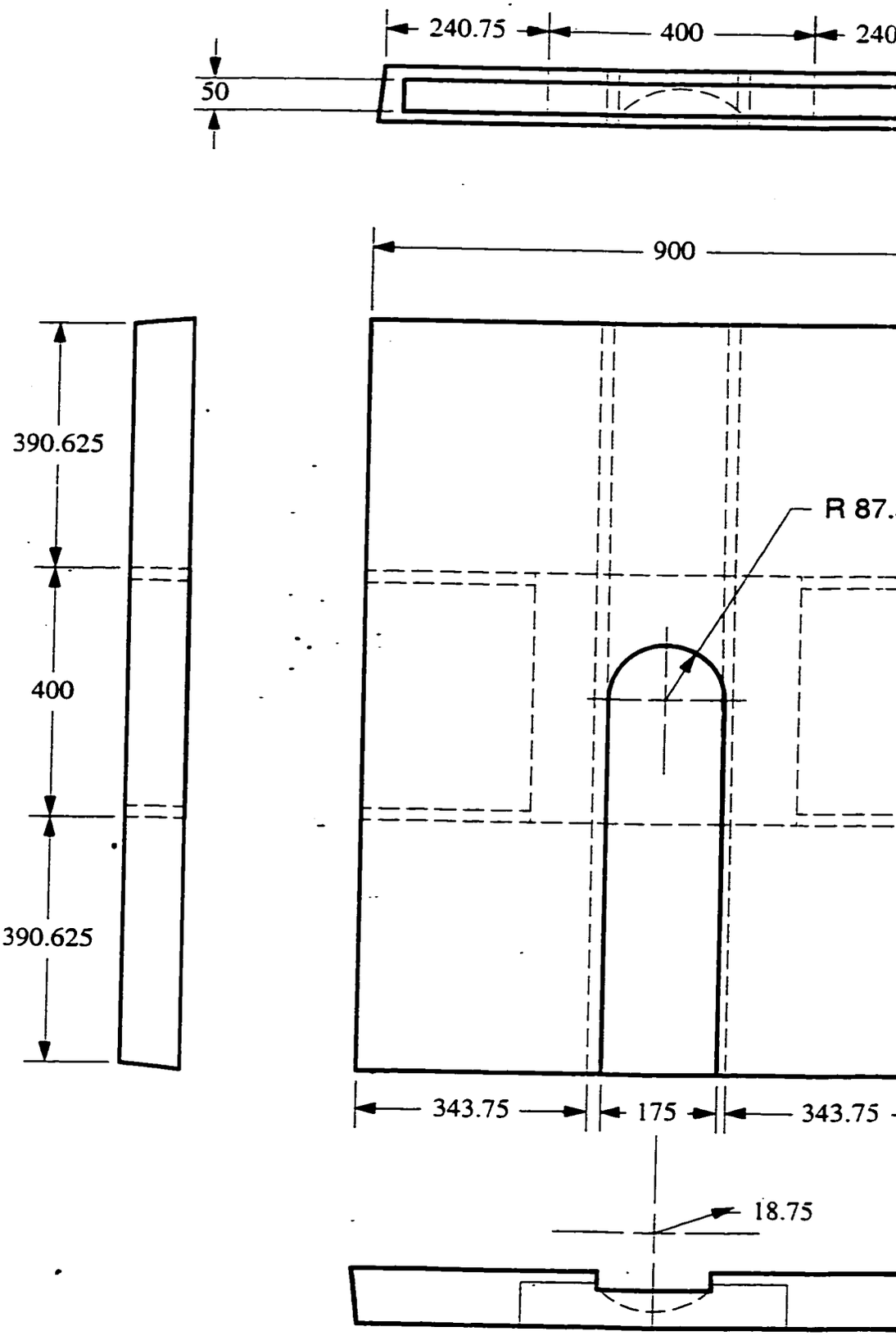
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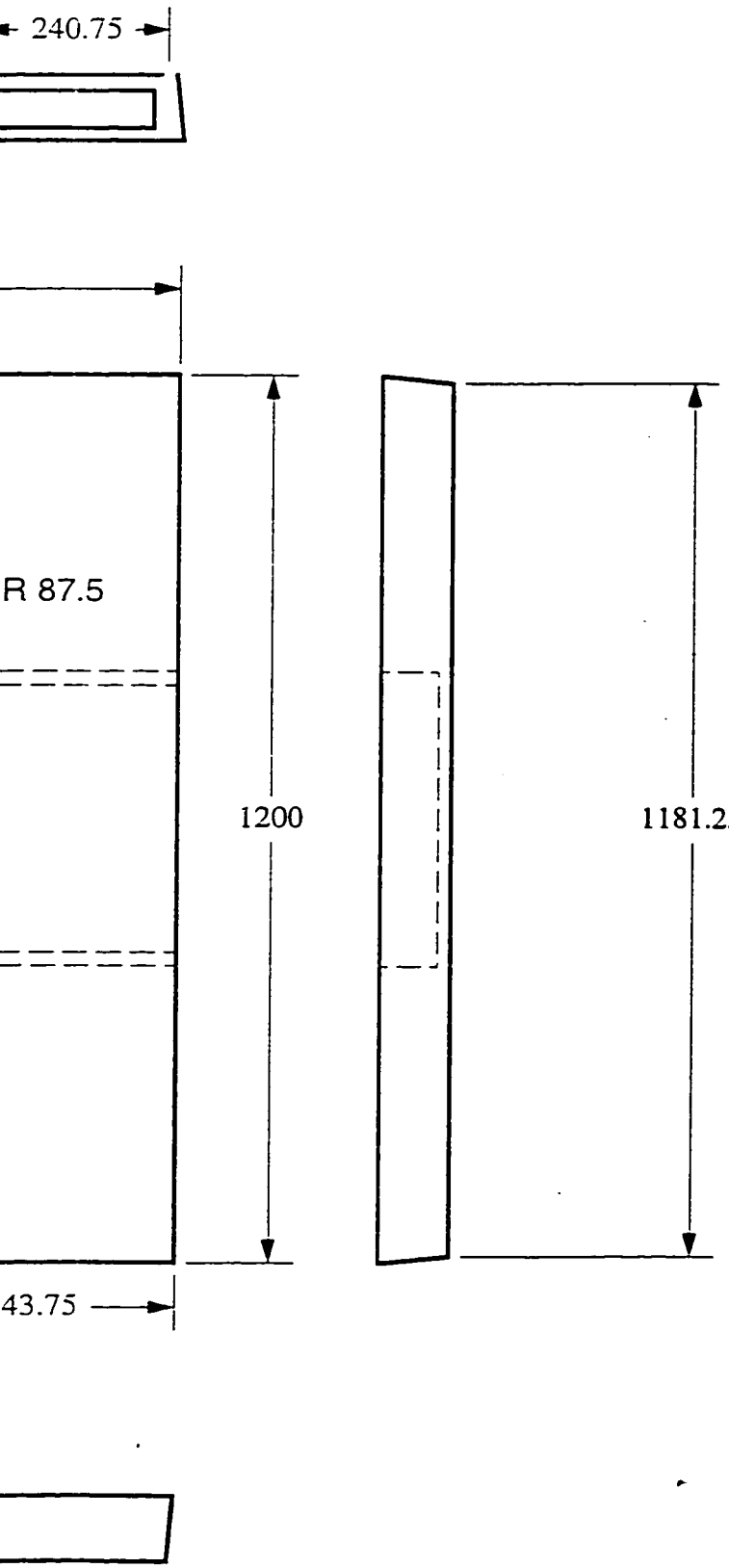

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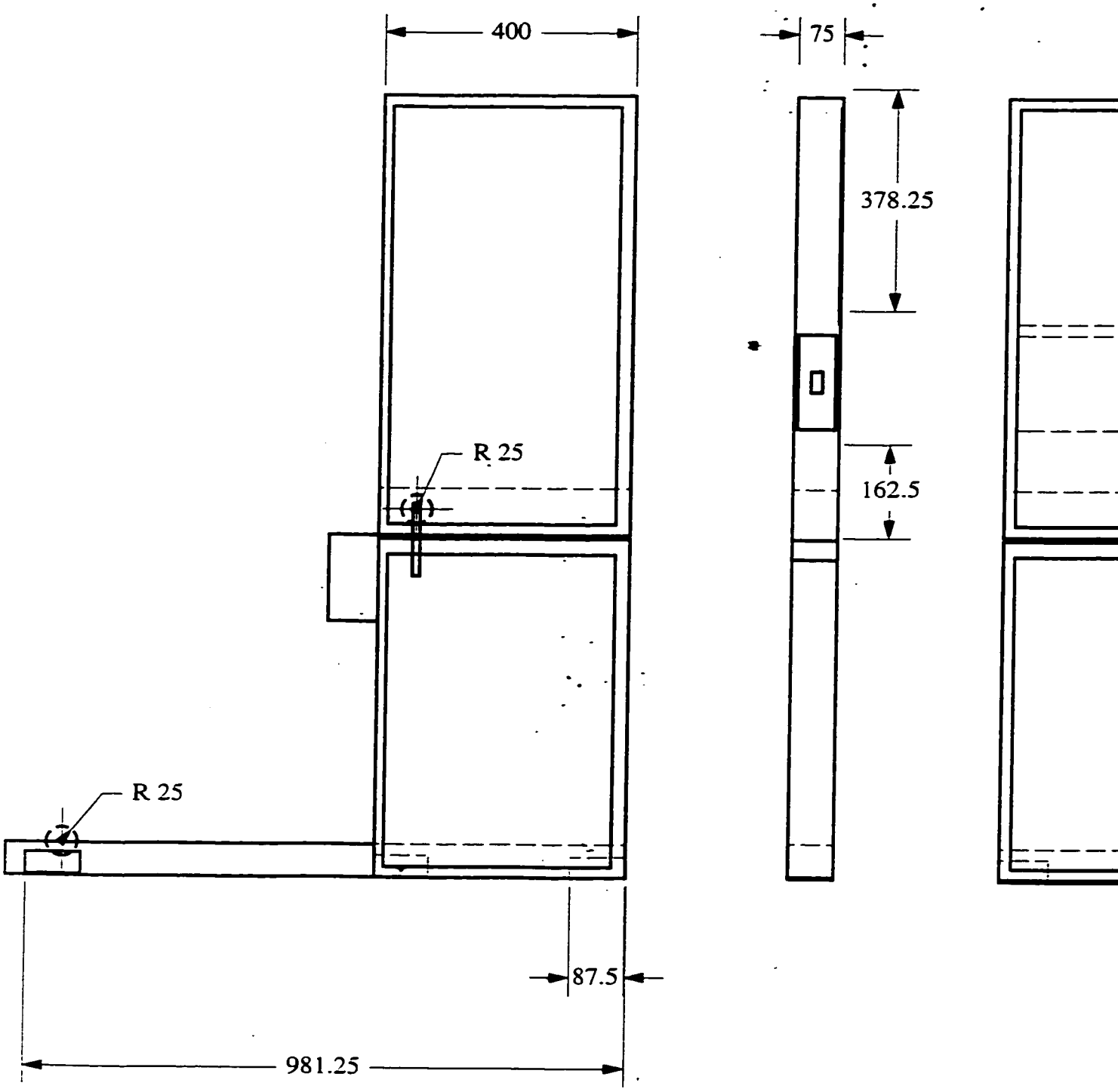
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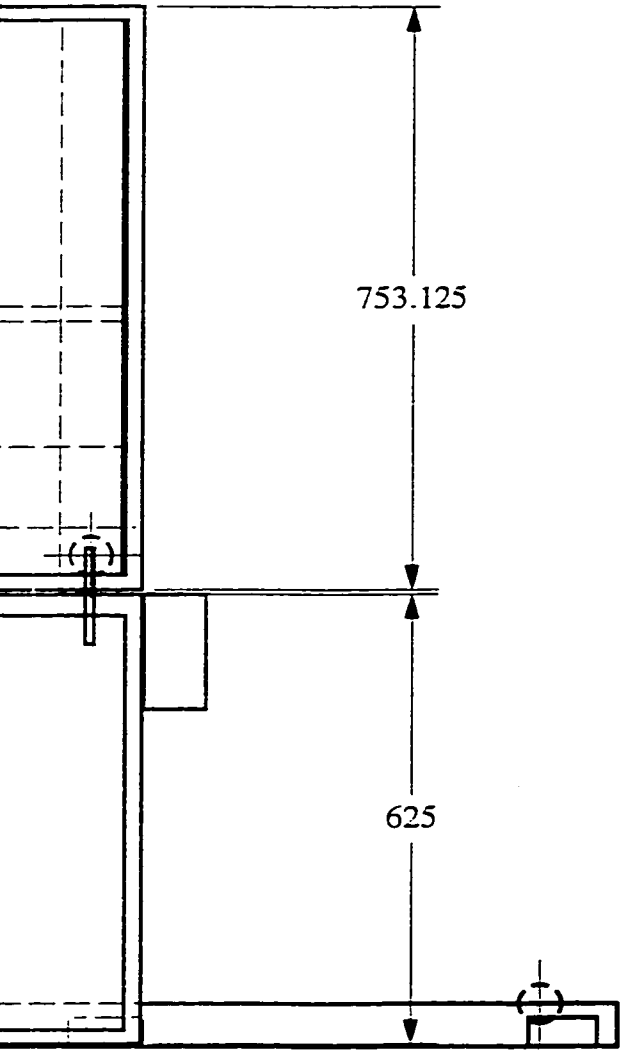

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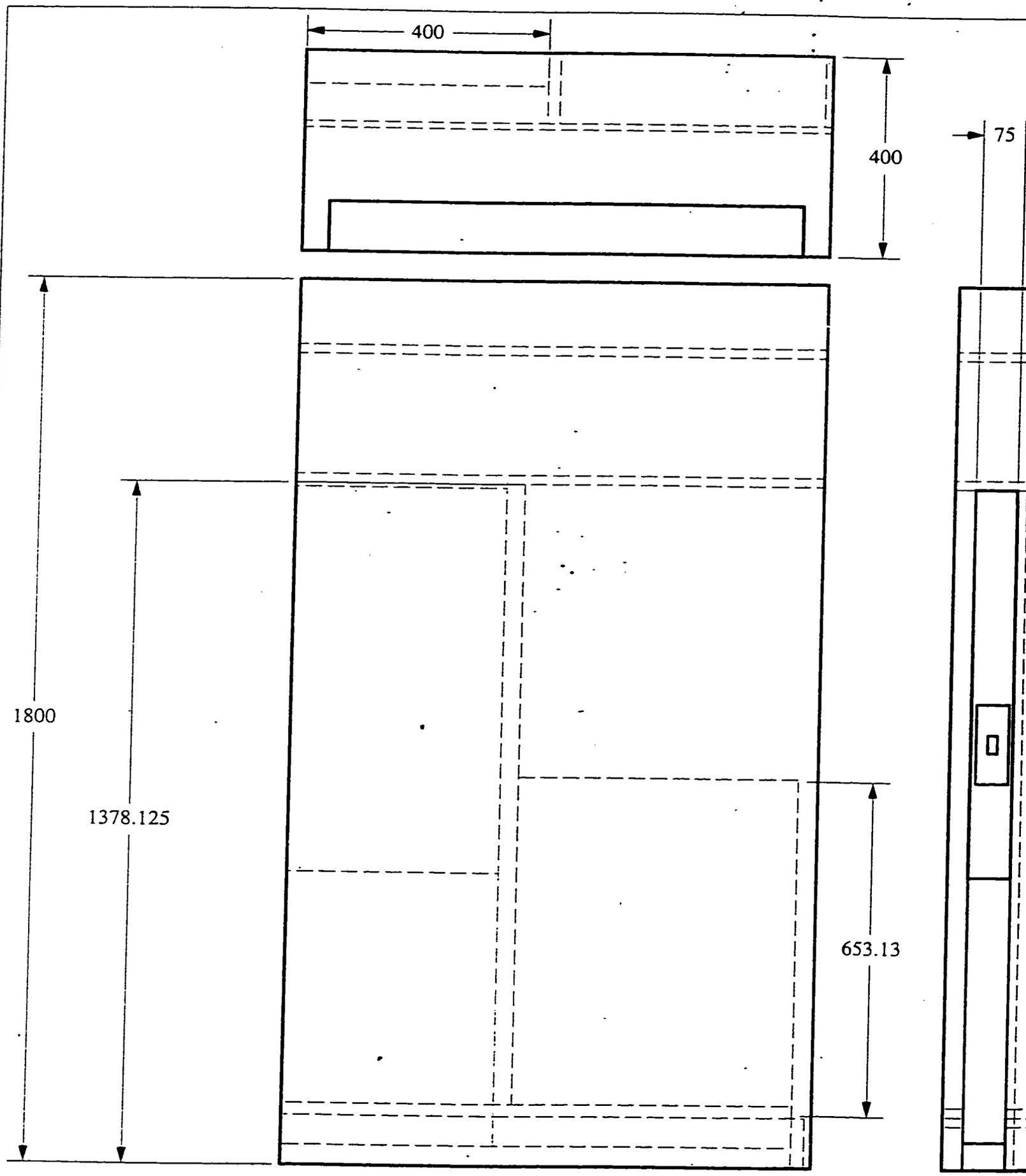
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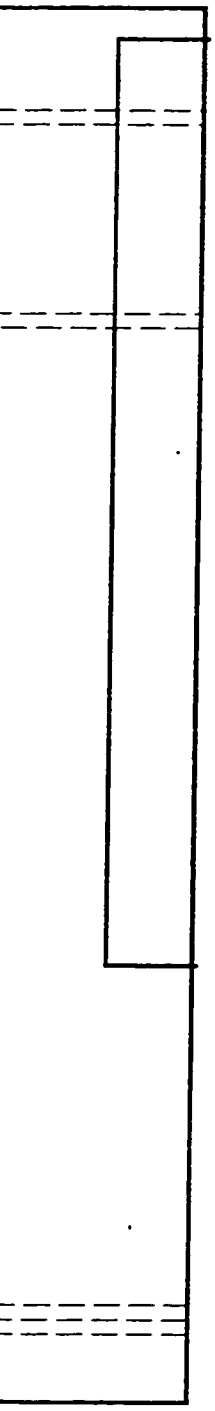

PROJECT: WORKSTATION FOR HOME OFFICE AND SMALL LIVING SPACE

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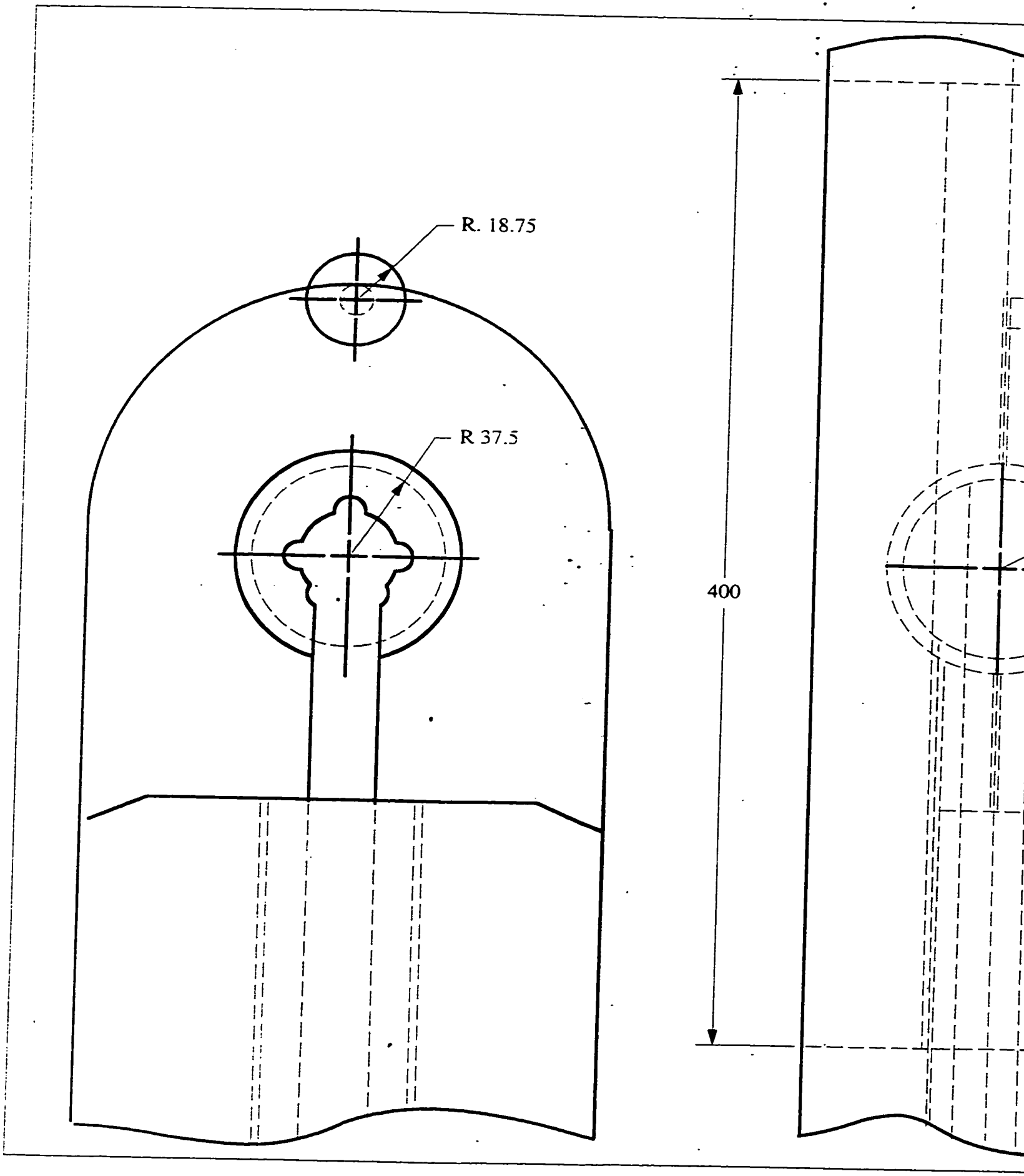
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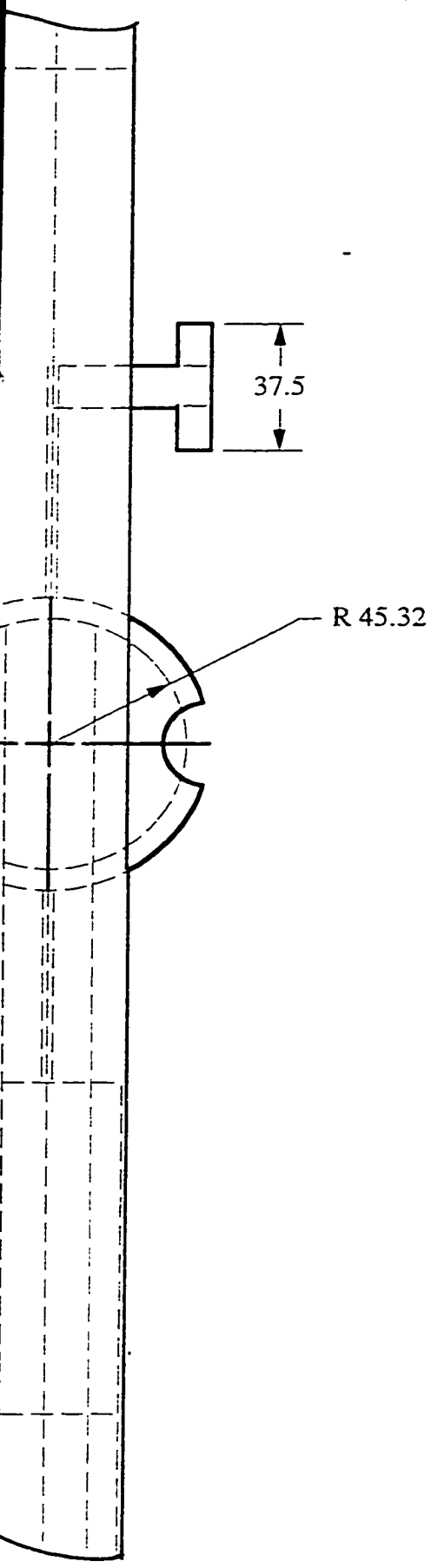

PROJECT: WORKSTATION FOR HOME OFFICE AND SMALL LIVING SPACE

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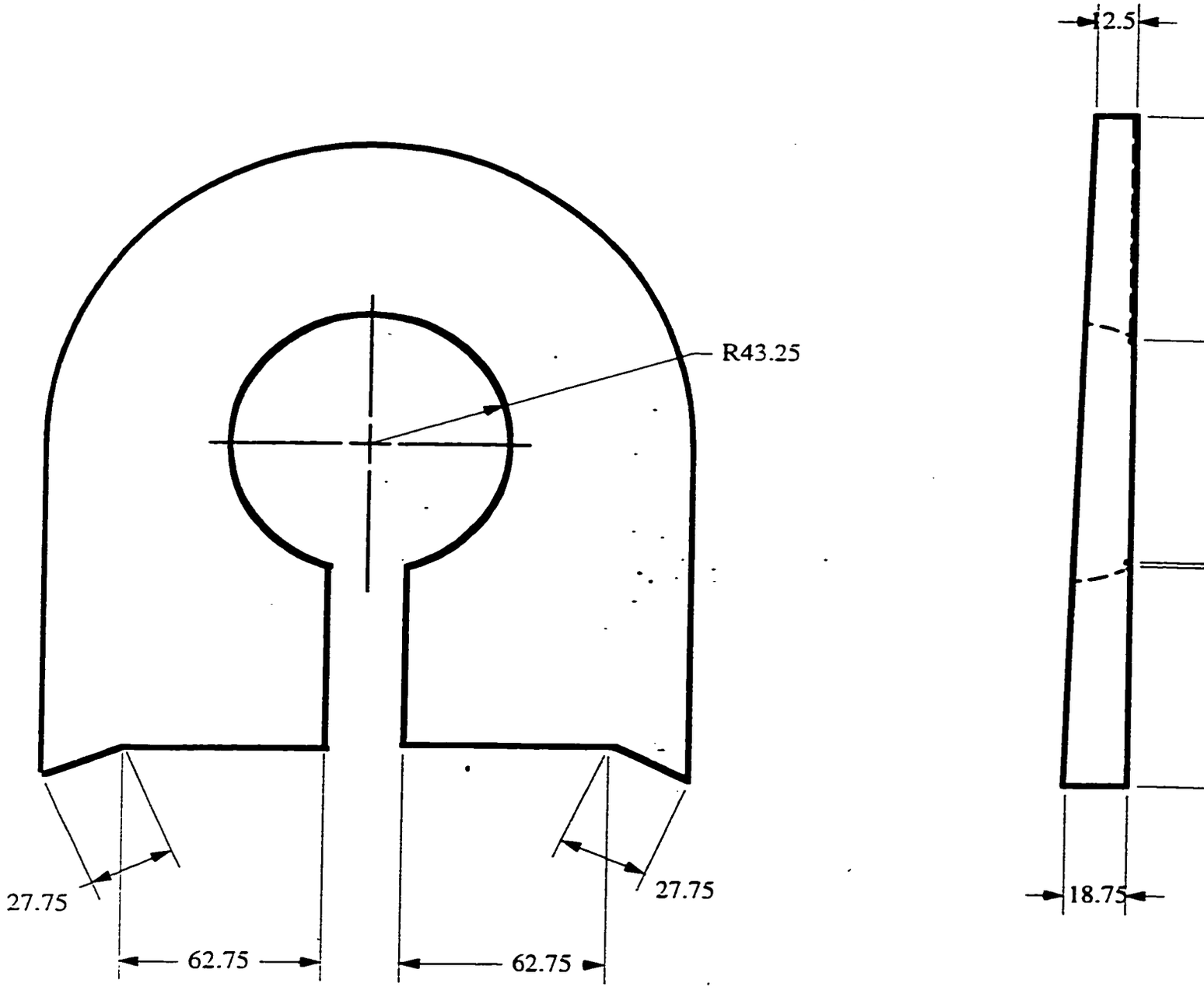
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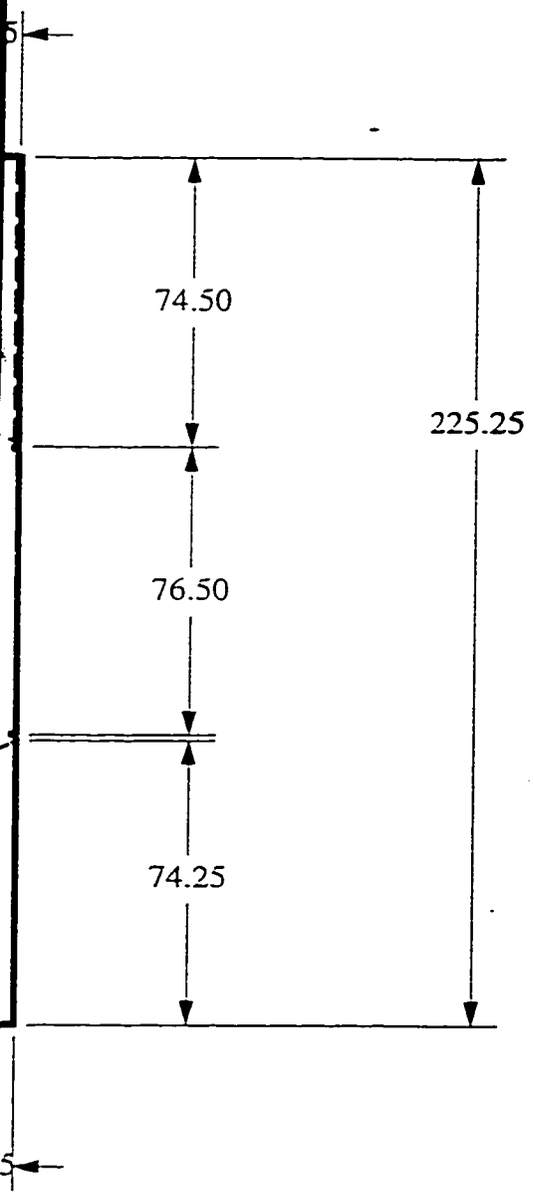

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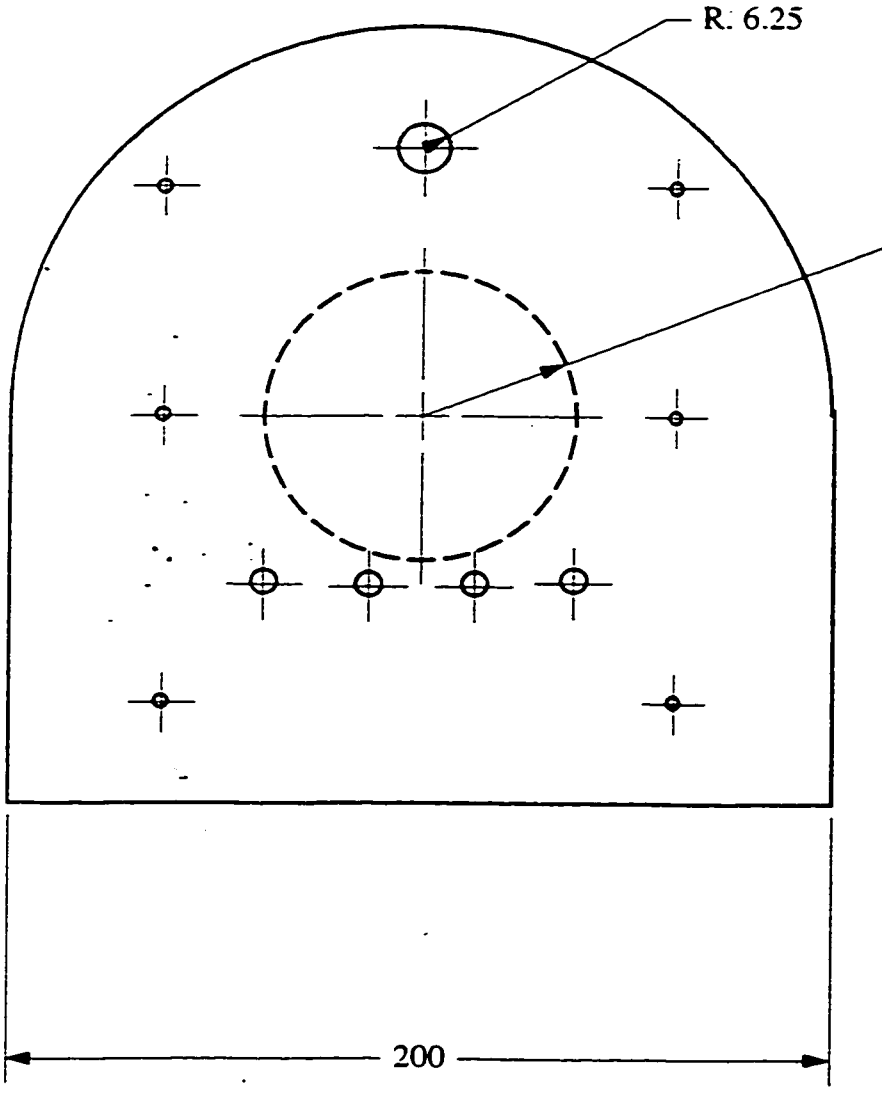
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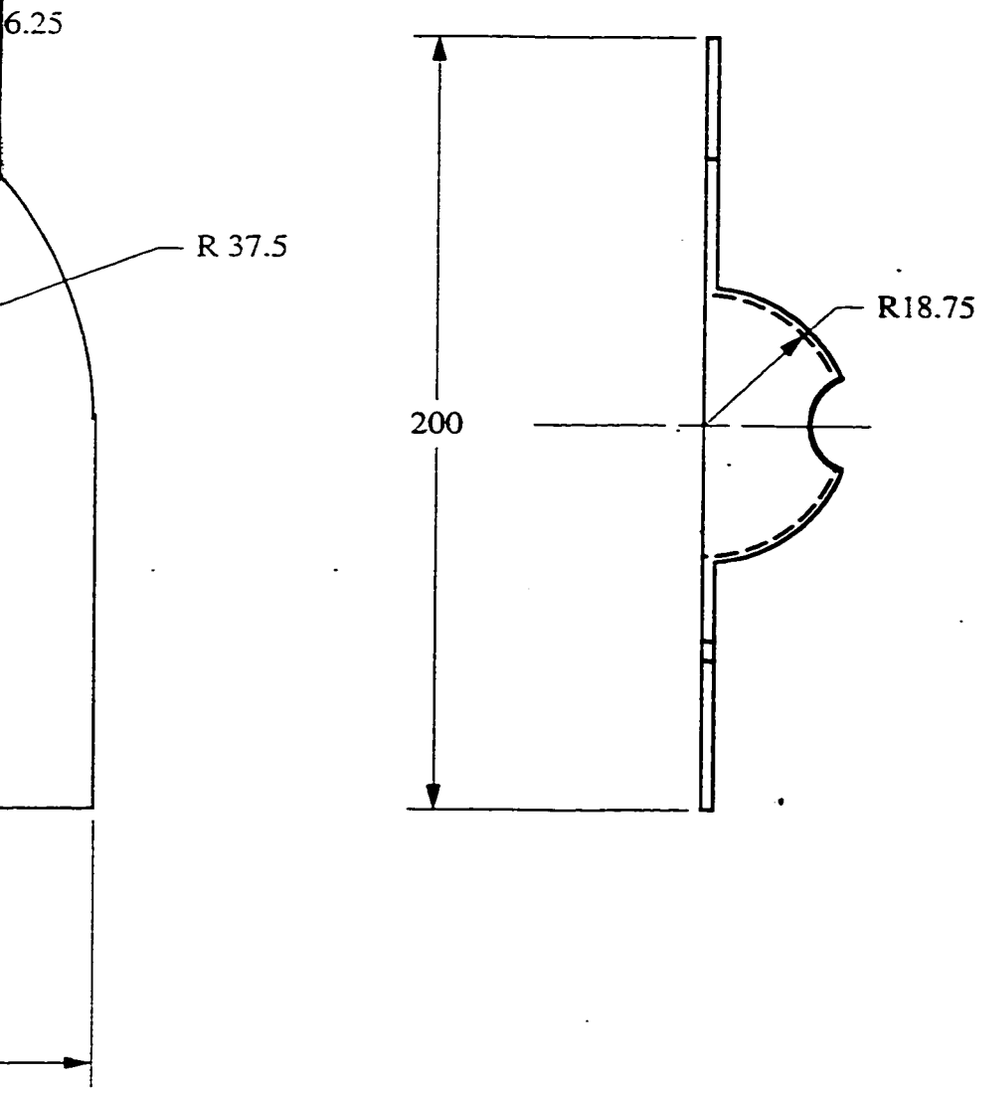

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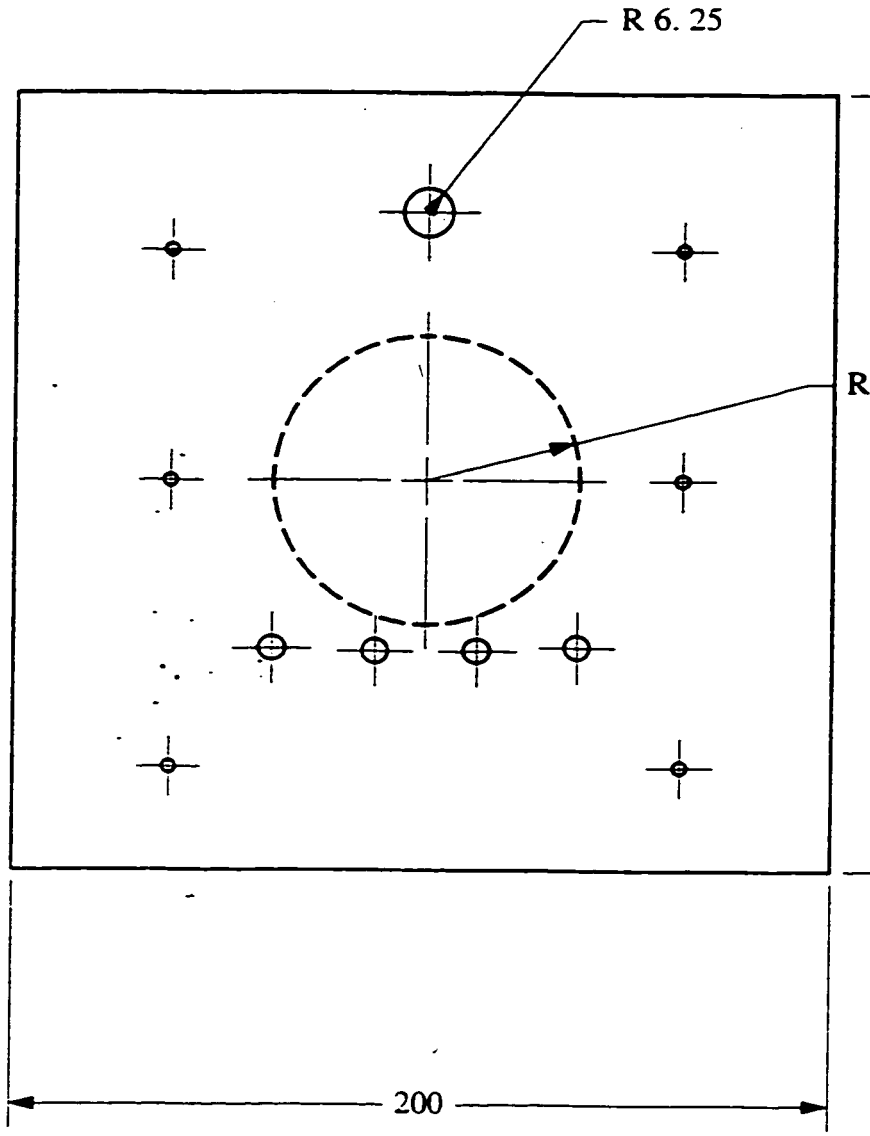
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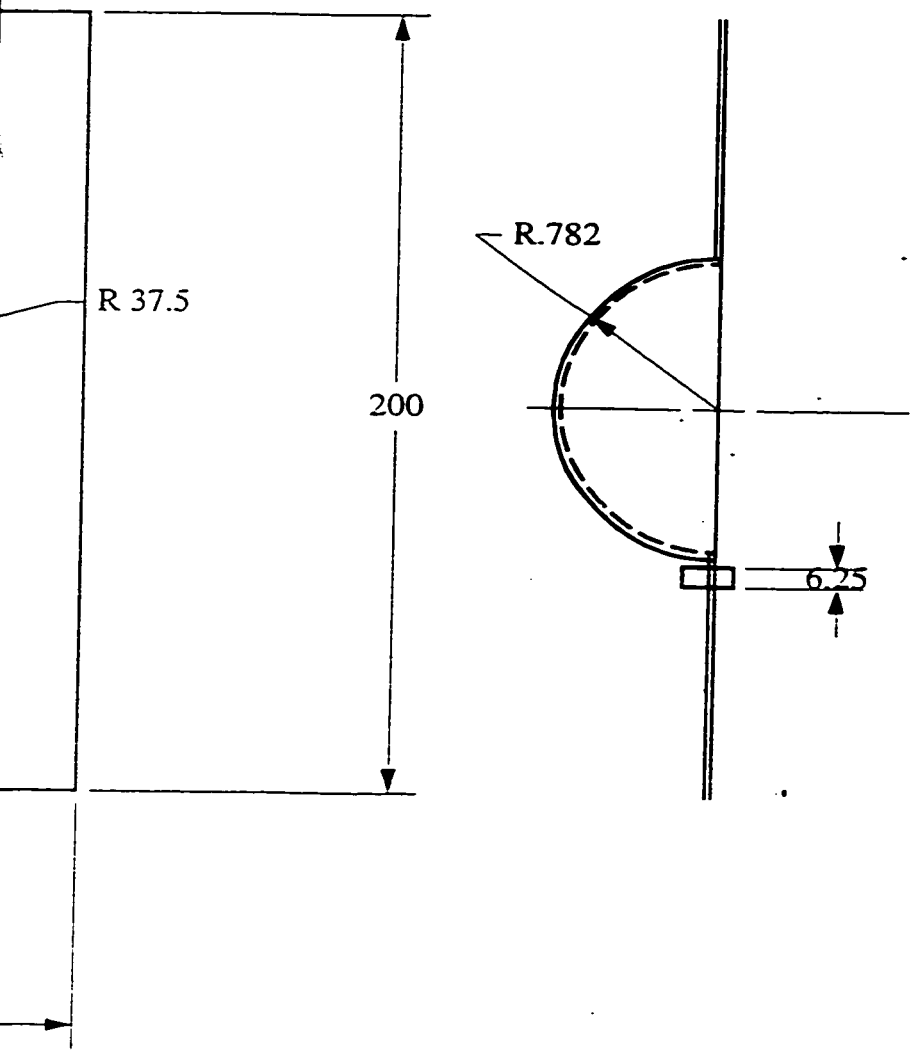

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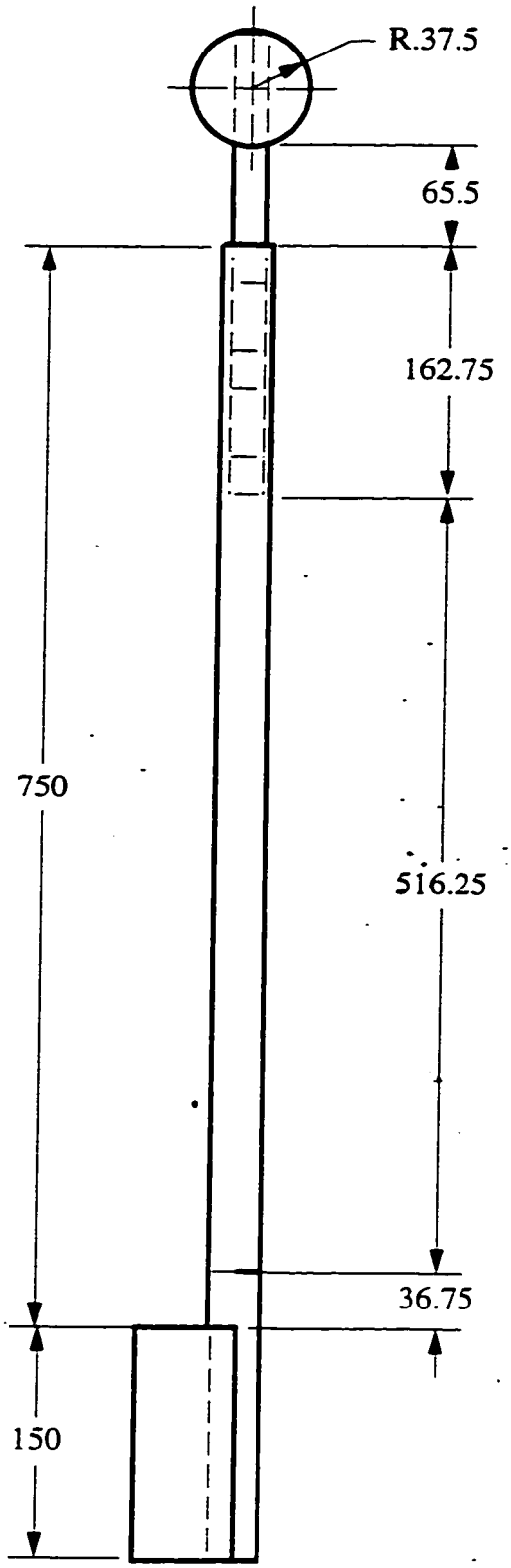
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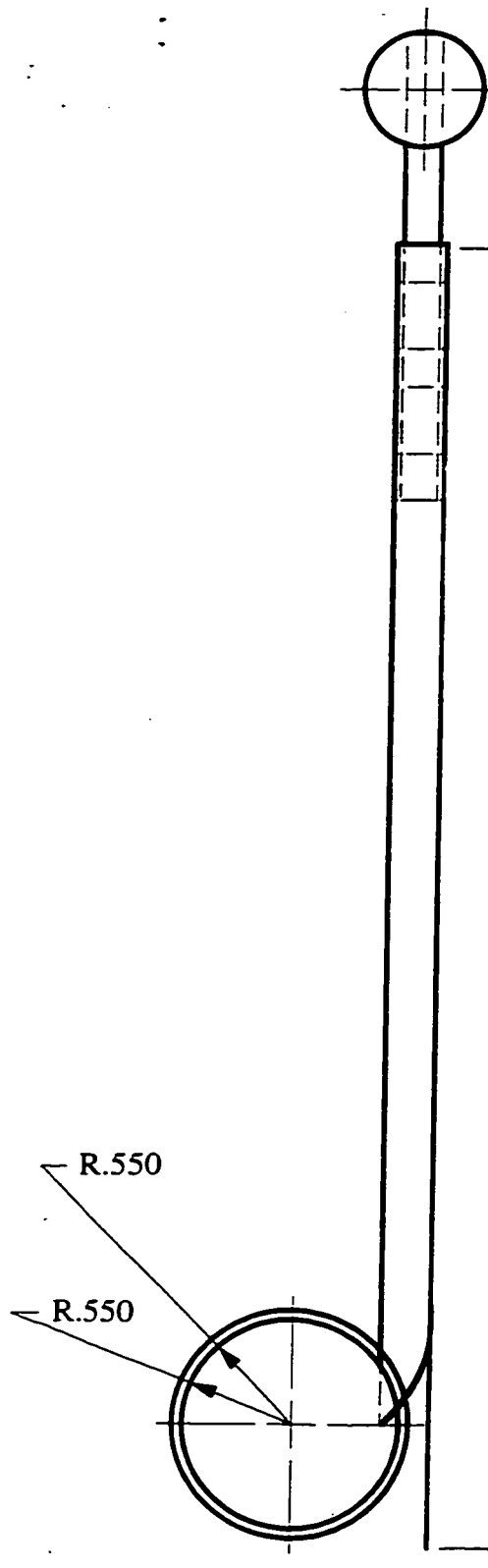
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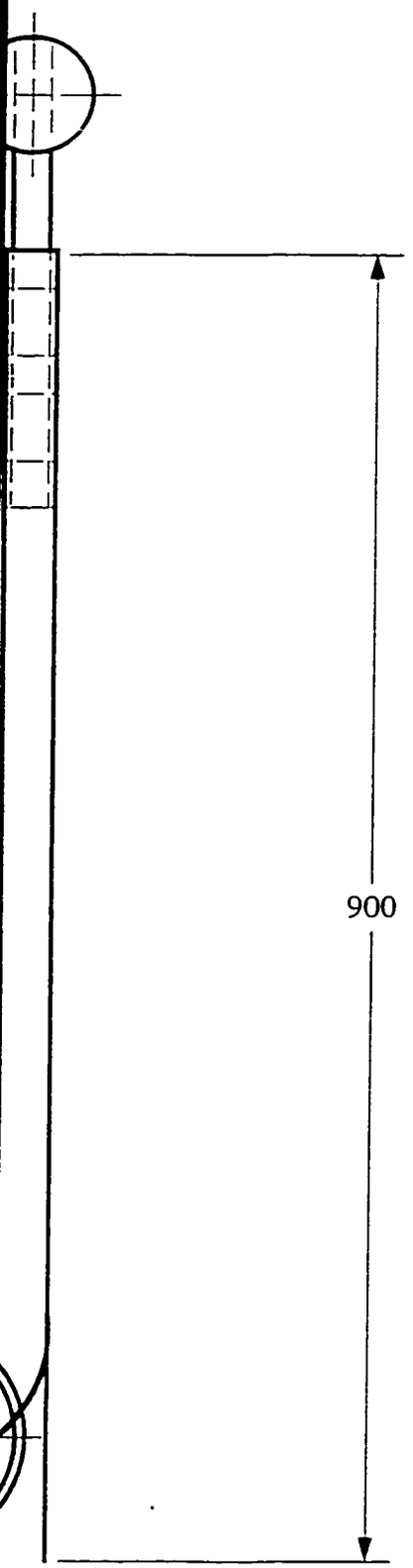

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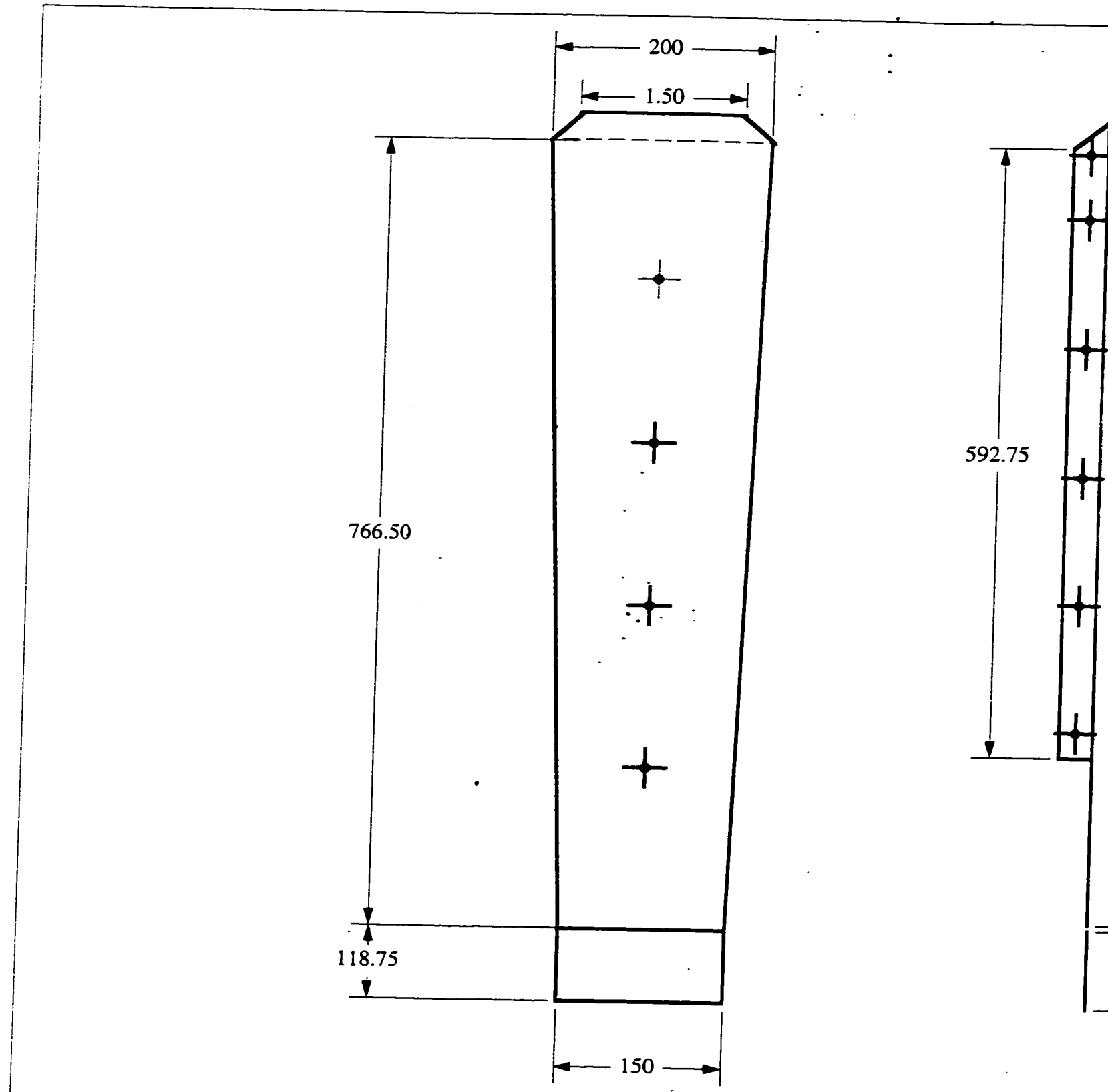
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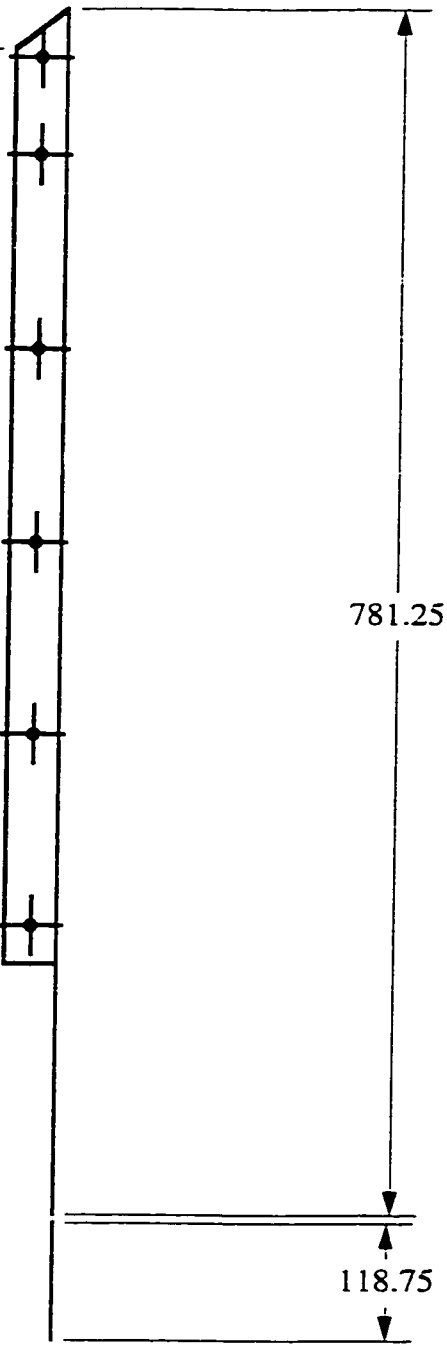

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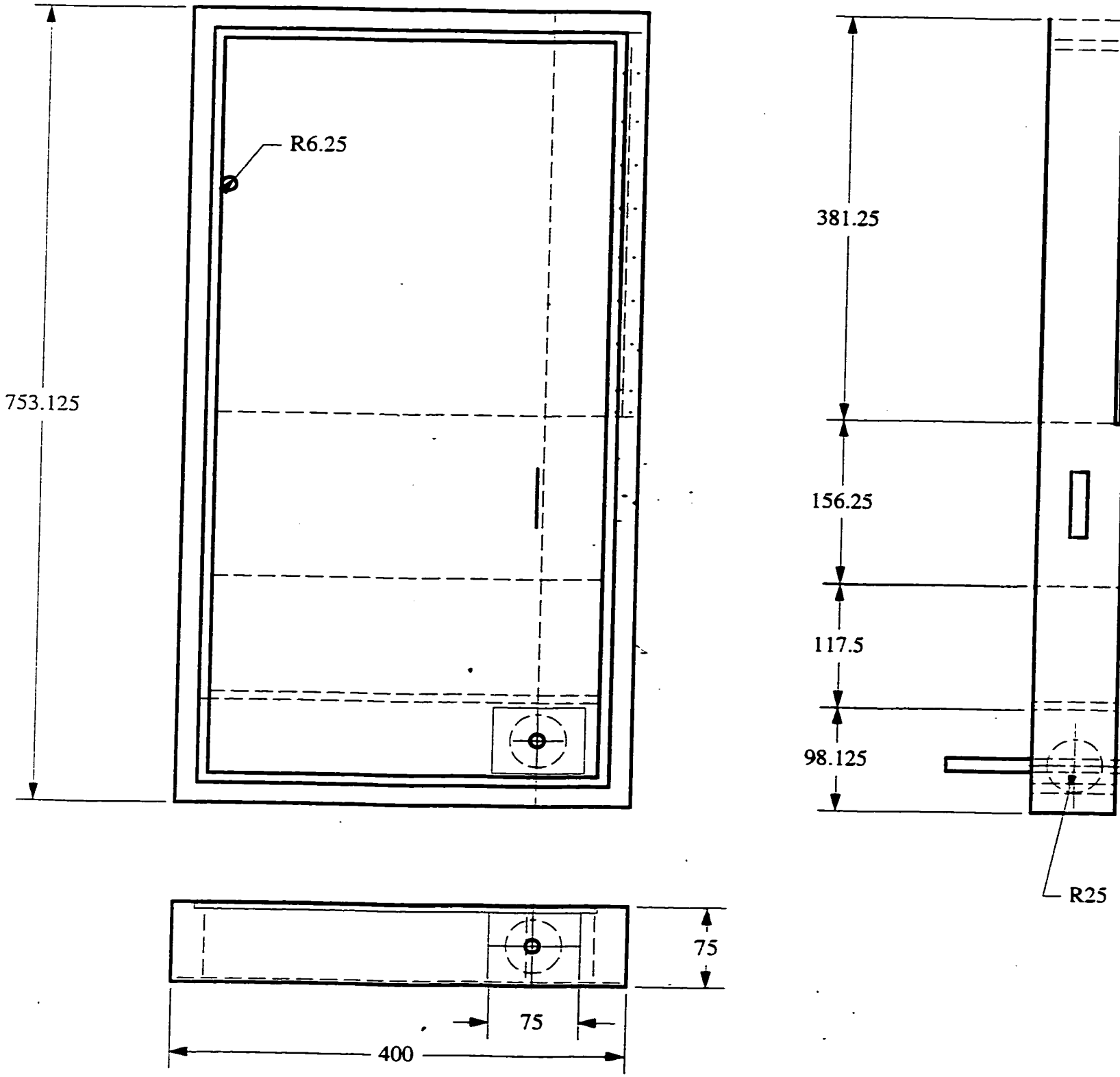
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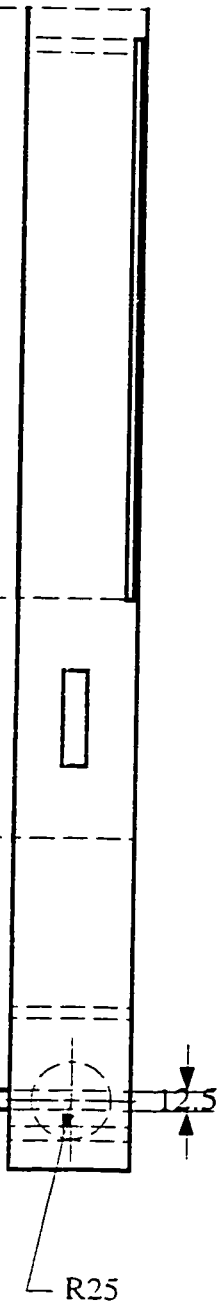
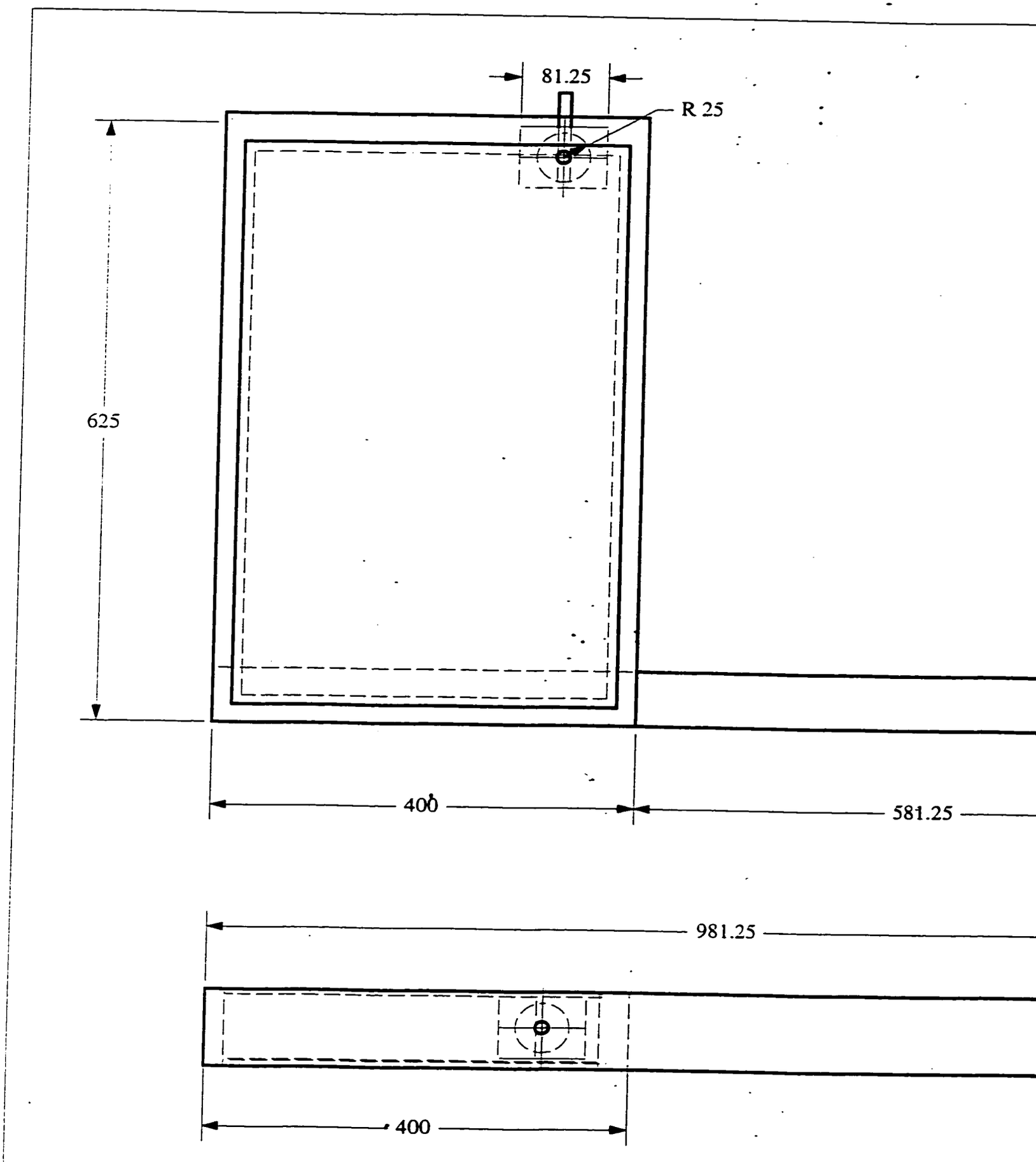
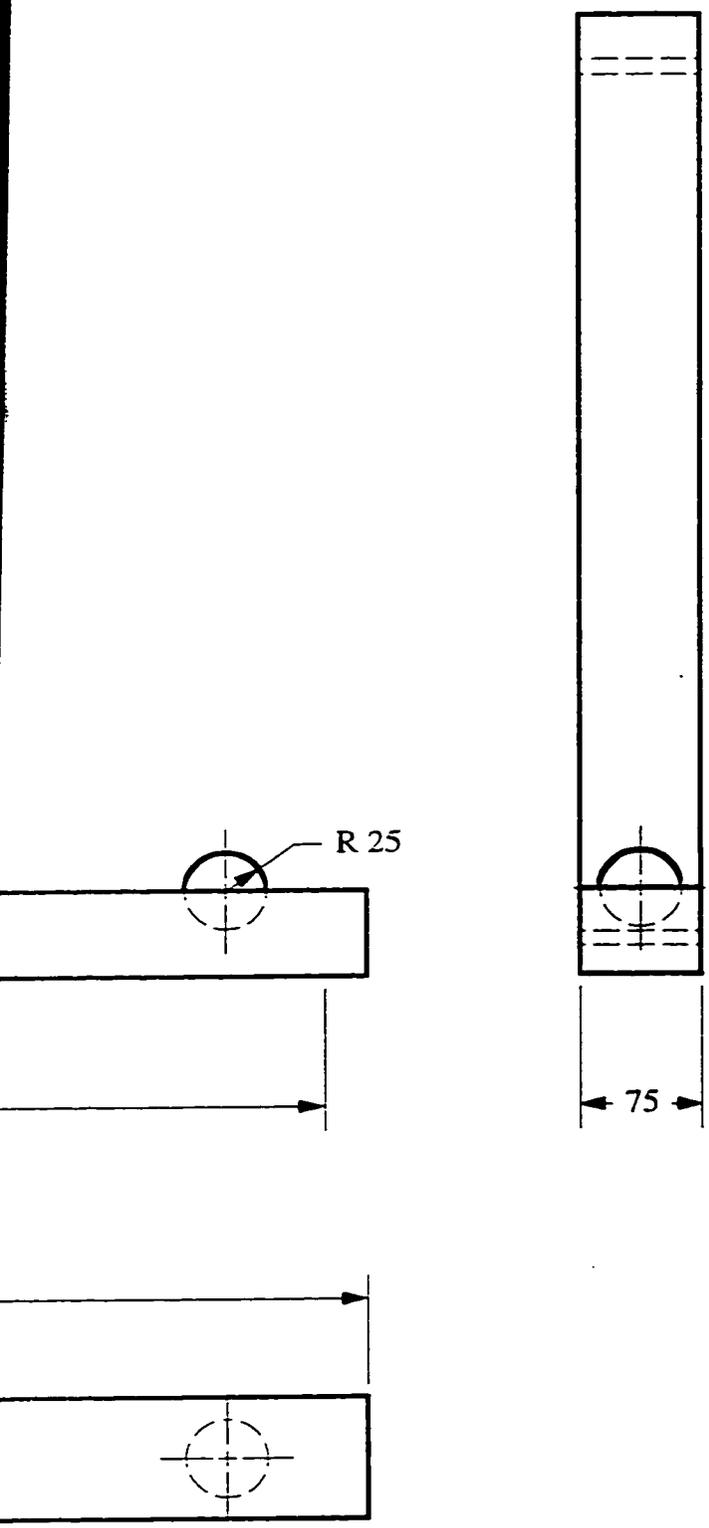
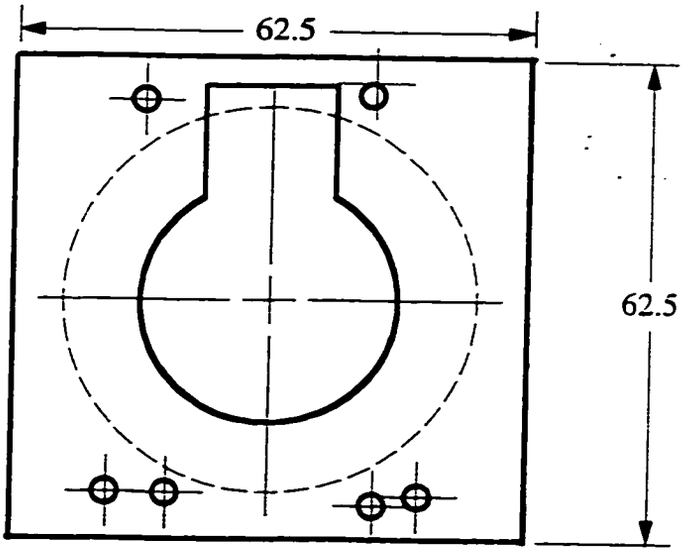


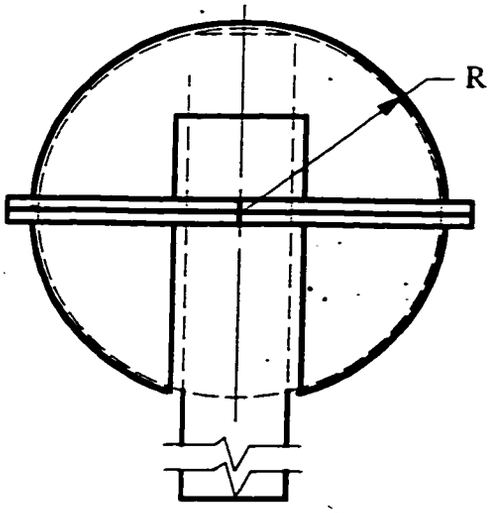
PROJECT: WORKSTATION FOR HOME OFFICE AND SMALL LIVING SPACE		
DRAWING: COMPUTER TABLE PLAN VIEW		
SCALE: 1:5	**DIM: MM**	**NO: 12**

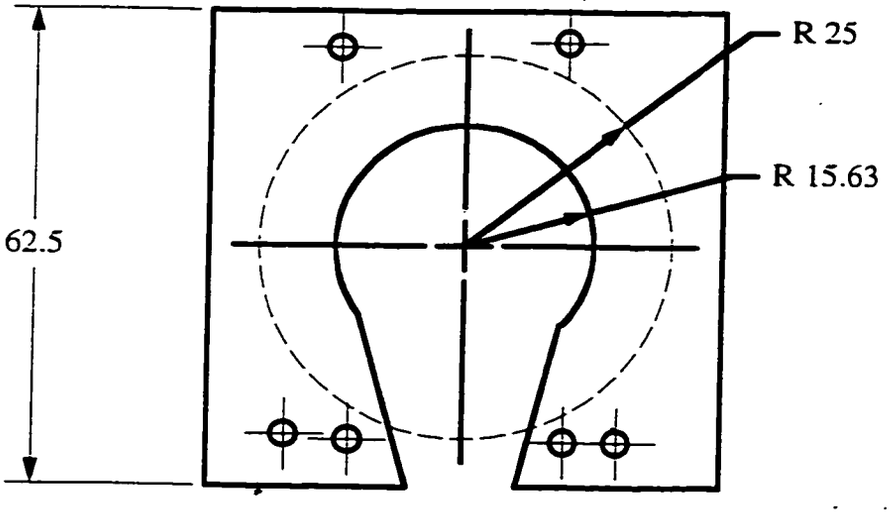

81.25
R 25
625
400
581.25
981.25
400



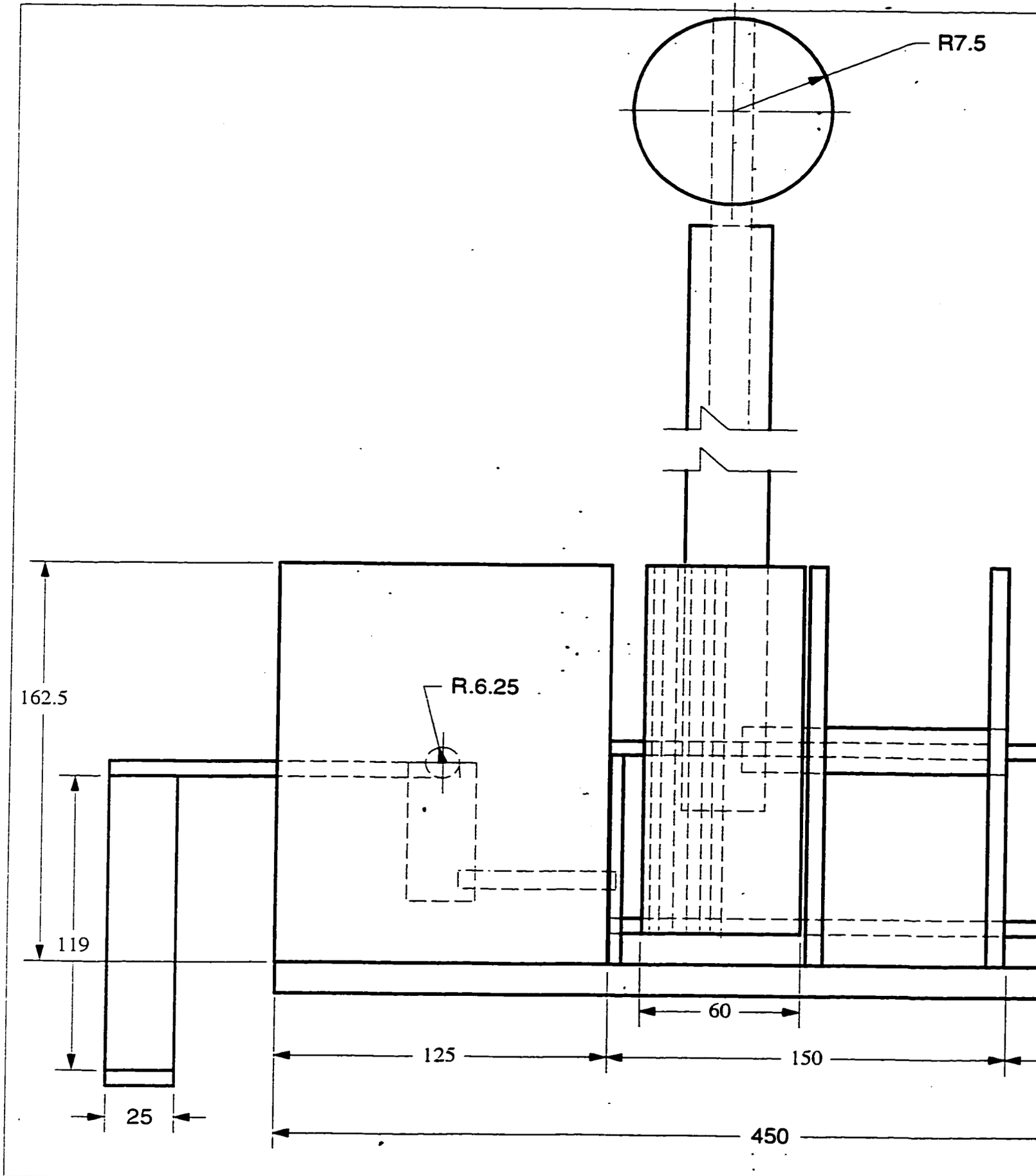
PROJECT: WORKSTATION FOR HOME OFFICE AND SMALL LIVING SPACE		
DRAWING: COMPUTER SUPPORT PLAN VIEW		
SCALE: 1:5	**DIM: MM**	**NO: 13**

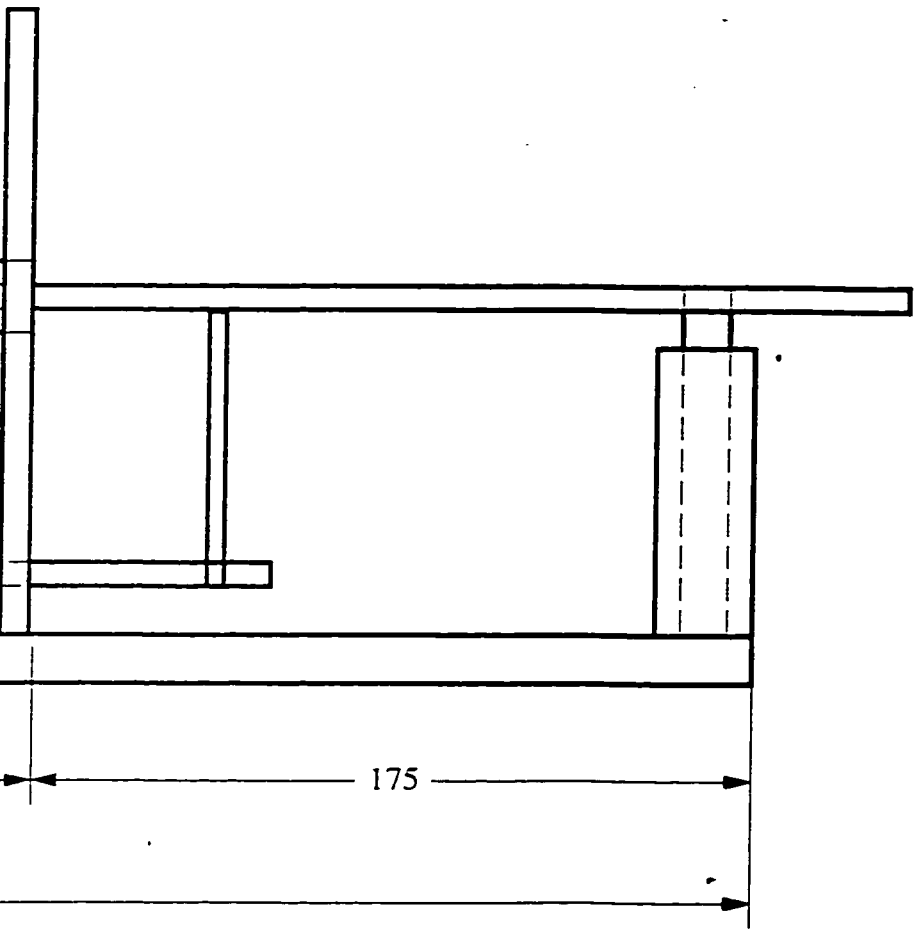

62.5
62.5


R 25


62.5
R 25
R 15.63

PROJECT: WORKSTATION FOR HOME OFFICE AND SMALL LIVING SPACE		
DRAWING: COMPUTER TABLE BALL-JOINT AND COVERS		
SCALE: 1:1	DIM: MM	NO: 14

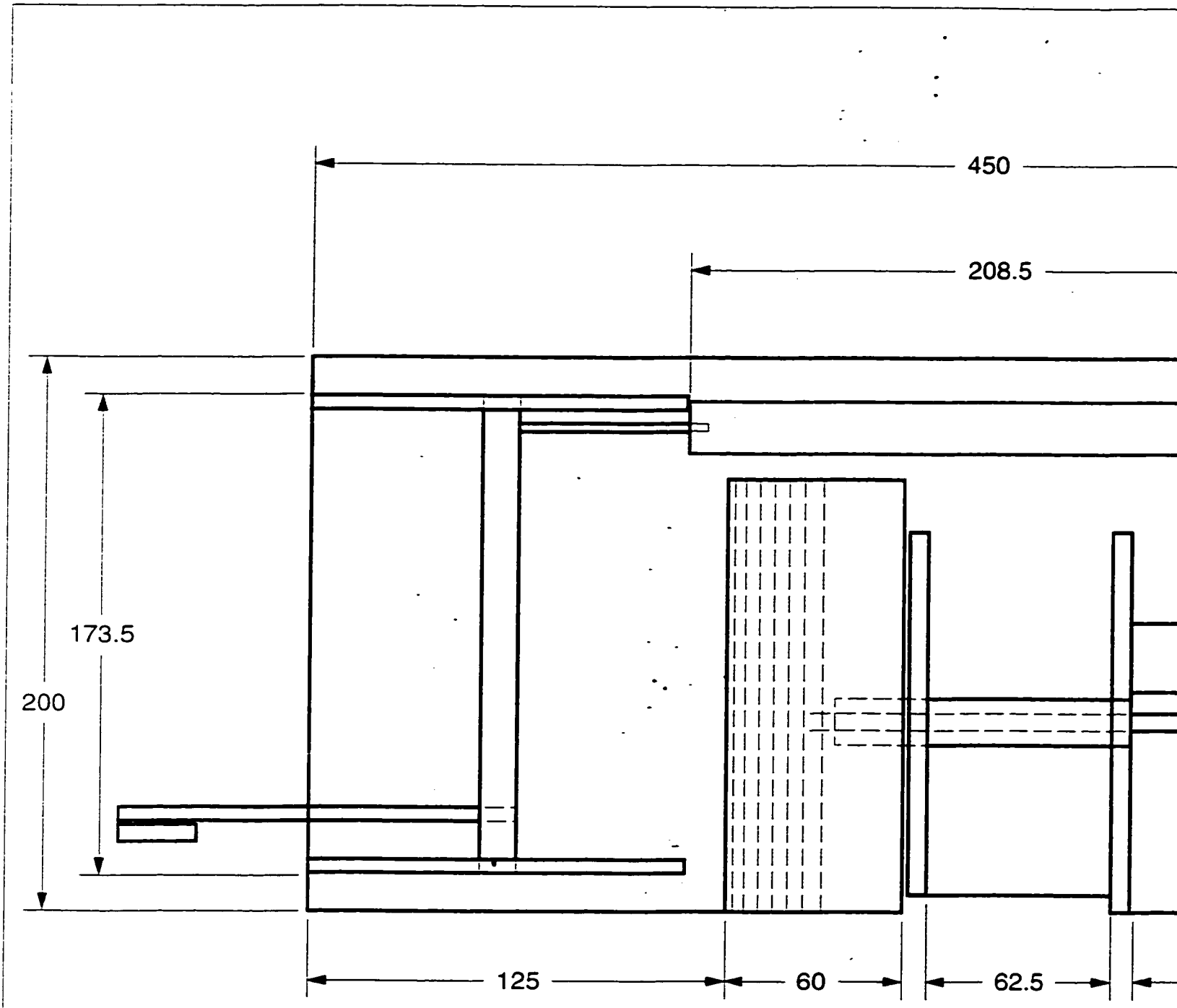

R7.5
R.6.25
162.5
119
60
125
150
25
450

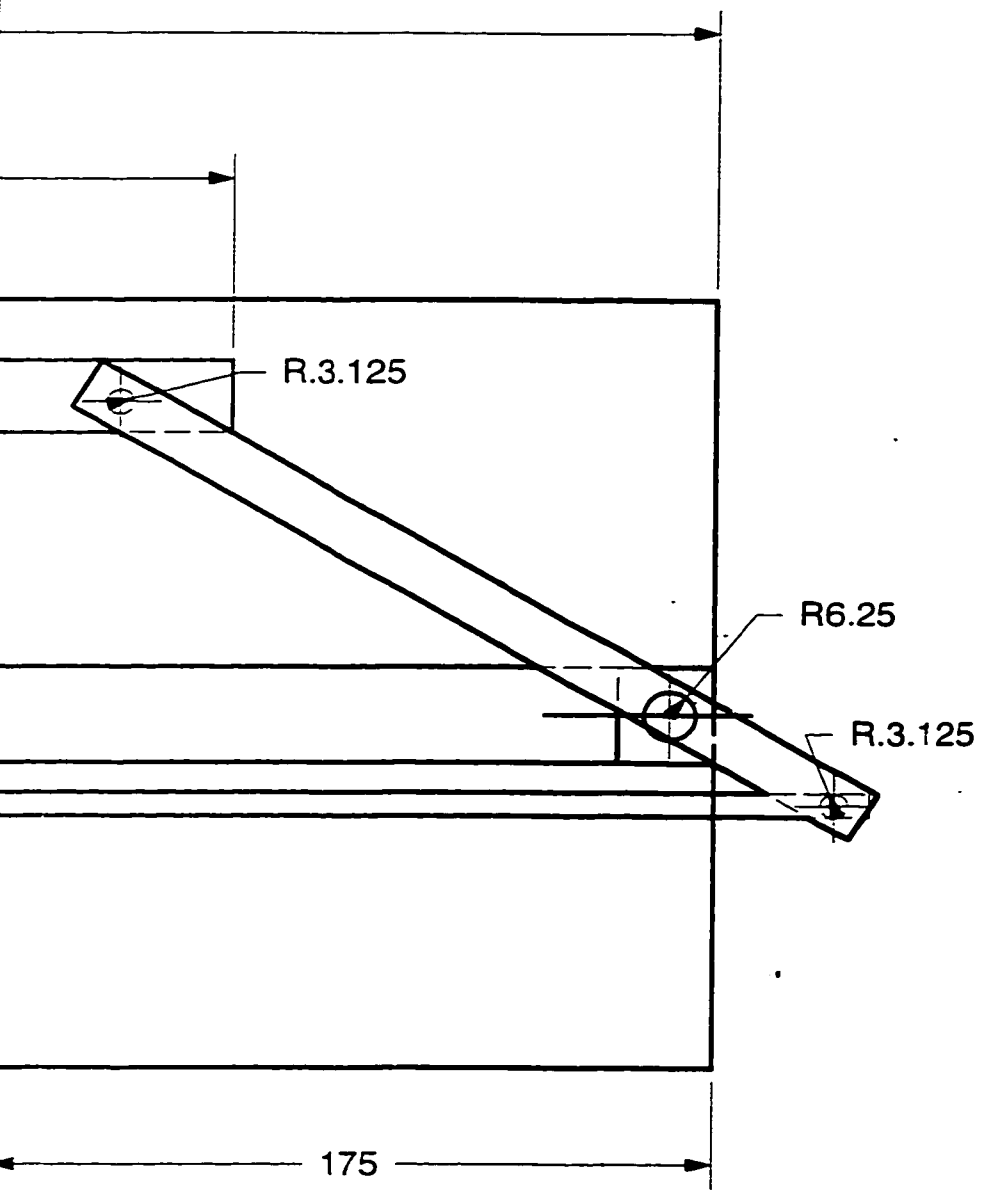


PROJECT: WORKSTATION FOR HOME OFFICE AND SMALL LIVING SPACE

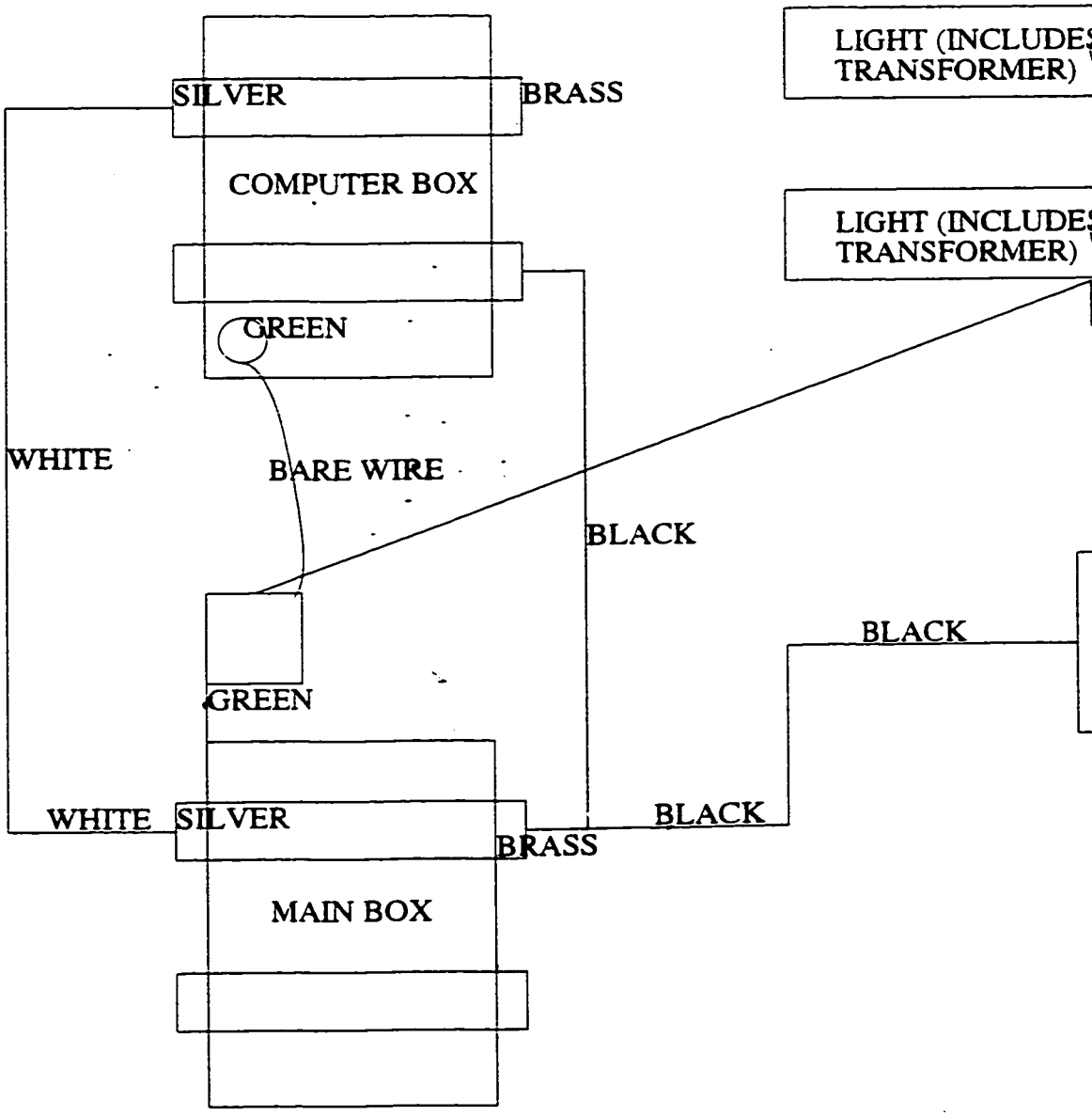
DRAWING: FRONT VEIW FOOT RELEASE, CLUTCH, AND LINKAGE SYSTEM

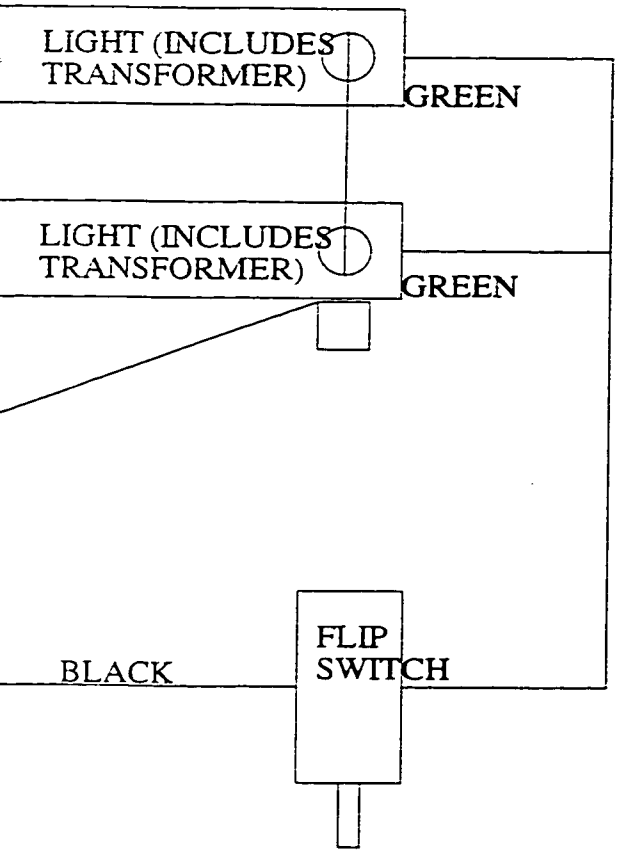
SCALE: 1:2	DIM: MM	NO: 15


450
208.5
173.5
200
125
60
62.5



PROJECT: WORKSTATION FOR HOME OFFICE AND SMALL LIVING SPACE		
DRAWING: FOOT RELEASE, CLUTCH, AND LINKAGE SYSTEM PLAN VEIW		
SCALE: 1:2	**DIM: MM**	**NO: 16**


LIGHT (INCLUDES
TRANSFORMER)
SILVER
BRASS
COMPUTER BOX
LIGHT (INCLUDES
TRANSFORMER)
GREEN
WHITE
BARE WIRE
BLACK
BLACK
GREEN
WHITE
SILVER
BLACK
BRASS
MAIN BOX



PROJECT: WORKSTATION FOR HOME OFFICE AND SMALL LIVING SPACE		
DRAWING: WIRING INSTRUCTIONS FOR WORKSTATION.		
SCALE: NOT TO SCALE	**DIM: MM**	**NO: 17**