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ERGONOMIC DESIGN OF A PHYSIOLOGIC BIRTH-SUPPORT SYSTEM

**A Research Thesis
for the Fulfilment of the Degree of
Doctor of Philosophy
by
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ABSTRACT

The main theme of this study is centred on the design and evaluation of an Obstetric Body-Support System for upright childbirth that is physiologic and biomechanically efficient, besides improving the tasks of the birth attendant in the management of labour and promoting the safety and well-being of the mother and her baby.

Current practices in obstetrics and consumers' expectations are not congruent. Childbirth - a physiological event is increasingly being managed as a pathological process under medical and surgical frameworks. Medicalisation has increased iatrogenic risks to both mothers and babies and is causing profound concerns.

The last two decades have witnessed two major developments in maternity care moving in opposite directions - the growing dependence on obstetric technology and the increasing demand for natural birth and humanised maternity care. Consumers' demands are no longer based simply on the emotive needs for change. They are based on recent research evidence that is indicating that less technological interference in childbirth is better than more.

The posture adopted by the mother during labour is considered to be the most important factor for the safe passage of the foetus through the birth canal. There is Biblical and historical evidence that the natural posture adopted by women during childbirth has always been in some form of the upright position - sitting, squatting, kneeling and standing. The supine position for delivery facilitates the management of labour, but it has no established benefit for the maternal mother and the foetus. Many physiological disadvantages that adversely affect maternal well-being and foetal oxygenation are associated with the supine position.

In contrast, the upright posture for childbirth has been found to be more beneficial to the mother and foetus. The advantages of the upright posture for labour include: taking advantage of gravitational forces to promote foetal descent; preventing compression of the aorta, inferior vena cava and umbilical cord; increasing the size of the pelvic inlet; promoting more effective bearing-down effort and promoting more efficient contraction. In terms of psychological responses, labouring in the seated position has been found to promote active participation, control and emotional satisfaction.

This study examined some of these issues from an ergonomic perspective for the design and evaluation of an Obstetric Body-Support System that is compatible with the physiology of childbirth and the management of labour in current hospital settings. Antenatal and postnatal user trials were conducted to evaluate the new Obstetric Body-Support System. Responses from birth attendants and childbearing women for the new System were both positive and encouraging, indicating acceptance, system compatibility and design viability.

The changing trend in childbirth demands solutions that are difficult to find in traditional maternity care and practice. The answer is in natural birth - where the woman's enormous psychological, physiological and biomechanical capabilities are relied upon to give birth spontaneously - without technological intervention.

Ergodesign - a new hybrid interdisciplinary technology was conceived to design and evaluate the Obstetric Body-Support System that supports and facilitates natural childbirth in the upright position. It is argued that the use of ergonomics and design as separate disciplines militates cohesive design thinking and the creative processes. Besides the symbiotic aspects of ergodesign, the truly interdisciplinary attributes become an effective and synergistic design tool, that is more powerful than conventional approaches of applying ergonomics and design as separate disciplines.

The ergodesigner as a scientist, designer as well as a change-agent played a vital role in solving the intricate human-equipment-environmental problems in the management of labour and childbirth in hospital systems. The application of ergonomics to improve childbirth is a complex task, requiring full participation from childbearing women, midwives and obstetricians. They contributed significantly by enlightening the ergodesigner with an "insight" surrounding labour and childbirth, and were involved in the development of body-support concepts, appraisals of mock-ups and evaluations of the prototype Obstetric Body-Support System.

A programme of further work is planned to evaluate the clinical aspects of the maternal woman and the baby before conclusion can be drawn on the safety of the new Obstetric Body-Support System.

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GLOSSARY

Anaesthesia: Loss of feeling or sensation. General anaesthesia implies not only a loss of feeling or sensation but also of consciousness and memory. Regional anaesthesia implies a loss of feeling or sensation in a restricted area of the body.

Analgesics: Painkilling agents not inducing unconsciousness.

Anthropometry: The science of measurement of the human body to determine differences in groups, individuals, etc.

Apgar Score: A general test of the baby's wellbeing given immediately after birth to ascertain the heart rate and the tone, respiration, blood circulation and nerve responses.

Asphyxia: Suffocation; state of decreased oxygen and increased carbon dioxide in blood and tissues.

Biomechanics: The application of the principles and techniques of mechanics to the structure, functions and capabilities of the human body.

Bonding: The spontaneous formation of attachment between mothers and their babies in the period immediately following birth.

Caesarean section: Delivery of the baby by surgery, through an incision in the mother's abdomen and uterus.

Cephalopelvic disproportion: A situation in which the head of the unborn baby is too large to pass through the pelvic bones of the mother.

Cervic: The lower end of the uterus, or neck of the womb.

Concept: An idea or impression of a design or theory.

Contraction: The regular tightening of the uterine muscles as they work to dilate the cervix in labour and to press the baby down the birth canal.

Demoral: A frequently used analgesic in hospital delivery.

Design: To analyse and devise a form that serves a particular purpose.

Discipline: A branch of knowledge, field of study or specialty subject.

Dystocia: Slow or prolonged or difficult labour.

Epidural anaesthesia: A regional anaesthesia in which a local anaesthetic agent is injected into the epidural space of the spine.

Episiotomy: A surgical incision into the perineum to enlarge the vagina opening to speed the birth of the baby. Also known as the "unkindest cut".

Electronic-foetal monitoring: The continuous monitoring of the foetal's heart by a transducer placed on the mother's abdomen over the area of the foetal heart, or an electrode inserted through the cervix and clipped to the baby's scalp.

Ergodesign: An integrated ergonomics and design approach used in equipment and system design.

Ergonomics: A technology that seeks to improve mental and physical well-being by optimising the function of human-machine-environment systems.

Evaluation: Appraisal or test to ascertain the "fit", usability, safety, etc of a piece of equipment or system.

Fontanel, fontanelle: Spaces in the skull of the foetus and young infant where the skull bones have not yet grown together.

Forceps: An instrument with two blades and handles for forcibly pulling the foetus, by the head, through the birth canal.

Haemorrhage: Excessive bleeding.

Iatrogenic: Produced or caused by a physician.

Interface: The point of contact between the human being and the equipment.

Intervention: In obstetrics, an invasive procedure that literally intervenes or interferes with the natural process of birth. The term denotes active interference and implies meddling with Mother Nature.

Ischial Tuberosity: The rounded portion of the bone of the pelvis on which the body rests when sitting.

Kinetosphere: A large cubical structure used for the study and measurement of the biospace or work-envelope.

Labour: Contraction of the uterus resulting in the birth of a baby.

Lacerations: A tear in the perineum.

Lamaze Method: A set of techniques, including complex breathing patterns, devised by Fernand Lamaze, as an alternative to drugs in reducing a woman's awareness of pain in labour.

Lithotomy position: Horizontal, supine or recumbent position. A woman giving birth in this position is flat on her back with legs spread in stirrups.

Low-risk pregnancy: The probability that pregnancy and childbirth will be uncomplicated or normal.

Mock-up: A full-size model of equipment for research, study or testing.

Multigravida: A woman in her second or subsequent pregnancy.

Multipara: A woman who has given birth to more than one child.

Multiparous: Bearing or having borne more than one child.

Optimisation: An effort to achieve the best system outcome.

Oxytocin: A drug that causes the uterus to contract. As a uterine stimulant, it is used to induce labour or to accelerate existing labour.

Parturient: A woman in the process of giving birth. Giving birth; pertaining to birth.

Perineum: The area surrounding the vagina and between the vagina and the rectum.

Phenomenon: Any sensations that can be perceived by the senses.

Placenta: The organ which develops on the inner wall of the uterus and supplies the foetus with its life-supporting requirements and carries waste products to the mother's system.

Postpartum: After the delivery or following childbirth.

Primipara: A woman who has given birth to one child.

Primiporous: Bearing or having borne only one child.

Primigravida: A woman having her first pregnancy.

Prototype: An original model from which other improved models can be made.

Psychoprophylaxis: A method of preparation for natural birth.

Sedentary Anthropometer: A device used for the study and measurement of the sitting postures.

Sociotechnical System: A system approach that takes into account and optimises both the social sub-system and the technical sub-system.

Symbiosis: A close association between two interdependent subjects.

Synergy: Efficiency achieved by a combined action.

System: A group or combination of interrelated, interdependent or interacting elements forming a collective entity.

Uterus: The sac of muscle in which the foetus develops and that contracts during labour to push the foetus out; also called "womb".

Vacuum extractor: A suction device affixed to the unborn baby's head to pull the baby out.

CONTENTS

	Page
Abstract	i
Acknowledgements	iv
Glossary	vi
Contents	xii
List of Figures	xvii
List of Tables	xix
CHAPTER ONE : GENESIS OF THE STUDY	1
1. Introduction	1
1.1 The Aim	2
1.2 Changing Practices in Childbirth	2
1.3 The Ergonomic Approach	5
1.4 Background to the Study	8
1.5 Scope of the Study	11
1.6 Structure of the Thesis	12
CHAPTER TWO : OBSTETRICS AND CHILDBIRTH	14
2. Current Obstetric Culture - Review of the Relevant Literature	14
2.1 Frequency of Obstetric Interventions and Risks	17
2.2 Some Long-Term Effects of Drugs	19
2.3 Scientific Management of Labour	21
2.4 Delivery Positions	23
2.5 Psychoprophylaxis	25
2.6 Humanising Birth	26
2.7 The Birth Process as Design Criteria	30
2.7.1 Design Considerations	30
2.7.2 Physiological Postures for the Expulsion of the Foetus and the After-Birth	31
2.8 The Body-Support System	31
2.8.1 Postural Variations	32
2.8.2 Pelvic-Support	32
2.9 Psychological Considerations	34
2.10 Familiarisation Programme	35
CHAPTER THREE : BIRTH POSTURES	36
3. Ergonomics of Birthing Postures - Review of the Relevant Literature	36
3.1 History of Birth Postures	39
3.2 Some Advantages and Disadvantages of Upright Postures vs Supine Postures	42
3.3 Anthropometrical, Anatomical and Biomechanical Aspects	44

	Page
3.4 Synergistic Effect	46
3.5 Biomechanical Advantages	47
3.6 Clinical Aspects : Iatrogenic Risks	50
3.7 Emotional Aspects	53
3.8 Ambulation	55
3.9 The Effects of Birth Chair Delivery on Maternal Satisfaction	56
3.10 The Effects of Birth Chair Delivery on Maternal Well-Being and Duration of Second-Stage Labour	58
4.10.1 Maternal Well-Being	59
3.11 The Effects of Birth Chair Delivery on Foetal Well-Being	64
3.12 Factors Other than Positioning that Affect Maternal and Foetal Well-Being	68
3.13 Valsalva Manoeuvre	70
3.14 Open-Glottis vs Close-Glottis Delivery	71
3.15 Intervention Strategies	74
3.16 Duration of the Second Stage of Labour Women are Allowed for Spontaneous Delivery	76
3.17 Holistic Childbirth	79
3.18 The Present Study	82
CHAPTER FOUR : ERGODESIGN	83
4. Ergodesign Approach and the Acquisition of Data - The Optimisation of Ergonomics and Design Technologies	83
4.1 Ergonomic Theory to Design Practice	85
4.1.1 Ergodesign : Its Synergy and Symbiosis	88
4.1.2 Ergodesign Approach	88
4.1.3 Ergonomics and Design Criteria	89
4.2 Development of User and System Data	89
4.2.1 Acquisition of Data : Its Challenges and Problems	91
4.3 Childbirth and Work : A Comparison of "Physical Loads"	92
CHAPTER FIVE : SYSTEM DESIGN AND DEVELOPMENT	95
5. Development of an Obstetric Body-Support System	95
5.1 Some Traditional Design Models and Methods	96
5.2 The Seven Ergodesign Phases	99
5.2.1 Rapport Building Phase	100
5.2.2 Feasibility Studies Phase	102
5.2.3 Concept Design Phase	103
5.2.3.1 Exploring Different Birth Postures	105
5.2.3.2 Development of the Pelvic-Support	113
5.2.3.3 Sedentary Anthropometer and Kinestosphere Studies	121
5.2.3.4 Development of the Back- and Head-Supports	124
5.2.3.5 Development of the Upper Body-Supports	124
5.2.3.6 Development of the Foot-Supports	124
5.3 Flashes of Insight	125
5.4 The Spirit of Birth	125

	Page
5.5 Disadvantages of an Electrically Controlled System for Childbirth	128
5.6 Criteria for Good Design	129
5.7 Final Design and Specification Phase - Development of the Obstetric Body-Support System	131
5.7.1 Development of the Maternal Body-Support System	132
5.7.2 Main Features of the Maternal Body-Support System	132
5.8 Design and Development of the Caregiver's Body-Support System	139
CHAPTER SIX : SYSTEM EVALUATION	146
6. Evaluation of the Obstetric Body-Support System	146
6.1 Methods and Participants	146
6.1.1 Personal Information of Prenatal Mothers	147
6.1.2 Personal Information of Postnatal Mothers	148
6.2 Setting Up	149
6.2.1 Briefing and Demonstration	153
6.3 Questionnaire Design	154
6.3.1 System Questionnaires	155
6.3.2 Active Birth Chair Questionnaires	155
6.4 Results	178
6.5 Prenatal Evaluations	180
6.5.1 Obstetric Body-Support System Evaluation Part A - Midwives Opinions on the Use of the System for Delivery and Childbirth	180
6.5.1.1 Summary of Results of Midwives Opinions on the Use of the System	182
6.5.2 Part B - Evaluation of Active Birth Chair Features	182
6.5.2.1 Summary of Results of Midwives and Prenatal Mothers Combined Responses on 15 Active Birth Chair Features	185
6.5.3 Analysis of Midwives Comments on Active Birth Chair Prenatal Tests	185
6.5.3.1 Independent Midwife	185
6.5.3.2 Independent Midwife	186
6.5.3.3 Independent Midwife	187
6.5.3.4 Independent Midwife	187
6.5.3.5 Wellington Hospital Midwife	187
6.5.3.6 Wellington Hospital Midwife	188
6.5.3.7 Wellington Hospital Midwife	189
6.5.3.8 Wellington Hospital Midwife	189
6.5.3.9 Wellington Hospital Midwife	190
6.5.3.10 Wellington Hospital Midwife	191
6.5.4 Part C - Evaluation of Delivery Seat-Kneeler Features	192
6.5.4.1 Summary of Results of Midwives Responses on 9 Delivery Seat-Kneeler Features	195
6.5.5 Analysis of Midwives Comments on Delivery Seat-Kneeler	195

	Page
6.5.5.1 Independent Midwife	195
6.5.5.2 Wellington Hospital Midwife	196
6.5.5.3 Wellington Hospital Midwife	196
6.5.5.4 Wellington Hospital Midwife	196
6.5.5.5 Wellington Hospital Midwife	197
6.6 Prenatal Evaluation of Active Birth Chair by Expectant Mothers	197
6.6.1 Part A - Personal Information	197
6.6.2 Part B - Feelings and Perceptions of Trials	198
6.6.3 Detailed Analysis of Expectant Mothers Responses	198
6.6.4 Part C - General Postural Comfort Rating	199
6.6.5 Part D - Body Parts Comfort Assessment	199
6.6.6 Part E - Active Birth Chair Features Evaluation	201
6.6.7 Part F - Multiparous Mother's Preference for Birthing Devices	201
6.7 Analysis of Expectant Mothers Comments on Active Birth Chair	203
6.7.1 Mother One	203
6.7.2 Mother Two	203
6.8 Postnatal Evaluations	204
6.9 Analysis of System Questionnaire	206
6.9.1 Part A - General Outcome of the Birth and Delivery	206
6.9.2 Part B - Evaluation of Active Birth Chair Features	207
6.9.3 Part C - Evaluation of Delivery Seat-Kneeler Features	209
6.10 Analysis of Birth Attendants Comments on the System	210
6.10.1 Principal Midwife	210
6.10.2 Assistant Midwife	211
6.10.3 Independent Obstetrician	211
6.11 Analysis of Birth Attendants Comments on Active Birth Chair	212
6.11.1 Principal Midwife	212
6.12 Analysis of Birth Attendants Comments on Delivery Seat-Kneeler	213
6.12.1 Principal Midwife	213
6.12.2 Assistant Midwife	214
6.13 Postnatal Evaluation of Active Birth Chair by Mothers	215
6.13.1 Part A - Personal Information	215
6.13.2 Part B - Childbirth Feelings and Perceptions	215
6.13.3 Detailed Responses on Childbirth "Feelings" and "Perceptions" of the Two Mothers	216
6.13.4 Part C - General Postural Comfort Rating	217
6.13.5 Part D - Body Parts Comfort Assessment	217
6.13.5.1 Summary of Responses to Body-Parts Comfort by Postnatal Mothers	219
6.13.6 Part E - Active Birth Chair Features Evaluation	219
6.13.7 Part F - Comparison of Active Birth Chair with Other Birth Devices	219

	Page
6.14 Analysis of Postnatal Mothers Comments on Active Birth Chair	220
6.14.1 Mother One	220
6.14.2 Mother Two	220
6.15 Summary of the Results and Discussion	221
CHAPTER SEVEN : DISCUSSION	223
7. Discussion	223
7.1 System Planning and Implementation	228
7.2 Research, Scholarship and Development	229
CHAPTER EIGHT : CONCLUSIONS AND FURTHER STUDIES	231
8. Conclusions	231
8.1 Modification to the Active Birth Chair	232
8.2 Further Study	233
REFERENCES	234
APPENDICES	248
Appendix A - Obstetric Body-Support System Evaluation Questionnaire Used in Postnatal Evaluation	249
Appendix B - Active Birth Chair Evaluation Questionnaire Used in Postnatal Evaluation	258
Appendix C - Further Study	269
Appendix D - Conferences and Publications	275

LIST OF FIGURES

		Page
Figure 2.1	Lithotomy-Drug-Surgical Syndrome	24
Figure 3.1	Aorto-Caval Compression in the Supine Position	43
Figure 3.2	Mechanical Disadvantage of the Horizontal Position for Childbirth and the Use of Forceps	48
Figure 3.3	Consequences of the Dorsal Position	51
Figure 3.4	Consequences of the Valsalva Manoeuvre	73
Figure 5.1	Concept Proposal: A Body-Harness System	107
Figure 5.2	Concept Proposal: A Body-Support System for Underwater Birth	108
Figure 5.3	Concept Proposal: A Two Person Body-Support System	109
Figure 5.4	Concept Proposal: A Simple Manually Adjustable and Articulate Body-Support System	110
Figure 5.5	Concept Proposal: A Fully Adjustable and Articulate Body-Support System with Electric Controls	111
Figure 5.6	Passage, Direction and Turning of Foetus from the Mother's Pelvic Inlet to the Pelvic Outlet, to the Birth Canal and to the Outside World	115
Figure 5.7	Design and Development of Pelvic-Support	117
Figure 5.8	Design and Development of Pelvic-Support	118
Figures 5.9 & 5.10	Design and Development of Full-Size 3D Models of the Pelvic-Support - Using Cadaver Female Pelvis	119
Figure 5.11	Development of Pelvic-Support	120
Figure 5.12	Construction of Mould for Pelvic-Support	120
Figure 5.13	Analysis of Birth Positions on Sedentary Anthropometer (top)	122
Figure 5.14	Analysis of Delivery and Birth Postures on Sedentary Anthropometer (bottom)	122
Figure 5.15	Posture and Biospace Analysis in the Kinetosphere	123
Figure 5.16	Posture Analysis of Birth Attendant in the Squat-Sit Delivery Position	123
Figure 5.17	Side Elevation of Maternal Body-Support System: The Active Birth Chair	134
Figure 5.18	Plan View of Maternal Body-Support System: The Active Birth Chair	135
Figure 5.19	Front Elevation of Maternal Body-Support System: The Active Birth Chair	136

Figure 5.20	Back Elevation of Maternal Body-Support System: The Active Birth Chair	137
Figure 5.21	Development of the Platform	138
Figure 5.22	Development of Adjustment Mechanisms for the Back-Support	138
Figure 5.23	Plan View of Caregiver's Body-Support System: The Delivery Seat-Kneeler	141
Figure 5.24	Side Elevation of Caregiver's Body-Support System: The Delivery Seat-Kneeler	142
Figure 5.25	Front Elevation of Caregiver's Body-Support System: The Delivery Seat-Kneeler	143
Figure 5.26	The Active Birth Chair	144
Figure 5.27	The Delivery Seat-Kneeler	144
Figure 5.28	The Obstetric Body-Support System with Armrests . . .	145
Figure 5.29	The Obstetric Body-Support System Without Armrests	145
Figures 6.1 & 6.2	Expectant Mothers Evaluating the Active Birth Chair During the Prenatal Test with Independent Midwives and the Ergodesigner	150
Figure 6.3	Ergodesigner Briefing "Domino" Midwives During Prenatal Test	151
Figure 6.4	Ergodesigner Briefing Manager of Maternity Unit, Kenepuru Hospital on Details for Postnatal Test	151
Figure 6.5	Manager of Maternity Unit, Kenepuru Hospital and Staff Midwife Evaluating the System with Ergodesigner	152
Figure 6.6	"Domino" Independent Midwives Testing the System with Ergodesigner	152
Figure 6.7	Body Parts Assessed	200
Figure 6.8	Body Parts Assessed	218

LIST OF TABLES

	Page
Table 2.1	Matched Home and Hospital Samples 18
Table 3.1	Length of Second Stage for Primiparae 1981-84 77
Table 3.2	Rates of Spontaneous Delivery in Primiparae by Length of Second Stage 1981-84 77
Table 6.1	Responses of Nine Midwives to Questions About the Obstetric Body-Support System 181
Table 6.2	Combined Responses of 10 Midwives and 3 Prenatal Mothers on 15 Active Chair Features 183
Table 6.3	Responses of 10 Midwives on 9 Delivery Seat-Kneeler Features 193
Table 6.4	Body Parts Comfort Assessment by M1, M2, M3 at Prenatal Test 200
Table 6.5	Users Responses to Active Birth Chair Features 208
Table 6.6	Users Responses to Seat-Kneeler Features 209
Table 6.7	Body Parts Comfort Assessment by M01 and M02 at Postnatal Test 218

CHAPTER ONE

GENESIS OF THE STUDY

1. INTRODUCTION

The management and care for the mother and the infant during childbirth requires a wide range of skills and knowledge from different disciplines. Extensive medical, technological and scientific knowledge are deemed necessary for the safety and wellbeing of human life in maternity hospitals. Birth is a complex physiological and psychological process. A caregiver must combine technical knowhow with compassion and sensitivity for the selection of medicine and technology according to individual symptoms and needs.

Not unlike normal production and manufacturing processes, new technology, legal values and social changes are affecting medical science in general, and obstetrics in particular with profound uncertainty, fear and controversy. Much of the problem is centred on the invasive procedures in modern obstetrics - such as timed-labour, drugs and mechanical interferences with the normal process of birth - so much so that obstetrics has now become one of the areas of medicine most open to public and media scrutiny.

Like most occupational tasks, the problems affecting childbirth could be most appropriately studied within the confines of the human-machine-environment system - or the Ergonomic Approach. The application of ergonomics in obstetrics and childbirth allows the human-machine and human-environmental interface problems - involving psychological, physiological and biomechanical factors - to be analysed, optimised and evaluated more scientifically. However, it must be mentioned that implementation here is, by far, more difficult than any industrial process because childbirth is a critical and complex physiological process involving the safety and wellbeing of both the mother and the infant.

This is a new frontier that no ergonomist has ventured into before. Consequently there is an acute shortage of ergonomic data, including basic anthropometric, dimensional, anatomical and biomechanical aspects. As labour and childbirth have always been totally private affairs, the generation of data, research protocol and, design and evaluation methods have presented challenges, seldom found in "industry" settings.

1.1 THE AIM

The main aim of the study was to apply ergonomics to the design and evaluation of an Obstetric Body-Support System for physiologic labour and childbirth and their management. A new conceptual method called "Ergodesign" was used in the System design process to integrate ergonomics and design approaches.

1.2 CHANGING PRACTICES IN CHILDBIRTH

During the last 20 years two significant trends in childbirth have drifted simultaneously in opposite direction throughout the Western world. On the one hand is the accelerating development in obstetric technology - with foetal monitoring, epidural anaesthesia, oxytocin augmentation, ultrasound and surgical procedures in hospitals - embracing the "scientific management" approach in childbirth. The other is the increasing move toward natural childbirth and the realisation that birth is a normal physiological process, a family affair based on spiritual and emotional needs - without drugs or other technological interventions (Houston, 1984).

The current aspiration of some of the Western world is concentrated in the quest for simpler lifestyle, ecology, protection of basic and natural resources and a movement away from impersonal technology - towards the ideals of alternative lifestyles, alternative birth, anti-smoking, anti-nuclear,

preventive medicine and holistic care of the whole person over the old model of illness, drugs, surgery and the treatment of the symptom (Naisbitt, 1982).

In direct contrast, the increasing reliance on intricate technology and medical knowledge has resulted in the management of pregnancy and childbirth more as a pathological symptom than a natural biological phenomenon. The importance of the psychological experience of the quality of the labour and birth to the mother is often neglected. This comes as no surprise, as Dr Basil Lee of the London Hospital points out - young doctors now graduating from medical school are weaned on mechanical medicine, nurtured on high technology and therefore are nervous of nature (Brook, 1985). Moreover, it is difficult to combine sophisticated technology with human warmth and empathy, particularly in surroundings that are geared to treat illness - surroundings that are built for efficiency, for safe and sterile procedures. Unfortunately, women are expected to give birth in such environments.

Recent research evidence is demonstrating that many common obstetrical practices have not been scientifically proven to benefit the healthy mother and infant in the way that was originally intended (Young, 1982; Brook, 1986). Many authorities now believe that any aspect of maternal and newborn care which is not clearly medically-based on sound scientific evidence should be left to the family's choice (Lozoff et al, 1977).

Worldwide, many well-informed women today are alarmed by the increasing use of drugs and surgical procedures such as the use of forceps and Caesareans. They are now rejecting the routine and unwarranted use of obstetrical interference to avoid the risks of complications to themselves and their baby (Kitzinger, 1987).

Since the 1970s women and their families are demanding for their rights to be treated with respect and humanity, to determine how, when and where to give birth, to be given choices in hospital maternity units and to participate knowledgeably in decisions about their own baby's care (Young, 1982). As a result of these demands many hospitals around the Western world are starting to re-examine their policies and many are starting to make important changes to "humanise" childbirth and hospital maternity care management (Bennett, et al 1993).

Korte and Scaer (1984) cite that out-of-hospital birth is growing fast, and the threat of many women opting for alternative birth is one of the most important reasons why American hospitals have made changes demanded by consumers. Since childbirth is an annual \$8 billion business in the US today, there is a strong economic motivation for hospital and doctors to keep childbearing women as customers.

As yet, only a minority of clinicians in New Zealand who are willing to accept the fact or recognise that the use of drugs and technological interventions during labour and birth is often counter productive, and actively explore other ways of helping women by increasing the efficiency of labour and birth through physiological means (Costello, 1987).

With the 1990 Nurses Amendment Act, which enables a midwife to take full responsibility for the care of a woman throughout her pregnancy, childbirth and postnatal period, and the current trend of privatisation and user-pay policy, and the proliferation of privately-owned hospitals in New Zealand, it makes good economic sense here too - if not for humanitarian and safety reasons - for our hospital system to adapt.

The immediate impression from the literature is one of risk, anxiety and helplessness of the consumers. Professional practices are not congruent with consumers' expectations. In ergonomic terms, the problems and current trends facing advanced technological obstetrics are very similar - if not identical - to those already experienced in the production and manufacturing industries during the past two decades or so. They are the result of the mismanagement and inappropriate use of technology. The symptoms - job dissatisfaction (labour is hard work!), alienation, lack of dignity, lack of challenge, lack of recognition, lack of participation, lack of respect, etc (Brook, 1986; Inch, 1985; Korte and Scaer, 1984) - highlight some of the concerns and frustrations experienced by women in advanced technological obstetric care today. All these symptoms are not new. They have been well documented especially in the textbooks of industrial psychology.

It would seem that, in both cases, the root cause of the problems is not due to the presence of advanced technology per se - but because of the neglect of basic ergonomics or human factor issues in the technological systems.

1.3 THE ERGONOMIC APPROACH

Ergonomics may be defined as a multidisciplinary science which has been developed to solve the social and technical problems relating to human beings, equipment and the work environment. The discipline is growing and employs an increasing number of basic sciences - including psychology, anatomy, physiology and biomechanics. Its aim is to adapt technology, work methods and the environment to fit the human components of the system, according to their capabilities and limitations. Because human characteristics are generally not amenable to change, while technology is flexible and is almost unlimited in design options, the

psycho-physiological and other needs of the human being must be taken as the central frame of reference to ensure human-equipment-environment optimisation when the system is designed.

The ultimate benefits of this mutual adjustment of technology by design to complement human abilities are increased safety, efficiency, satisfaction and wellbeing of mothers, babies, midwives, obstetricians and other caregivers in the birth-care system.

Implicit in the study is the assumption of the ergonomist/designer as a change-agent who is expected to participate creatively and proactively with other disciplines. In this case with obstetricians, midwives, doctors, mothers, birth educators, designers and manufacturers. The ergonomist should avail himself to develop policy or concept on how technology should be harnessed and designed, rather than always reacting to what other disciplines have to dictate.

Used creatively, ergonomics is a unique science that is most suited to improving the function of a complex system such as the obstetric system under study. Ergonomics focuses on human factors, the equipment and the environmental sub-systems in which humans interact. No other sciences - including the engineering sciences, medical sciences or the applied social sciences share this unique status. More importantly, ergonomics is also an applied technology that supports other engineering sciences or system design technologies. It is rich in methodologies that enable the discipline to develop procedures for harnessing technology in the form of compatible equipment and systems that promote efficiency, safety, health and the wellbeing of the humans involved in the system. It is therefore, the most appropriate and effective science-technology for addressing the problems associated with the management of labour and birth alluded to above.

The concept of **Ergodesign** is conceived in this study, as a hybrid interdisciplinary approach to address the intricate ergonomics and design problems of the study. A macroergonomics procedure is used to study and understand the complex and interrelated psychological, physiological, cultural, medical, technological, managerial, as well as the historical aspects of childbirth to provide the necessary background to present a global picture of the problem. Such detailed analyses are necessary to enable the Ergodesigner to make effective and accurate inferences, and to propose design philosophies for the subsequent conceptualisation, design and evaluation of the obstetric body-support system.

The management of labour and childbirth exist in a very intricate system involving a hierarchical structure of personnel, as well as medicine, technology and other diagnostic equipment. It is a complex sociotechnical system not unlike that of an intensive care system (Yap, 1979).

The management of labour and childbirth involves two major subsystem components to effectively perform all the intricate tasks in the birth processes and maternal and infant care. They include obstetricians, midwives, nurses, doctors and other clinicians and caregivers that make up the personnel or social subsystem, and the equipment and the technology that make up the technical subsystem. Both have profound effects on the outcome of a labour and birth.

The design of the technical subsystem defines and affects the tasks to be performed. The design of the personnel subsystem prescribes the way in which the tasks are performed.

The two subsystems interact with one another at every human-equipment interface. Thus, they are interdependent to each other and the sociotechnical system is affected by causal events in the environment.

Once the technical subsystem is designed it is relatively stable and fixed. The personnel subsystem is often forced to adapt in order to maintain system efficiency.

As the personnel and the technical subsystems respond jointly to causal events, sociotechnical optimisation in the present study will require joint design of the two subsystems. Optimising one and then fitting it to the other subsystem will result in a suboptimisation of the joint sociotechnical system (Hendrick, 1991).

1.4 BACKGROUND TO THE STUDY

Interest in the present study was stimulated by personal experiences and belief that labour and childbirth could be made significantly more efficient and safer by the application of ergonomics.

During the past 20 years, demands for changes in the management of the birth process has increased. Informed women are pressuring to revert the existing highly medicalised and technological obstetric culture back to the more human-centred midwifery culture (Bennett et al, 1993; Inch, 1985).

To realise this paradigm shift towards a safer natural birth culture will require the input and dedication from a wide range of disciplines - including doctors, obstetricians, midwives, mothers as well as politicians and lawmakers. It is my own belief that ergonomics is singularly the most important discipline that has the scientific methodology not only to participate in this paradigm shift - from invasive control to a natural process - but, it also has the potential, as a science and a technology, to ensure the full realisation of a labour management culture that is truly human-centred. More to the point. Events and experiences that surrounded the birth of my children have compelled me to undertake the present study.

My wife Choi Seong and I have three children. Tracey born in 1975, Cindy in 1982 and Peter in 1984. Like many parents we had only scant knowledge on the intricacy of childbirth, and the pros and cons of the use of drugs and advanced technology in the management of labour.

The delivery of our three children presented some unforgettable and traumatic experiences in our life. After sitting through the Caesarean section beside my wife when Peter was delivered, the emotional sense of despair, powerlessness and guilt have been profound. Tracey and Cindy were also Caesars!

When Tracey was born, 20 years ago in May 1975, I was a fresh graduate in industrial design. Was ill-informed and naive about childbirth, and the rights and wrongs of existing hospital protocol and routine. Despite the trauma and shock of the Caesarean section I was thankful that both mother and baby were well. I was extremely impressed by the precise routine of the management of the labour, the administration of drugs and the sophistication, design and power of the monitoring equipment - all the interventions I now know might have been the causal factors for the need of the mechanical deliveries.

At the time my second daughter Cindy was born, in October 1982, I was more appropriately informed about the processes of labour and the pros and cons of the management of it. My MSc studies in Ergonomics at Loughborough University led me to question and inquire about existing hospital routines closely - in an ergonomic perspective, and to probe seriously into the advantages or otherwise, of the "scientific" management of labour, and the consequent "control" of the natural process of childbirth in modern obstetrics. However, strict hospital protocol and "accepted" routines, hitherto, appeared intimidating and precluded any opportunities for discussion or questioning.

When Peter was conceived, we knew that there was no chance to reverse the Caesarean trend for a natural birth experience. The obstetrician advised us that after two operations, the uterus may not be able to withstand the stress of labour, therefore Peter was delivered by an elected Caesarean on 17 November 1984.

The Department of Human Sciences at Loughborough University taught me many relevant skills - basic ergonomics, postures, biomechanics, task design, system design, and the management of change. Through my involvement with the Pinderfields Hospital in Leeds, where I undertook a study to design and evaluate a computer system for intensive care, I began to realise that the medical model in patient treatment - like most other human sciences - is not a perfect or absolute science. Prognosis and diagnosis of symptoms are seldom absolute. There appears to be no absolute objectivity. The medical model in the identification and treatment of symptoms is a science as well as an art which, to some extent depends on the experience and intuition of the clinician.

There are many similarities in the management of patients in intensive care and in childbirth in terms of the reliance on the medical model for prognosis and diagnosis. In both cases, there is a total dependence on drugs and technology, along with strict hospital protocol and patient management routines.

The only difference - a significant difference - is that childbirth is a healthy and natural process which is increasingly being treated as an illness under the medical model. In all natural and uninhibited birth a woman assumes a variety of postures instinctively and intuitively rather than choose to confine in bed, as the medical model for the management of labour will prescribe.

In a hospital setting, whether in intensive care or the labour ward, many clinical procedures and practices, such as patient examination and operation are depicted by the design and availability of the tools and equipment. As in industry setting, poor equipment and system design will predispose a task to be performed ineffectively and will affect the subsequent quality of the system goal.

It was with this personal background, interest in ergonomics and industrial design and my desire to make childbirth physiologic and holistic that the present study was undertaken.

1.5 SCOPE OF THE STUDY

While this study has emphasised the application of the macroergonomic system approach, it does not set out to be a clinical study of childbirth. Such an undertaking is beyond the scope and resources of the present study. However, the effects of medication and technology on both mothers and babies are analysed to highlight their interdependence with posture, physiology and the way labour is controlled.

It is recognised that clinical factors such as maternal blood loss, perineum integrity of the mother, the baby's Apgar scores and oxygenation are some of the indicators used in current researches to measure labour outcomes. While these indicators, are still inconclusive and fuzzy, they are accepted as valid and needed within obstetrical and midwifery scholarship.

The obstetric body support system is designed with the expectation to improve the quality of childbirth. It is, however, considered neither necessary nor appropriate for an ergonomist/ designer to conduct experimentations on the clinical aspects of childbirth due to obvious ethical and accountability reasons.

The ergonomic factors and design elements - rather than the already well-researched and well-documented clinical emphases are considered to be a more appropriate and worthwhile undertaking. There has been no major research study in obstetrics that approaches the subject in an ergonomic and design direction.

The study and its findings are presented with the aim to encourage women to approach pregnancy, labour and childbirth with confidence, enjoyment and spiritual fulfilment. The contribution of ergonomics and design is presented in practical terms to demonstrate the symbiotic nature of the two disciplines. Perhaps more importantly, the study has been carried out with the expectation that women as well as men, caregivers and clinicians are made more aware of the complexities surrounding childbirth. It is hoped that ergonomists and designers who may read this report will become interested in this area of research work to extend the current study with the aim of establishing natural birth firmly in the contemporary obstetric culture.

1.6 STRUCTURE OF THE THESIS

Chapter One introduces the reader to the aims, background and scope of the study, along with the changing practices in childbirth and the application of ergonomics to address some of the problems prevalent in modern obstetrics.

Chapter Two reviews the current obstetric culture in the management of labour and childbirth. The use of drugs, intervention and possible iatrogenic risks are critically reviewed along with the management of labour under the medical model in hospital settings.

Chapter Three reviews the historical, scientific and ergonomic aspects of birth postures and their effects on the maternal mother and the foetus. The advantages and disadvantages of the upright and supine positions for childbirth are critically discussed.

Chapter Four introduces the reader to the Ergodesign Approach in system design and reviews some of the major developments of Ergonomics and Design - as sciences and as technologies - during the past 50 years of their inception. "Ergodesign" is advanced for the first time in this study as a robust and synergistic approach for solving ergonomics and design problems in the design and development of the Obstetric Body-Support System.

Chapter Five describes and discusses some of the models of design and demonstrates in detail the ergodesign approaches and processes used in the design and development of the Obstetric Body-Support System.

Chapter Six describes the methods and procedures of the evaluation of the Obstetric Body-Support System in a comprehensive process involving mothers, midwives and obstetricians. Results of the evaluation are presented and discussed in this Chapter.

Chapter Seven is a reflective discussion of the study. The aim is to highlight values, beliefs, politics and disciplinary issues encountered and experienced during the study.

Chapter Eight concludes and sums up the major findings, together with a plan for future work to extend the present study.

CHAPTER TWO

OBSTETRICS AND CHILDBIRTH

2. CURRENT OBSTETRIC CULTURE

REVIEW OF THE RELEVANT LITERATURE

Modern obstetrics is based on the assumption that birth is made safer by the use of advance science and technology. However, when research findings are impartially analysed, it is consistently acknowledged that on balance birth is made less safe by the indiscriminate use of drugs and technological interferences (Tew, 1986). Many procedures in the management of labour and birth have not been scientifically proven to be safe and "the history of obstetrics is, according to Odent (1985), a catalogue of futile and dangerous manoeuvres".

The increasing frequency of obstetrical interventions in hospital carry a great risk of complications for mother and baby. Recent trends in mortality and morbidity rates of hospital births have alarmed many researchers, for example, Tew (1986), Houston (1985), Young (1982), Odent (1985), and many others who are calling for a critical evaluation of the management of labour and childbirth in hospitals.

Traditionally, childbirth has always been considered as a spiritual and physical event. The mother's psychological and emotional feelings of her labour were considered to be of significant importance. However, in modern hospital birth today the spiritual dimension of birth is somewhat repressed and the psychosocial influences are sometimes ignored. Childbirth in hospitals is no longer regarded as a normal physiological function in which the mother could actively participate.

The underlying problem seems to be an attitudinal one. Labour and birth are no longer seen as a normal physiological function initiated and controlled by the woman's body, but as an illness requiring hospital intervention, sophisticated technological aids and medications. Obviously, a small percentage of births - about 10% will probably require this kind of attention, but according to most authorities, there is no reason for the majority of births to be treated as potentially high-risk cases (Junor and Monaco, 1984).

As cited by Inch (1985), Professor Kloosterman, Chief Obstetrician of the Amsterdam Teaching Hospital, points out that 80-90% of women are capable of delivering themselves normally without any help. He went on to say that "spontaneous labour in a healthy woman is an event marked by a number of processes which are so complex, so perfectly attuned to each other that any interference will only detract from their optimal character ...". He feels that the doctor or midwife who is always on the lookout for pathology and eager to interfere will much too often change physiology into pathology.

While the safe delivery of mother and baby has always been the principal function of the obstetrician, many of the practices are now in question. According to Brackbill, Rice and Young (1984), many of the obstetrician's practices are carried out primarily because they are part of medical and hospital tradition. They claimed that since the 1950s many artificial practices have been introduced as a matter of routine which have changed childbirth from a physiological event to a very complicated medical procedure in which all kinds of drugs and mechanical interventions are used - sometimes unnecessarily. Many of them are potentially damaging to the baby and even to the mother.

Concern for the indiscriminate use of drugs and mechanical interventions has been expressed in many countries, especially in the US, Europe and Canada (WHO, 1985).

The World Health Organisation (1985) highlighted some of the problems which persist in obstetrics:

- The scientific understanding of many of the fundamental biological processes in pregnancy and birth is deficient.
- The attempts to predict which pregnant women will have trouble have, to a large extent, failed.
- Screening tests for use during pregnancy have gone into widespread use without proper evaluation.
- Birth has been "medicalised" and the technology used has itself given birth to more technological intervention.
- It is no longer known what normal (ie. "non-medicalised") birth is.
- Women often have very little choice over what will happen to them and their babies.

The report points out that "It is frequently forgotten that the large majority of pregnant women could have a completely uncomplicated pregnancy and birth, and a healthy newborn baby, without any medical intervention". Because of the attempt to reduce the perinatal mortality rate for babies, about 990 childbearing women out of 1,000 are "subjected to extensive, intensive and expensive clinical procedures in an attempt to save the 10 babies who die". This is in spite of the fact that there is little scientific evidence that these procedures could have helped those who die, or the greater proportion of the 990 who live.

2.1 FREQUENCY OF OBSTETRIC INTERVENTIONS AND RISKS

While this is not a clinical study, an inkling of the scale of the problem regarding the routine use of drugs and technological interventions for labour and birth will heighten our realisation of the importance for the design of an alternative or improved system for the management of birth in New Zealand.

Table 2.1 on page 18 shows the result of a study conducted by Mehl (1977), to assess the extent of obstetrical interventions and the subsequent risks for births in a traditional hospital. In the study, Mehl compared 1,046 hospital births with an equal number of home births. All the women in both groups were considered to be "low-risk" pregnancy (that is, there are no complicating factors that may lead to difficulties with the birth). The two sample groups were further matched on several other variables: maternal age, education, socio-economic status, number of previous births and number of prenatal risk factors. Among the women in the home birth sample, 66% chose a family physician as their birth attendant, 31% chose a lay-midwife and 3% chose a nurse-midwife. All mothers in the hospital birth sample were attended by an obstetrician or a family physician.

The outcome shows that while the infant mortality rate was not significant - all morbidity measures favoured babies born at home - that is when the least drugs and technological interventions were used.

Babies born in hospitals far exceeded babies born at home in respiration distress, poor Apgar score, birth injuries, neurological abnormalities, infections and the need for resuscitation and oxygen. Forceps were used 21 times more frequently in hospital births. Mother's data indicates that hospital births - as can be expected - were characterised by the alarmingly

high frequency use of medication and Caesarean which is three times higher. Despite the fact that episiotomies were also almost nine times higher, lacerations were still substantially higher for hospital mothers. Postpartum haemorrhage was also about three times higher following a hospital birth.

TABLE 2.1 MATCHED HOME AND HOSPITAL SAMPLES		
Outcomes for Matched Home and Hospital Samples		
Babies	1,046 Home Births	1,046 Hospital Births
Neonatal death	0	1
Respiratory distress	1	17
Resuscitation required	14	52
Oxygen required	13	93
Poor Apgar scores		
1 minute postnatal	56	116
5 minutes postnatal	11	23
Birth injuries	0	30
Forceps	17	363
Neurological abnormalities	1	6
Infection	2	8
Mothers	1,046 Home Births	1,046 Hospital Births
Oxytocin	69	172
Analgesic drug	14	555
Anaesthetic	35	803
Episiotomy	103	914
Laceration	170	223
Caesarean section	28	86
Postpartum haemorrhage	9	25

(Mehl, 1977)

2.2 SOME LONG-TERM EFFECTS OF DRUGS

Recent research has indicated that the long-term effects of analgesia and anaesthesia drugs on the newborn baby are profoundly more alarming. Some of these dangers are reviewed below.

Obstetric drugs can have long-term effects on the newborn baby. Brackbill (1979) analysed the data of 53,000 women who gave birth at 12 different teaching hospitals from 1959 through 1966. From this, 3,500 women who were the "healthiest" and who had the most uncomplicated pregnancies, labours and deliveries - to rule out the possibility that the babies might have been born damaged due to complication in pregnancies or deliveries - were selected for further investigations.

Obstetric medications were found to affect the children's behaviour at least through seven years of age. Among the older children whose mothers had received drugs during labour and birth, there were low reading and spelling scores, and lower scores on a visual-motor test.

In a different study Haire (1978) asserts that a large percentage of learning disabled and handicapped children result from obstetric practices which interfere with the normal biochemical checks and balances provided by nature to assure the normal progression of labour and a good maternal and infant outcome. She adds that she and many other individuals working with brain-injured children, believe that a large proportion of brain-injured and learning disabled children are the result of obstetric drugs administered to induce or stimulate their labour. Most women are unaware that obstetric drugs diminish the supply of oxygen to the unborn baby's brain and can result in brain damage.

One in every 35 children born in the United States today will eventually be diagnosed as retarded; in 75% of the cases there is no family or genetic predisposing factor; one in every 10 to 17 children has been found to have some form of brain dysfunction or learning disability requiring special treatment. Such statistics are not confined to the lower socioeconomic group but cut across all segments of American society (Brackbill, Rice and Young, 1984).

New concerns are being raised by childbearing women because no-one knows what degree of oxygen depletion, head compression, or traction by forceps, the unborn or newborn infant can tolerate before the child sustains permanent brain damage or dysfunction. The recent findings regarding the cancer-related drug diethylstil-bestrol have alerted the public to the fact that neither the approval of a drug by the US Food & Drug Administration nor the fact that a drug is prescribed by a physician serves as a guarantee that a drug or medication is safe for the mother or her unborn child. In fact, the American Academy of Paediatrics Committee on Drugs has recently stated that there is no drug, whether prescription or over-the-counter remedy, which has been proven safe for the unborn child (Brackbill, Rice and Young, 1984; Phillitteri, 1985).

Drugs are widely used during pregnancy, labour and delivery in America. As a result babies die more frequently from causes relative to the amount of medication given to the mother in that country than in any other country. A United Nations survey (1972) of 13 countries showed America as having the highest infant mortality rate, of 5.5 in every 1,000 live births, due to post-natal asphyxia and birth injuries - conditions "which are more likely to occur if the mother has received obstetric medication" (Haire, 1972).

Anaesthetic drugs such as epidurals often lead to further interventions. A woman with no sensation in her pelvic floor has much less ability and desire to push during labour. According to Savage and Simkin (1987), approximately 65-75% of the women who receive epidurals for pain relief also require the use of forceps to deliver their babies. This rate contrasts significantly with unmedicated women where the use of forceps is between 4-21%.

With regards to infant mortality rates they cite a research by Dr Emanuel Friedman, which indicated two infant deaths per 1,000 spontaneous deliveries, compared with 11 deaths per 1,000 deliveries with midforceps and 29 deaths per 1,000 deliveries if midforceps were used at the end of a long labour.

Children who were delivered by midforceps also had a much greater incidence of hearing and speech disorders. At age three the impairments occurred at a rate of 33 per 1,000, compared with 6 per 1,000 among children who were born by normal vaginal birth.

2.3 SCIENTIFIC MANAGEMENT OF LABOUR

The ramifications of introducing new technology in obstetrics without due respect for the less tangible system component - human factors - has been alluded. The current development in obstetrics has predominantly been technologically-centred, leading to the reorientation of childbirth being managed by a technological process rather than the reliance on the natural physiological process.

Concern in the practices of modern obstetrics appears to be centred in four main related areas:

- routine and indiscriminate use of drugs
- unwarranted frequent use of surgical interventions
- the assumption of pathology in pregnancy and childbirth
- the risk of complications in hospital birth

Much of the cause for the problems outlined above seem to have stemmed from the inflexible approach of the profession, which in turn has originated from the influence and rigid adherence to the "scientific management" principles. There is much evidence of industrial engineering and time and motion studies in the processes of modern obstetrics.

Labour is often time-managed in a routine assembly line manner, where the women unprepared, frightened and passive, are transferred from the early labour room, to the advanced labour room, to the delivery room, to the recovery room, to the postpartum room (Korte and Scaer, 1984).

In a similar vein, Savage and Simkin (1987) add that when the women arrive at the hospital they are often unprepared, passive and frightened, are sent to the labour room, given a hospital gown, given an enema and a pubic shave, given a Pitocin to stimulate labour contraction, given a scopolamine to induce an hallucinogenic haze, confined to bed, forced to use a bed pan, hooked up to an intravenous, and wheeled to the delivery room her doctor performed an episiotomy and delivered the baby by forceps. This is unnatural. In nature the labour and birth of a child would never need to go through such a routine.

"Too many hospitals are like factories, inhospitable, cold, but most of all quick. Quick efficient assembly-line babies born into sterility. Needle and blades and masks." (Brook, 1985)

2.4 DELIVERY POSITIONS

The traditional position for a woman giving birth in a hospital delivery room is on her back, with her legs in stirrups - the position we often see in films, TV or books. This is called the lithotomy position.

The position which is preferred by many obstetricians is considered by Dunn (1976) to be the worst conceivable position for labour and birth.

Yet, women giving birth in hospitals are routinely put in the lithotomy position. The only reason for this posture is that it facilitates intervention procedures such as episiotomy and the extraction of the baby by forceps.

Dunn (1976) asserts that the lithotomy position for labour and childbirth is the major contributing factor that predisposes a woman to a chain of physiological dysfunctions, that necessitate drugs and surgical remedies - to compensate for the loss of postural and physiological efficiencies - thus, creating the "lithotomy-drug-surgical" interdependency syndrome.

Figure 2.1 on the next page shows the lithotomy-drug-surgical syndrome. The syndrome implies that it is difficult to use any obstetric intervention in isolation, they are not independent of each other. Usually one intervention will lead to the other, so that the use of the first intervention increases the probability that a second is necessary, which in turn increases the probability of a third and so on. Brackbill et al (1984) refers to this interdependency as the "intervention daisy chain" and Inch (1985) calls this the "cascade of intervention".

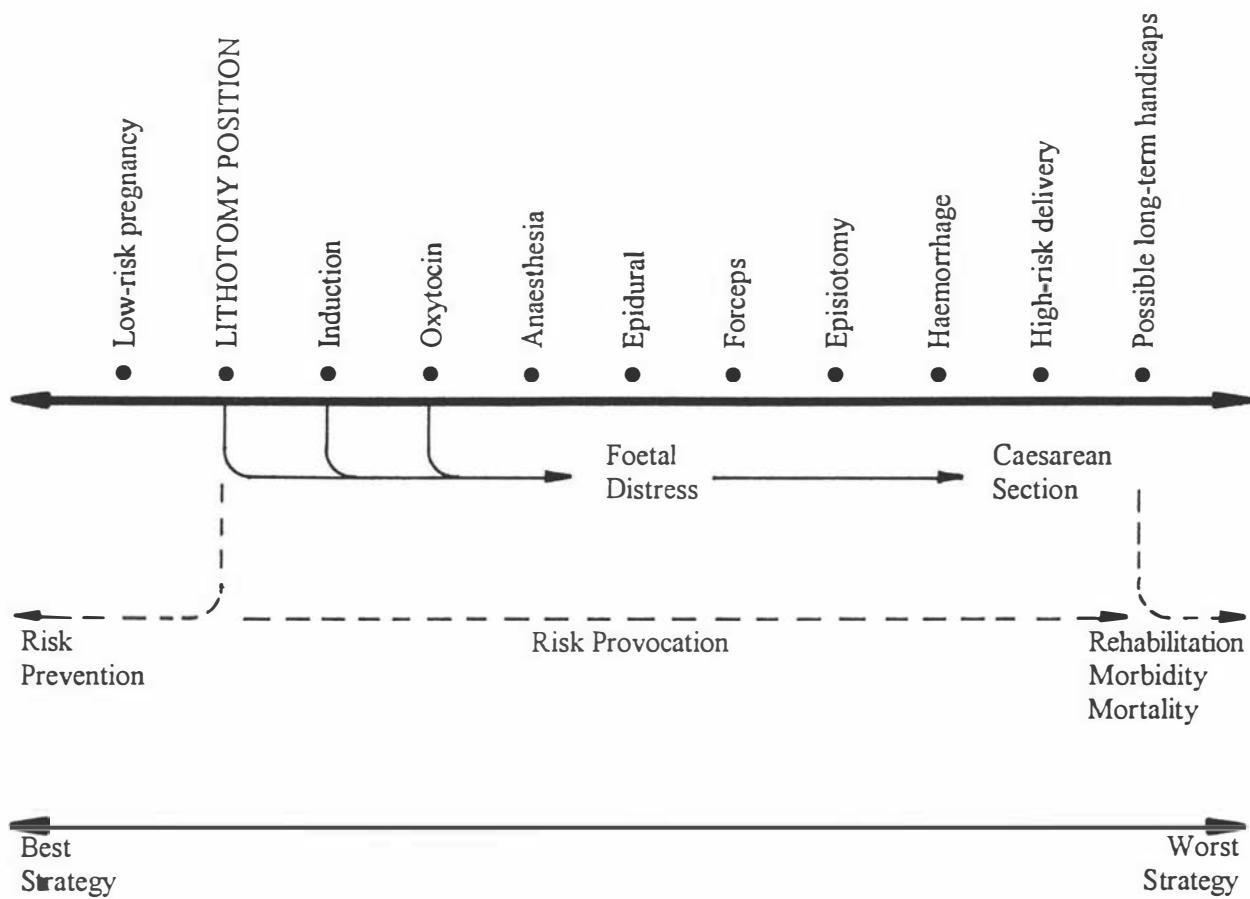


FIGURE 2.1 LITHOTOMY-DRUG-SURGICAL SYNDROME

According to the lithotomy-drug-surgical syndrome, for example, when labour is not efficient due to the lithotomy position, it will be induced, the contractions will then have to be monitored electronically, if the contractions are too weak oxytocin will be administered to increase the rate, when the contractions get too strong, Demerol or an epidural will have to be administered to relieve pain, if the foetus becomes distressed - as it so often does, an emergency Caesarean will be performed to relieve it and so on.

2.5 PSYCHOPROPHYLAXIS

Childbirth has always been a frightening and lonely experience in which technology is playing a greater role than nature. This need not be the case. Given adequate education and preparation, and an awareness of the options which are available, childbirth can become an exhilarating and joyous experience.

Many childbearing women are now demanding a more holistic birth, incorporating psycho-spiritual awareness, natural medicine, but above all a Natural Birth - where a woman "surrenders herself to primitive instinctual pleasure and wellbeing of the body and the harmonious functioning of her physiological processes" (Kitzingen, 1985). Here "psychoprophylaxis" can help.

"Psychoprophylaxis" - meaning "mind prevention" or "mental prevention" of discomfort, stress, fear and pain during labour and birth is now gaining increasing use in antenatal classes in many parts of the world. This is called the "Lamaze Method" - after Fernand Lamaze who popularised the psychoprophylaxis method in childbirth in France (Savage and Simkin, 1987).

The Lamaze method is based on several principles (Savage et al, 1987). The most important is that education dispels fear. Dick-Read (1942) believes that there is a fear-tension-pain syndrome in relation to childbirth. His theory is that since pain is psychologically oriented, pain in childbirth is basically the result of centuries of brainwashing and could be relieved in labour by first clearing the distortion of misrepresentation. He wanted birth to be more conscious, spiritual for the woman. He changed the words "uterine pain" to uterine contraction (Brook, 1985).

The Lamaze method prepares women to dispel the fear-tension-pain syndrome by educating the woman for the realities of childbirth. Lamaze students are taught relaxation techniques to counteract muscular tensions - the natural response to pain. The method also includes a series of breathing exercises designed to help women cope with the pain of labour.

2.6 HUMANISING BIRTH

Recent scientific discoveries about the physical vulnerability of the foetus and the psychological needs of the newborn infant, have sensitised our behaviour towards childbirth (Verny and Kelly, 1987). The new importance currently given to mother-infant "bondings" are heightening our awareness of the crucial moments immediately after birth for both the mother and the infant, and the physical environment into which the baby is born.

French obstetrician Frederick Leboyer describes the delivery and handling of the newborn baby in hospital as "the torture of the innocent" (Laboyer, 1983). In his book and film of the same name - Birth Without Violence - he alerts our attentions to the "birth trauma" and violence inflicted unthinkingly on babies by many traditional procedures. He advocates that the environment where the baby is born should be highly sensitive to what is happening and try to feel with the newborn person. He maintains that the baby must be introduced to the new physical sensation of the world - gently and unhurriedly - to minimise the physiological trauma. He suggests changing newborn management by using the following environmental conditions and procedures:

- low, indirect lighting
- room temperature adjusted to the newborn's comfort
- quietness and minimum talking during the birth process
- gentle handling of the new baby by the hospital staff
- immediate placement of the newborn on the mother's naked abdomen after birth to promote immediate "bonding"
- delay in clamping the umbilical cord until pulsations have ceased
- gentle massage of the new born body
- immersion of the newborn in a warm bath with gentle support by the mother, companion or practitioner
- no active stimulation or resuscitation measures unless specifically indicated

Laboyer believes that with these measures, the fear and pain of birth that the baby experienced will be replaced by peace, comfort and happiness. The key element in this type of birth is the avoidance of unnecessary interventions in spontaneous birth so that the transition from the mother's body will be smooth and non-traumatic (Young, 1982).

The relevance of 'gentle birth' can only be understood in the light of current theories concerning the psychological effects of birth traumas. Brook (1985) reports "that great psychologists and psychiatrists like Carl Jung, Sigmund Freud, Otto Rank, Theodor Reik, Wilhelm Reich, and now R. D. Laing, have had their own specific theses on how and why birth affects us so deeply and sets up patterns of behaviour for our entire lives, unless something is done to change the imprint".

It has been found that common symptoms of schizophrenia, most particularly those known as "auditory hallucination - hearing voices" - directly correlate with the altered state of consciousness shortly before or shortly after birth (Johnson, 1971). By taking schizophrenics back to their earliest experience of life under the influence of drugs, in a process akin to "rebirthing" or "regression therapy", Johnson concluded that the altered state of consciousness is caused by shock, acute pain, fever, concussion and anoxia (lack of oxygen). She thinks that schizophrenia reflects an auditory memory of something first experienced in the womb or the birth canal, and because the babies can hear during pregnancy and hear even more clearly during the traumatic trip through the birth canal, the secret voice of madness may be the repetition of sounds heard while being born.

Her point was that there are certain high-risk factors that could be avoided; for instance, conditions which might contribute towards dysfunction in the central nervous system of the foetus during the last few weeks of pregnancy, traumatic labour and delivery, and complications in the period immediately after birth, such as emergency surgery, drug reactions and toxicity.

Brook (1986) maintains that it is possible that autistic children actually choose to keep quiet, not wanting to express themselves, because their

feeling was stifled at birth. They were cut off at the umbilical cord too suddenly.

With the effects of a traumatic birth in mind, our whole attitude in the management of birth must change. Hurd (1980) suggests that the main criteria must be that of health rather than illness, within an environment in which childbirth is appreciated as a cornerstone of family development, and the family as the cornerstone of society. The best way to accomplish this is to look back at the basic principles of birthing and childcare in the developing countries in order to go forward in understanding and fostering the human needs of families (Kennell, 1980).

Childbirth is in the midst of a revolution. If anyone can take it further, shake orthodox medical practice to its roots and rebuild confidence in childbirth, it is the women and the midwives. With the commitment towards substituting expediency with tenderness, machines and devices with loving people, we can change the way we manage birth (Brook, 1986).

Indeed, Laboyer has already initiated this change. At Pithiviers, France, Odent (1985) is now following his lead. Besides discarding drugs and conventional techniques as Laboyer did, Odent introduces "gentle birth" in the public health system at Pithiviers where there are no rules to regulate the woman in the way she gives birth. Instead she is encouraged to "listen" to what her body tells her to do and to react instinctively both in the birth process and the spontaneous welcome of her newborn baby. This is natural birth.

Here, at Pithiviers, the Caesarean rate is only 6.6%, episiotomies 6%, forceps are never used but, vacuum extraction is only 5.2% and babies needing special care is only 1.5% (Balaskas, 1986). The improvements compared with traditional hospitals have been spectacular.

2.7 THE BIRTH PROCESS AS DESIGN CRITERIA

For the purposes of analysis, we consider the birth process in several distinct sequences to establish ergonomics and design criteria.

In the birth process, the factors involved are the expelling powers, the passages and the passenger (Bailey, 1972). The expelling powers include the involuntary uterine contraction; the voluntary efforts of the abdominal, diaphragmatic and thoracic muscles; and the contraction of the levator ani muscles. The term "bearing down" is used to describe the woman making a voluntary effort to expel the baby after the cervix becomes fully dilated.

The passages are comprised of the hard part - the maternal bony pelvis and the soft parts - the lower segment of the uterus, the cervix uteri, vagina and the pelvic floor. The parturient or birth axis is the direction that the infant follows as it passes through and out of the pelvis. As it will be discussed later, the birth passages present considerable design constraints in the development of the maternal pelvic-support.

The foetus is the most important passenger, but the after-birth - the amniotic fluid, the placenta, the cord and membrane are also expelled.

The hard parts of the foetus are his head, shoulders and hips. The head is the most important part because of its size and its relative rigidity. The cranial vault is compressible, but the face and the base of the skull are not.

2.7.1 Design Considerations

From a design viewpoint, the voluntary and involuntary contractual powers; the anatomy and anthropometry of the birth canal; the foetus and the after-birth constitute the most important factors on which the design

must be based. In other words, given that the birth processes are not amenable to change - they are the major "human factor" problems that have to be solved by the interface design. From here the following criteria have been established.

2.7.2 Physiological Postures for the Expulsion of the Foetus and the After-Birth

After the cervix is fully dilated and the membranes ruptured, the second stage of labour begins. There are various upright birthing postures that are physiologically advantageous and effective in expulsive efforts. The squatting, semi-squatting and the sitting postures have been widely used and have been proved to be significantly physiologic. According to many experts, for example Dunn (1976); Odent (1985) and Balaskas (1985), even if these postures are not predetermined, instinct or the discomfort and pain during uterine contraction will guide a woman to adopt these advantageous positions for labour and birth.

2.8 THE BODY-SUPPORT SYSTEM

While at this early stage no preconceived idea has yet been determined, a body-support system with some features resembling an office chair is envisaged. For the moment, let's refrain from calling it a "birth chair" to avoid preconceived mind-set hence, a more general term, the "body-support system" will be used.

The common upright postures adopted for childbirth - sitting, squatting and semi-squatting are somewhat akin to the work postures adopted in industry. For instance, with some modifications an office chair could support a sitting birth posture; a kneeler chair could support an adapted squatting birth posture, and the semi-squat birth posture could be supported with an

industrial stand-sit chair - so could the forward-sloping seat proposed by Mandal (1981) support the semi-squat posture. These similarities provide extremely important references for this investigation.

The accumulated technologies through the years - such as under-thigh pressure, position of lumbar-support and pressure distribution under the ischial tuberosities and across the seat; and the methodologies that have been developed for subjective comfort evaluation are also invaluable factors that may be applied to the development of the body support system.

2.8.1 Postural Variations

The body support system should be designed to enable a woman to make adjustments and to adopt some postural variation. An effective lumbar-support for the maintenance of lordosis during the second and third stages of labour is also important.

2.8.2 Pelvic-Support

One of the most challenging and crucial features of the body-support system is the analysis and development of a pelvic-support that will promote comfortable supports to the mother and permit a foetus to be expelled safely from the birth canal - simultaneously.

For comfortable birthing the pelvic-support must be designed to support the body weight of the woman directly on the ischial tuberosities. However, a support structure for childbirth must be markedly different from a seat designed for normal sitting. Essentially, a support that allows a foetus to pass safely from the sitter's birth canal must have an opening or void around the woman's perineum (the area surrounding the vagina and between the vagina and the rectum).

When a person sits on a chair, the bulk of the body weight is "spread" on the buttocks and the thighs. The pressure around the ischial tuberosities on a support structure - with a reduced surface area would increase significantly. Hertzberg (1955) has indicated that the pressures under the ischial tuberosities can reach up to 4,218 g/cm² (60 lb/inch²) in certain body types. Tichauer (1978) has demonstrated that the pressures could be even higher.

From the standpoint of ergonomics, the compatibility of such a support structure for childbirth must be considered in relation to the anthropometry and anatomy of the pelvic outlet - the pelvis, the birth canals, and the entire perineal region.

The ischial tuberosities are approximately 25mm (1 inch) in width and 40-50mm (1½-2 inches) in length. They vary in span from 120-160mm (4¾-6¼ inches). Fortunately the bi-ischiatic diameter of women tends to be larger than those of men, generally by about 20mm (¾ inch) (Kira, 1976).

This indicates that the maximum void to allow the foetus to pass through - on the transverse axis of the ischial tuberosity can be no larger than 75-90mm (3-3½ inches), since for comfort, the ischial tuberosities must be fully supported.

These dimensions and anatomical relationships may present very tight constraints to the design of the pelvic-support. While the cervix, which forms the lower third of the uterus, enters the vagina at a right angle (Verralls, 1977), and that the vagina is slightly off-centre of the perineal region - this may be insufficient to compensate for the critical dimensions surrounding the ischial tuberosities in relationship to the siting of the birth outlet and the size of the foetus.

However, such anatomical problems seem to be not entirely insurmountable. The major criteria are effective body support, exposure of the perineal region and comfort. These criteria may be achieved by tilting the body support system so that the woman is sitting-squatting in a slightly reclining posture - transferring the bulk of the bodyweight to the back support - thereby, relieving the pressures on the ischial tuberosities. More importantly, from an ergonomic point of view, the pelvic outlet is rendered more accessible for the foetus as well as the birth attendants. The provision of foot, thigh, arm and hand supports will further alleviate the pressures on the ischial tuberosities. They will also stabilise the birthing posture and contribute to the improvement of the 'pushing' power during bearing down.

2.9 PSYCHOLOGICAL CONSIDERATIONS

It would be deficient to base ergonomics and design criteria primarily on physiological and biomechanical aspects for the design of an equipment for use in a process as spiritual and emotional as childbirth. The human factor problems that may arise from the human-machine interaction are many and diverse - ranging from "knobs and dials" questions to other more complex interface compatibility of a new design. Therefore, it is important that the psychological aspects of childbirth are also analysed and considerations be duly given to the subjective factors such as the satisfaction and pride, joy, comfort and enthusiasm of using the equipment.

The woman's acceptance, confidence and motivation are the main psychological criteria for the design of the body support system. This can only be achieved if the equipment is simple, convenient, attractive, reliable, safe and "friendly" to use.

2.10 FAMILIARISATION PROGRAMME

The literature indicates that many women are naive, awkward, embarrassed and distressed about the birth process (Balaskas, 1985; Brook, 1986; Kitzinger, 1986). The user's fear and unfamiliarity of any new equipment or system must not be overlooked. It must be overcome by compatible man-machine interface design and other user-supports - such as education and training - to aid and assist the complex and yet delicate function of childbirth. This is an important aspect of system-thinking that must concern an ergonomist as much as a designer.

Hence, the design and development of a standard training programme, backed by an instruction manual that discusses the basics of the upright physiologic birth and the correct use of the body support system must be considered as an integral part of system implementation.

CHAPTER THREE

BIRTH POSTURES

3. ERGONOMICS OF BIRTHING POSTURES

REVIEW OF THE RELEVANT LITERATURE

The basic philosophy of ergonomics - in terms of biomechanics - considers the human being to be an organism subject to two different sets of laws: the laws of Newtonian mechanics, and the biological laws of life (Tichauer, 1978). The philosophy highlights the importance that human activities are surrounded by the external physical environment; and inside the human body the 'internal biomechanical environment' or the musculoskeletal system - which responds to the demands of the activity.

Posture is an important criterion for all biomechanical functions and the design of equipment, workspaces and work procedures. It affects the worker's ability to use equipment, reach, hold, push or pull, and it influences the length of time an activity can be performed without adverse health effects such as fatigue and cumulative disorders or diseases.

There are many examples of cumulative diseases or injuries caused by prolonged and repetitive loading of the same group of muscles under unnatural postures. For example, back injuries and various forms of overuse injuries in industry (Corlett, 1983).

Where an activity or posture is assumed to satisfy only the technical requirement, engineering criteria or other constraints, functional inefficiency, fatigue and diseases may arise. In order to improve the situation, criteria for designing work

activities and the resulting posture must be based on the body's requirements as a living organism (Corlett, 1983).

The study of posture is related to the wellbeing and effective performance of the operator at work. In this context, the relationship between posture, physiology and biomechanics promises tremendous scope for the analysis and study of childbirth - since labour is a physiological process which efficiency is dependent on good postures.

The study of physiological costs - as measured by oxygen consumption, or heart rate in relation to physical activities and postures - is perhaps one of the earliest fields of interest in ergonomics which has provided predictive models for dynamic work.

During the past 40 years or so, most aspects of postures have been extensively explored. Very comprehensive standards and guidelines for sitting, lifting, pushing and pulling; and design criteria for chairs, computer workstations, cockpits, etc are now readily available.

In recent years, many new techniques and new methods have been developed for the analysis of postures. The increased sophistication of biomechanical analysis and instrumentation have also contributed greatly to this research, as well as the health and wellbeing of workers.

Much of the existing research work, however, has been concentrated on the work-related aspects of postures. The major areas of research have been work physiology, manual material handling and sitting. The aims of most of these studies have been for the prevention of lower back injuries and other musculoskeletal diseases, safety and efficiency (Bendix et al, 1976; Corlett and Bishop, 1976; Graudjean et al, 1983; Karhu et al, 1977; Mandal, 1981).

Some postural aspects of childbirth have been investigated. For example, Jordan (1980) investigated the birthing postures in relationship to the anthropological aspects of four different cultures and Englemann (1882) studied extensively the birthing postures of primitive people around the world.

The physiological aspects of a variety of birth positions have also been studied by a large number of obstetricians and clinicians. These investigations have been predominantly concerned with the efficiency of labour, drugs requirements, loss of maternal blood, etc. They were mainly medical and clinical studies (Atwood, 1976; Balaskas, 1985; Caldeyro-Barcia, 1979; Dunn, 1976; Gupta et al, 1987; Howard, 1958; Liu, 1974; Odent, 1985).

Most of these studies were of a very narrow, albeit, specialised area. Collectively, the problems surrounding childbirth have been extensively investigated by a multitude of disciplines over many hundreds of years. However, no other studies have been found in the literature which examine the subject in a true integrated or interdisciplinary approach. There were also no studies found which address childbirth in an ergonomic approach. Furthermore, in nearly all of the studies, no evidence has been found where the ease of use or compatibility of the equipment was considered to be important for the experiment.

Consequently, this study will examine some of these related issues in a more integrated perspective - and to demonstrate the interdisciplinary nature of ergonomics, and its closely-related discipline, industrial design.

Like most occupational activities, the postural and physiological problems affecting childbirth could be most appropriately studied within the confines of the human-machine-environment system - or the ergonomic approach. The application of ergonomics in obstetrics and childbirth allows the human-machine

and human-environmental interface problems - involving physiological, psychological and biomechanical factors - to be analysed, optimised and evaluated more scientifically.

3.1 HISTORY OF BIRTH POSTURES

"During labour, the Vestal Virgins assume their positions around the woman, leading her in a variety of magical incantations with rhythmic breathing to blow off the magic spirits of pain. Finally when the delivery is near, the Vestal Virgins position the woman in one of the most torturous of the culture's institutions, a special apparatus used only at the time of birth. In it the woman is made to lie flat on her back with legs and feet raised at a 90-degree angle and bent at the knee. It is thought that if a woman is able to deliver her baby in this almost impossible position, she will have passed the first initiation rites of motherhood."

The opening paragraph by Brown (1981), presents a scenario of how an anthropologist unfamiliar with the Western world might view the management of childbirth in our culture today.

Throughout the ages and until the mid-eighteenth century the maternal positions assumed by women of all cultures during labour and birth have been some form of upright posture, such as sitting, squatting, kneeling or standing (ICEA Review, 1978; Howard, 1958; Dunn, 1976; Englemann, 1882; Jordan, 1980; Hillan, 1985).

Prehistoric figurines, pottery and early illustrations of childbirth from Mesopotamia, Egypt, India, Greece and many other countries show the position adopted by the parturient woman to be predominantly - if not exclusively - upright. Etchings of childbirth by medieval artists also depict similar custom regarding birth postures.

The use of the birth stool dates back to around 2500 BC. It probably originated from the Egyptians and Jews, and its use spread to Europe via the Greeks and Romans (New Zealand Woman's Weekly, 1984).

Egyptian hieroglyphics and Peruvian pottery of the Mochila period depict women in the seated posture during childbirth, and the Bible refers many times to the Hebrew custom of giving birth upright. Genesis (30:3) describes a common upright position which is still widely used today: The woman would give birth with either her partner or a midwife seated behind her - supporting her back. The childless Rachel says to Jacob: "Here is my maid Bilhah; go in to her, that she may bear upon my knees and even I may have children through her". The Bible also describes Leah's holding her husband's concubine on her lap during delivery, thereby acquiring claim of the infant. In Exodus (1:15-16) The King of Egypt said to the midwives, "When you serve as midwife to the Hebrew women, and see them upon the birthstool, if it is a son, you shall kill him; but if it is a daughter, she shall live".

The upright position was used in antiquity through the Middle Ages, and until the mid-eighteenth century when Francois Mauriceau who was the obstetrician to the Queen of France replaced the sitting position on the birthstool to the recumbent position in bed to facilitate the management of labour, examinations and the use of Chamberlen forceps (Howard, 1958; Caldeyro-Barcia, 1979).

The recumbent position continued as the major posture for labour and delivery during the 19th and early 20th centuries when most births were taking place in the home. By 1975, around 95% of all women in Western countries had hospital deliveries. As hospital births increased, the bed was replaced by the delivery table, and the woman lay on her back in the

lithotomy position for the delivery. The use of the delivery table and lithotomy position has spread with time, to the most modern, and technologically advanced maternity hospitals of the world.

Throughout the past 50 years or so, in the study and investigation of maternal and foetal wellbeing, the horizontal position - recumbent, supine or lithotomy - has been regarded to be unnatural and unphysiologic for labour and birth (Dunn, 1976; Caldeyro-Barcia, 1979; Howard, 1958; Russel, 1969; Bond, 1973).

There appears to be widespread agreement in the literature that the supine position should be avoided because of the danger of supine hypotension. Gupta et al (1987) asserts that it has been known since Scott and Kerr (1963) that the weight of the gravid uterus on the vessels diminishes uterine perfusion in this position.

A return to the physiologic position was started by Forrest H. Howard in 1954 in New York. He delivered 219 babies in a modified sitting position, and reported that the delivery in the physiologic position, which is a sitting or squatting position, is practical, satisfactory from the mother's viewpoint, and should result in less intracranial damage to the child than is now encountered by the use of the various recumbent positions (Howard, 1958).

Upright birth postures - sitting, squatting, kneeling and standing - are now increasingly being accepted by many women, obstetricians and midwives as an alternative to the horizontal positions for labour and delivery (Caldeyro-Barcia, 1979; Oden, 1985; Bennett et al, 1993).

3.2 SOME ADVANTAGES AND DISADVANTAGES OF UPRIGHT POSTURES VS SUPINE POSTURES

In a process which is as complex as labour and delivery, it seems quite impossible to arrive at a concensus on any one "best" position for labour and birth. From the point of view of an ergonomist, any maternal posture must also be compatible with the difficult tasks obstetricians and midwives have to perform. Birth postures that hinder the management of labour could compromise maternal and foetal safety.

From a physiological perspective, research evidence has reported significant advantages of the upright positions with respect to labour efficiency, safety and comfort for both the mother and the baby.

Pavlik (1984), in a review of the literature, asserts that there is now unequivocal evidence that the supine position for labour and birth has many physiological disadvantages which can lead to problems such as a narrowing of the birth canal; compression of the maternal aorta, inferior vena cava, iliac arteries and ureters; loss of pelvic mobility; loss of the benefit of gravity; and diminished efficiency of contractions (Bond, 1973; Dunn, 1976; Howard et al, 1953; Kelley, 1982; Notelovitz, 1978; Pritchard et al, 1985). Figure 3.1 on page 43 shows the maternal aorta and inferior vena cava compressions caused by the supine position.

Supine hypotensive syndrome occurs in 10-20% of women when they are in the supine position. The weight of the uterus compresses the ascending vena cava, which in turn diminishes blood return to the right atrium with a resultant drop in cardiac output and maternal blood pressure (Howard, 1953; Pritchard, 1985). As foetal oxygenation is dependent on uterine blood flow, foetal hypoxia, brady cardia and acidosis may develop when the labouring woman is in the supine position (Goodlin, 1971; Whitley, 1985).

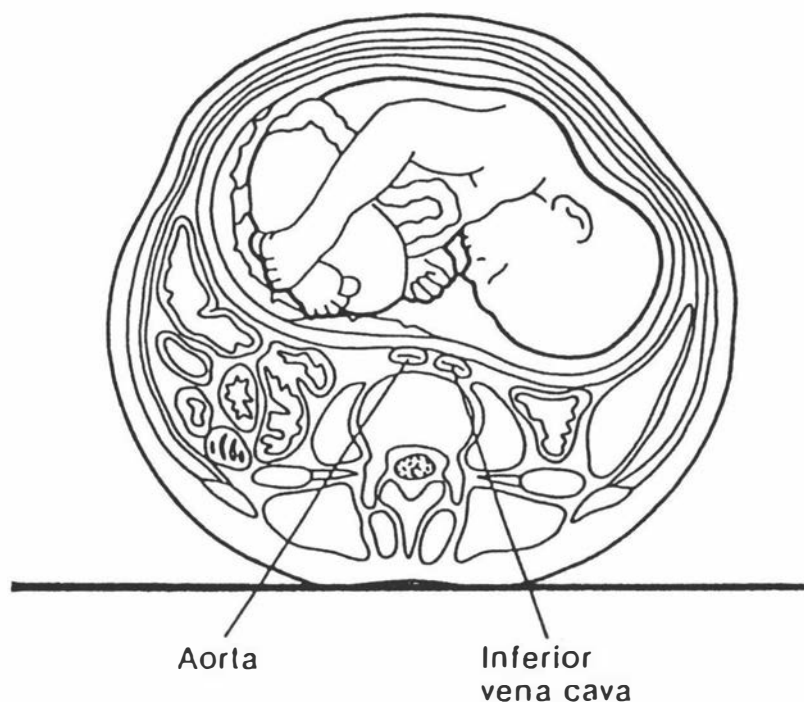


FIGURE 3.1 AORTO-CAVAL COMPRESSION IN THE SUPINE POSITION

According to Dunn (1976) the less physiological supine position which fails to use the forces of gravity may also result in greater discomfort and pain, slower progress of labour, maternal antepartum and postpartum haemorrhage and foetal distress. His famous and often quoted diagram "Consequence of the Dorsal Position During Labour" is shown on page 51.

Dunn opines that labour has always appeared to become "more difficult, more protracted and more painful" in the wake of "civilisation". He believes that the main explanation for this may lie in the posture adopted by the mother during labour. He quoted a British survey (source not mentioned) of women's view on the modern management of labour that, "women wanting to get into a good position for pushing were ... often not allowed to be propped up ... and commented that it was a great strain to hold their legs up while laying flat ... many found themselves trying to push uphill". He asserts that "No other animal species adopts such a disadvantageous posture during such an important and critical event", and women have every right to complain.

3.3 ANTHROPOMETRICAL, ANATOMICAL AND BIOMECHANICAL ASPECTS

In ergonomics balance, postural efficiency of all human activities is dependent on the capabilities and limitations of the musculoskeletal system, and the compatibility of the equipment.

Accepted customs which are not scientifically-based on anthropometrical, anatomical and biomechanical principles often exacerbate the inherent problems associated with the recumbent position. In the management of second stage labour, midwives, under the impression that they are assisting women to adopt a modified squatting position by encouraging them to put their feet on the attendant's hips at both sides of the bed may be doing more harm than good. The maximum distance between the feet when a woman squats naturally is 44mm (18"), and the width of the bed is 66mm (27") (Thomson, 1988). Beischer and MacKay (1986) questioned whether unergonomic wider abductions of the limbs women are encouraged to achieve is stretching the perineum laterally when both these need to be relaxed for labour and delivery.

In a letter to the British Medical Journal, Leak (1955), has expressed similar concern and questioned the effect of the lithotomy position on the perineum. He asserts that in flexing the thighs, the perineum is pulled forward, resulting in the tightening and narrowing of the orifice.

According to WHO (1985), an episiotomy rate of no more than 20% is necessary. However, Korte and Scaer (1984) reported an average episiotomy rate of 71% in a survey of 18 US hospitals. Reynolds and Yudkin (1987) reported an episiotomy rate of 44.7% for 1984 and 69.7% for 1981. These figures contrast significantly with the 6% being achieved

at Pithiviers, France, where mothers are encouraged to labour and deliver almost exclusively in the upright posture (Odent, 1985).

Obstetrical difficulties are characteristic of the human species. Odent (1985) explains that "even among tail-less anthropoids which stand upright, there are never any mechanical difficulties during birth because there is no real pelvic cavity and because the vulval orifice is not off-centre. Moreover, in all other primates apart from homo sapiens (humans), the transverse diameter of the pelvis is always larger than the biparietal diameter of the foetal head, just as the sagittal diameter of the pelvis is larger than the foetal occipitofrontal diameter, in particular among the three great anthropoids (the orang-utan, the chimpanzee and the gorilla); while the biacromial diameter (distance between the shoulders) is always distinctly smaller than the sagittal diameter of the pelvis".

"What characterises the human being is the permanent upright stance, the existence of a pelvic cavity with a hollow back, a hollow sacrum, a flat pubic symphysis and an off-centre vulval orifice. In humans the foetal occipitofrontal diameter (120mm) and the biacromial diameter (120mm) are larger than the sagittal diameter of the pelvis (105mm). The foetus therefore has to travel in a corkscrew motion during birth. Thus in the human species, even small variations in foetal and maternal dimensions are enough to produce foeto-maternal disproportion.... The fact remains, however, that most deliveries should be perfectly normal and advanced technology is itself very often a factor in foetal distress."

Given the inherent difficulties in birth, and the tight tolerances in foeto-maternal proportion, the importance of an efficient posture for labour and birth is highlighted and the physiologic upright posture is made more attractive.

3.4 SYNERGISTIC EFFECT

Anatomical and physiological studies have shown the efficacy of the upright, gravity-assisted position to be significantly more superior for labour and birth than the supine recumbent position. In the physiologic posture, the gravid uterus presses on the proprioceptors in the cervix and later in the pelvic floor - eliciting the Ferguson reflex - thus causing release of pituitary oxytocin (Nelsson-Ryan, 1988).

Mendez-Bauer (1976) claims that gravity can add 30-50mm Hg to the pressure exerted by the foetus head on the cervix in the first stage of labour and in the birth canal in the second stage of labour. In an experiment with 20 women who laboured in the upright posture and a control group who laboured in the horizontal posture, Caldeyro-Barcia (1979), reported that the experimental group had more efficient and intensive contractions, and the dilation of the uterus of the group was 1.7 to 1.9 times that of the control group. "In the upright position the effect of gravity on the foetus is synergistic with the effects of uterine contractions of bearing-down effort".

Inefficient uterine action is considered to be the major cause for prolonged labour, often leading to drugs and other interventions such as forceps and Caesareans. Upright birth positions could avert this condition. As mentioned above, Mendez-Bauer (1976) who estimated that the force of gravity in the upright position was equivalent alone to a continuous uterine contraction force of 30-50mm Hg, reported that this increased efficiency was achieved without any increase in the incidence of foetal distress. Besides increasing uterine contraction, the upright posture for birth was found also to decrease the need for analgesic drugs, shortened labour and improved neo-natal Apgar scores, (a general test of the baby's wellbeing).

3.5 BIOMECHANICAL ADVANTAGES

The weight of the viscera and the increased advantage of the biomechanics of the musculoskeletal system significantly enhance intrauterine pressure in the bearing-down phase of the second stage of labour. The maximum pressure that can be exerted by the woman depends on the posture she adopts. Mengert and Murphy (1933) who carried out experiments on non-pregnant women showed that intra-vaginal pressures when bearing-down in the various postures were as follows:

Sitting	154mm Hg
Standing	145mm Hg
Squatting	143mm Hg
Semi-recumbent	135mm Hg
Knee-elbow	134mm Hg
Supine	127mm Hg
Lateral	118mm Hg

Postural efficiency for bearing down tends to decrease as the body approaches the supine position. Thus a woman in the sitting position is 30% more effective in bearing down than when she is in the lateral position. However, Mengert and Murphy cautioned that the finds should not be applied unreservedly to straining ability in the second stage of labour until further research has been undertaken.

Howard (1958) who applied the principles of physics and the Newton's law of gravity on Mengert and Murphy's data, calculated that only 65% of the force needed for delivery in the horizontal position will be required in the sitting position. Thomson (1988) reported an exploratory study to assess the practicality of the birth chair by Romney (1983) who suggests that 30 minutes of pushing in the birth chair is equal to 60 minutes of pushing on the bed.

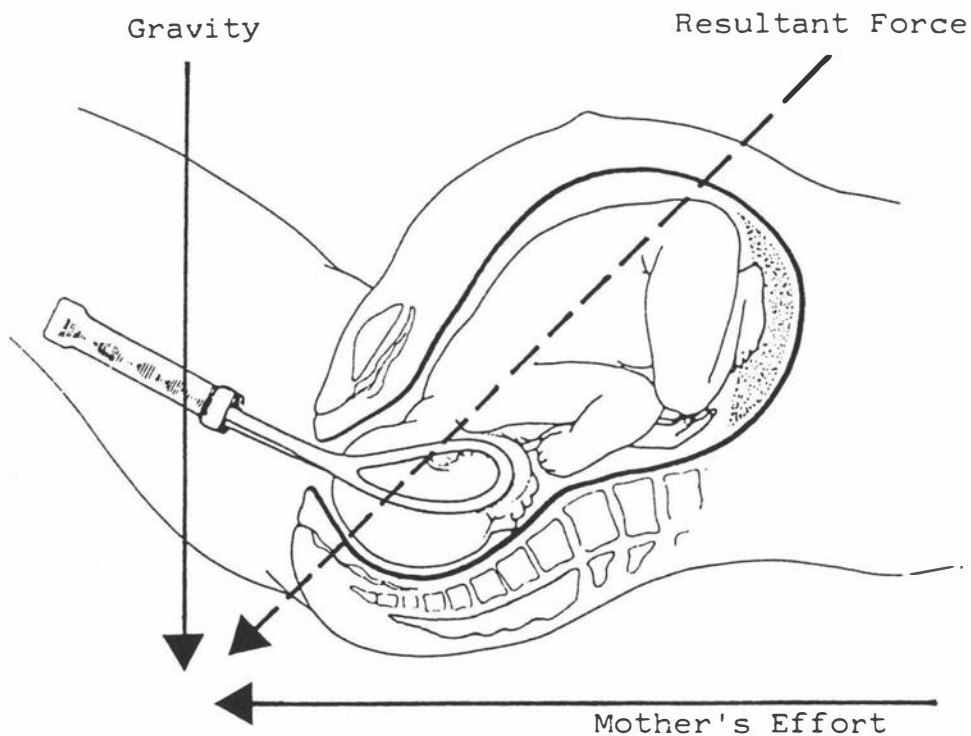


FIGURE 3.2 MECHANICAL DISADVANTAGE OF THE HORIZONTAL POSITION FOR CHILDBIRTH AND THE USE OF FORCEPS

In the horizontal position, even the use of forceps is faced with major mechanical and gravitational disadvantages. Howard (1958) reported an experiment by Wylie, who used a spring-scale to measure the forces required for deliveries with Tucker McLean forceps. Wylie found that the average pull necessary to extract the foetal's head was 35 pounds (15.9kg), and the greatest was 74.8 pounds (35.7kg), the pull being in general in the horizontal and the baby's weight being vertical. The drawing above illustrates the problem, using Pythagorean formula. Howard (1958) has demonstrated that if the mother is upright, only 80% of the force needed in the horizontal position is required to deliver the baby. The average pull exerted in the upright posture is 28 pounds (12.7kg), compared to 35.5 pounds (16.1kg) for the horizontal position.

The drawing on the previous page shows the resultant force created by the maternal and gravitational forces. If the mother is lying on her back, she is pushing her baby out at right angles to the gravitational force, resulting in greater incidence of tearing, as the resultant force is directed at the perineum rather than the vagina. Considerably more effort is required as the mother attempts to push the baby "up hill" (Dunn, 1976; Inch, 1985).

To be born the foetus must pass through the pelvis. The bones that make up the pelvis are bound by a tough tissue or ligaments. During pregnancy a variety of hormones - relaxin - soften the ligaments, making them more flexible in readiness for the childbirth. The shape and size of the pelvic cavity are therefore amenable to some postural mouldings and expansions.

X-rays and measurement studies carried out by Vaughan (1937) have confirmed that squatting alters pelvic shape in a way that is advantageous for childbirth. More recent radiological studies conducted by Russell (1969) showed that both the transverse and anteroposterior diameters of the pelvic outlet were bigger during squatting. Increases of 10mm and 20mm in the transverse and anteroposterior diameters respectively were observed. More remarkably the average increase in the area of the outlet was between 20-30%. Less "civilised" women have instinctively made use of these facts to overcome quite marked cephalo-pelvic disproportion (pelvis too small to accommodate the baby). In Western societies the problem of marked cephalo-pelvic disproportion would be resolved by Caesarean section (Howard, 1958).

Borell (1966) showed that the symphysis pubis is capable of an average downward displacement of 25mm during the foetal descent. During the actual birth and for some time afterward, the symphysis pubis "displaced upward an additional 20mm from the original position". The pelvis has the

potential for considerable adjustments to increasing the anteroposterior sagittal diameter during birth. Pelvic drives are more efficient in an upright position or when the uterus is tilted forward. Hence, parturients who labour in the upright posture as long as possible during the first stage of labour would result in an advantageous drive and a more efficient second stage of labour (Gold, 1950). If she is on her back the sacrum and coccyx are fixed, and thus will hinder any potential of outward movements which might increase the size of the pelvis.

3.6 CLINICAL ASPECTS : IATROGENIC RISKS

The overriding concern in childbirth must be the well-being of the mother, the well-being of the foetus and its subsequent growth and development. In the consideration of birth postures, research studies have suggested that it is the longer-term risks that may affect the woman and the foetus - rather than the immediate advantages or disadvantages of the particular posture that need attention (Dunn, 1976; Brackbill et al, 1984; Korte et al, 1984).

The "Consequences of the Dorsal Position" shown in the diagram overleaf - has been alluded to before. Research studies over the past 30 years or so suggest that the "consequences of the dorsal position is a significant contributing factor to iatrogenic risks of more serious and permanent kinds".

Slow labour process, pain and foetal distress are contributing factors that may predispose a woman to obstetric interventions such as oxytocin infusion, use of analgesics and surgical induction. The literature implies that it is difficult to use any intervention in isolation, especially those involved in the active management of labour. As alluded earlier, one intervention will lead to the other, so that the use of the first intervention

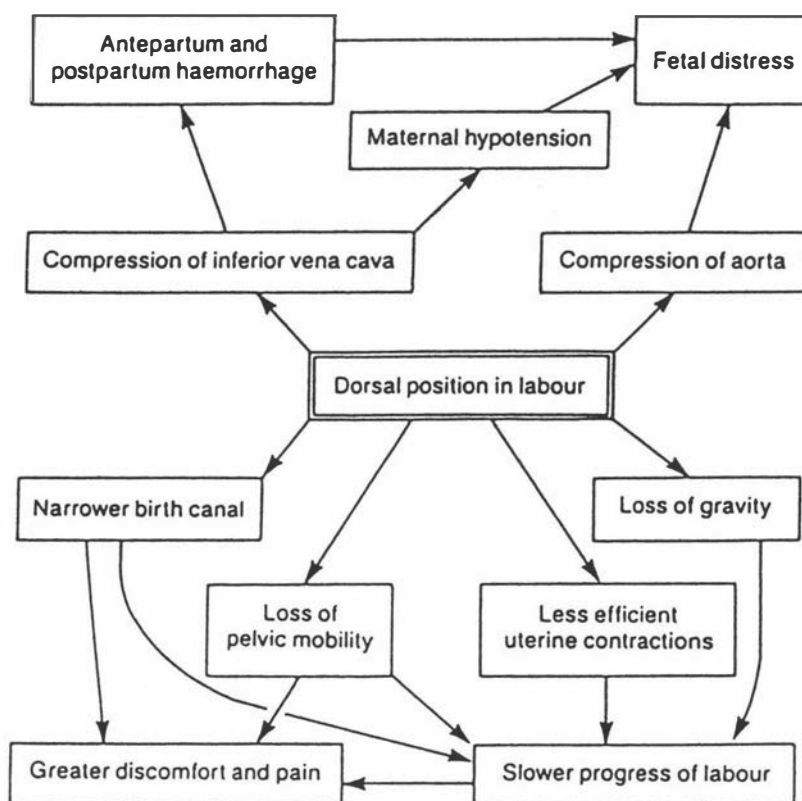


FIGURE 3.3 CONSEQUENCES OF THE DORSAL POSITION

increases the probability that a second is necessary, which in turn increases the probability of a third and so on.

Mahan and McKay (1984) in a review of the research literature on the subject conclude that there are five signs that indicate that an intervention may be required in the second stage of labour.

These are:

- Abnormal foetal heart rate patterns (especially loss of variability)
- Duration over two hours in primigravidae or an hour in multiparae

- Neonatal pH levels of less than 7.2
- Poor quality contraction
- Arrested descent and rotation of the foetus

They also report that full dilation may not always be accompanied by adequate descent of the foetus to initiate a bearing-down reflex. The use of gravity in the squatting and sitting positions may enhance foetal descent and elicit the bearing-down reflex.

The 'symptoms' identified by Mahan and McKay appear to be all "consequences of the dorsal position" recognised by Dunn (1976) almost 10 years earlier.

In his address to the Royal College of Obstetricians and Gynaecologists, Dunn (1976) gave a staggering list of the risks and complications of active management of labour that may result from the "consequences" of the dorsal position:

"hazards of preceding x-ray and amniocentesis; unexpected prematurity; amnionitis and congenital infection; prolapsed cord; antepartum haemorrhage; complications of foetal monitoring; increased maternal stress and pain; complications of maternal analgesia; abnormal or excessive uterine activity/tone; uterine rupture, preceptitate delivery; foetal distress, obstetric delivery; failed induction; Caesarean delivery; birth asphyxia and respiratory distress; hypoglycaemia; hyperbilirubineamia; special care and mother-child separation; long term handicaps"

Dunn cited findings that a twofold to threefold increase in foetal distress and low Apgar scores in association with amniotomy and oxytocin infusion - with six times as many infants requiring special care. When labour was induced, women were twice as likely to receive analgesic drugs and be delivered by forceps, while the infant was four times as likely to be transferred to a special-care unit, and, when not so transferred, was two to three times as likely to have sucking or breathing problems. The increase in Caesarean section following failed induction is well known.

He said that the findings did not surprise him and added that: "For some years I have been increasingly dismayed by the amount of birth asphyxia that I suspected but could not prove was iatrogenic - and with it there has been a corresponding increase in hypoglycaemia and hyperbilirubinaemia. Too much bilirubin, too little oxygen, and too little blood-glucose: they are the three most important causes of long term handicap".

3.7 EMOTIONAL ASPECTS

If childbirth is to be viewed - holistically - as an important life event rather than a crisis, maternity care must be measured in both physical and emotional terms. To a growing number of well-informed women, childbirth is not simply a physically-timed event focused primarily on the avoidance of complications and pain. Childbirth generally has a very happy outcome. Like other important achievements in life, the hard work of labour is usually followed by exhilaration and pride in accomplishment of a challenging task (Gennaro, 1988).

The amount of pleasure a woman experiences during childbirth seems to be related to the amount of participation she has during the labour. Entwisle and Doering (1981) have indicated that for the woman to

experience satisfaction, the most important aspect to be considered is the possibility of remaining in control during labour and delivery. This is far more important to her than the avoidance of pain. Birth experience need not be painless or uncomplicated to be satisfying. Many women have reported enjoying and experiencing rapturous moments at birth, and have described the sensation of their childbirth experience as 'joy', 'excitement', 'a wonderful free feeling', or 'near mystical bliss' (Tanzer, 1968).

Oakley (1980) also found that if the woman has been deprived of control during the delivery, the risk of postnatal depression is increased. Willmuth (1975) who studied 1,145 women found that the perception of maintaining control was closely associated with satisfaction. Willmuth pointed out that the control desired by women in labour was related to "participation in decision-making". This relationship is also supported by Davenport-Slack and Boylan (1974) who reported that the most important factor in contributing to a positive experience in childbirth is the woman's desire to be an active participant. Women who were active participants were much more satisfied with their birth experience than the women who rely on their physician and on drugs.

Therefore, it would seem, the important variables that contribute to a holistic or humanistic childbirth should include the highly meaningful - albeit less tangible - psychological and emotional factors. Hence, the criteria for a good birth should be made on the basis of a physiologic posture that promotes efficient contraction and intrapartum care, the safety of the mother and her baby, and the woman's preferences and wishes in labour "within the confines of safety for mother and child" (Hillan, 1985).

3.8 AMBULATION

Before we look at the maternal and foetal outcome of birth chair deliveries, it may be worthwhile to mention that although there is a widespread agreement in the literature that the dorsal recumbent position is to be condemned because of the danger of supine hypotension and the resulting foetal hypoxia that may occur, there has been no clear data to support any one "best" upright position for labour during first stage.

However, the standing and ambulant positions for first stage of labour have been shown to contribute to shortening the duration of labour with decreased pain and improved levels of comfort (Caldeyro-Barcia, 1978; Flynn et al, 1978; Mendez-Bauer, 1975). Ambulation also facilitates application of the presenting part against the cervix, provides better alignment of the presenting foetal part with the pelvic inlet, and enhances descent of the foetus because of gravity (McKay, 1978). In the supine position the foetal presenting part may be required to "climb over" the sacral promontory (Hillan, 1985).

Roberts et al (1983) suggested that "position change" may be more important than a single "best" position while Williams et al (1980) reported that ambulation should be encouraged and facilities for ambulation should be available for those women desiring it. Both Notelovitz (1978), and McKay (1978), have recommended full mobility and vertical positioning during labour for those women without complications.

3.9 THE EFFECTS OF BIRTH CHAIR DELIVERY ON MATERNAL SATISFACTION

The influence of the emotional aspects, and the importance of the woman's perception of satisfaction in childbirth have been outlined above. It is refreshing to see in recent published work that attitudes are now changing to incorporate these aspects in maternity care, and some studies have been carried out to measure the mother's emotional perception of their birth experience. The effect of birth chair delivery on maternal satisfaction has attracted much attention, and the reaction from women with respect to this form of delivery has been very positive and encouraging.

Hillan and co-workers (1985), who conducted a randomised study concluded that most women who delivered in the birth chair found it to be comfortable. It allowed them to see what was happening and enabled them to take an active part during the delivery process. Good eye to eye contact with the obstetrician or midwife was possible from the chair and they implied that this might have helped the women to remain in control.

In a literature review on the subject, Shannahan and Cottrell (1988) studied research findings from five countries and concluded that birth chair deliveries have been identified as allowing for more effective pushing; increasing maternal delivery comfort; allowing for more active participation in the birth process, decreasing maternal feelings of vulnerability; allowing women to see their infants at the moment of birth; and decreasing backache. The following significant references were mentioned.

A Swedish study reported by McKay (1978), involving 40 women who delivered in the birth chair found the position to be more comfortable than the conventional delivery table. Other favourable responses included being able to push more effectively and seeing the infant at the moment of birth. Kesby (1982) who carried out a study with 20 multiparae women at a British hospital has reported similar results. The women in this study considered the birth chair delivery to be "quite comfortable" compared to their previous birth experience.

Valenti et al (1982) reported that 123 women accepted birth chair delivery because this type of delivery allowed the maximum degree of participation in the childbirth process. The feeling of more active participation has also been reported in a study involving 80 Norwegian volunteers, conducted by Haukeland (1981). Beardsell (1983) found that the birth chair was considered to be the most satisfactory alternative delivery method for 85 mothers at a British hospital who delivered in the chair. They also mentioned that the birth chair was comfortable, relieved backache, and made bearing-down easier.

Berg and Selbring (1980), of Sweden, and Nagai (1982) of Japan who carried out studies in their own country reported that multiparae women, generally, compared birth chair delivery favourably with recumbent delivery, and hoped to use the chair again in future childbirths. Women in these studies found the upright position to be natural and reported feeling less vulnerable. A randomised study of 189 women conducted in a British hospital by Stewart et al (1983) indicated that the majority of the women who delivered in the birth chair were comfortable, and many reported decreased backaches.

Shannahan and Cottrell (1988) conducted a quasi-experimental study to compare women's maternal perceptions of their childbirth experiences of using a birth chair to those using the traditional delivery table. The sample consisted of 55 primiparae; 22 women delivered on the delivery table, and 33 women delivered in a birth chair. The major findings were that both groups were satisfied with their delivery experiences. No significant differences were found between groups on overall score in the five categories: active participation, effort, control, satisfaction and comfort. However, women using the birth chair had a significantly higher score on the comfort subscore.

Results from the abovementioned studies suggest that the birth chair is a sound alternative to the bed or delivery table in terms of maternal satisfaction.

3.10 THE EFFECTS OF BIRTH CHAIR DELIVERY ON MATERNAL WELL-BEING AND DURATION OF SECOND-STAGE LABOUR

The physiological advantages of the upright position over the supine position have been outlined above. These benefits are now well known, and subject to intense study and investigation. Significant aspects of the upright position that enhance labour and delivery include: the force of gravity which assists the parturition process; Mendez-Bauer (1976) has claimed that this increases the foetal head-cervic pressure by as much as 30-50mm Hg; radiographic studies carried out by Russell (1969), and others have shown that the cross-sectional surface area of the birth canal may increase by as much as 30% when the woman changes from dorsal to the squatting position; Mengert and Murphy (1933) have demonstrated that the sitting position is 30% more efficient than the lateral position during bearing-down; Howard (1958) has calculated that only 65% of the force

required for delivery in the supine position is needed in the sitting position; Romney (1983) has claimed that 30 minutes of pushing in the birth chair is equal to 60 minutes on the bed.

The supine position is disadvantageous for labour, and should be condemned because of the weight of the gravid uterus pressing down on the aorta and inferior vena cava (Scott and Kerr, 1963), resulting in grave "consequences" to the maternal mother and the foetus (Dunn, 1976), which in turn may result in iatrogenic risks (Brackbill, 1984; Inch, 1985; Korte and Scaer, 1984). The supine position also predisposes the umbilical cord to compression (Carr, 1980).

These phenomena have now been put to test in experiments around the world - using the birth chair - to evaluate maternal and foetal outcome. The results so far have been promising - albeit with some mixed and inconsistent findings, especially in areas relating to the incidences of perineal swelling and maternal blood loss. However, many researchers in recent studies are now suggesting that the mixed results may have been caused by the inappropriate techniques used to manage birth chair deliveries, unergonomic chair design, poor experimental design and procedures, and other methodological problems (Pavlik, 1988; Nelsson-Ryan, 1984; Cottrell and Shannahan, 1986; Thomson, 1988; Kitzinger, 1972).

3.10.1 Maternal Well-Being

It was Forrest H. Howard M.D., who reintroduced the upright posture for delivery at the St. Anthony's and Bannock Memorial Hospitals in Pocatello, Idaho, in 1954. Hence, it is most appropriate that we consider his pioneering experiment and findings here first.

Howard (1958) delivered 219 babies on a special delivery bed he designed, with a back that could be lifted from the horizontal to the vertical position, so that the mother in the lithotomy position comes into a sitting position.

He concluded that "delivery in the physiologic position which is a sitting or squatting position, is practical, satisfactory from the mother's viewpoint and should result in less intracranial damage to the child than is now encountered by the use of the various recumbent positions".

With respect to the sitting birth posture, he asserted that "inasmuch as the knee crutches are placed so that weight is distributed generally over this area, there has been no concern over the possibility of thrombotic phenomena. Because of the placement of weight and its broad support, it is no more apt to pose a problem than supporting weight on the back".

In a more recent study, Hillan (1985) compared the maternal outcome of 250 women who delivered in a birthing chair with a control group of similar number who delivered in the conventional dorsal recumbent position.

The study was carried out in the Glasgow Royal Maternity Hospital to assess the benefits of delivery in a birth chair. The "Century E-Z birthing chair" that was used in the study allowed the woman to be in a semi-squatting position and allowed the midwife access to the perineum to control the delivery. The 500 women in the study have mixed parity. All had singleton pregnancies with a cephalic presentation and were at term. Women admitted both in spontaneous labour and for induction were included in the study.

Multigravidae were, as far as possible, induced with oral PGE² in order to allow ambulation if requested. Intravenous oxytocin was used to augment labour when necessary, but its use was restricted to the minimum dosage to achieve satisfactory uterine activity.

The main findings were that: women delivering in the birth chair had a shorter mean duration of active pushing and this was statistically significant; primigravidae delivering in the chair required fewer forceps deliveries and this was especially marked in those women who had epidural analgesia; of those primigravidae with epidural analgesia, the percentage requiring forceps delivery for delay in the second stage of labour was 22% in the chair group and 46% in the bed group. This was significant and suggests that the chair may help to overcome the problem of delivering spontaneously while under epidural block.

Perineal damage was significantly reduced for all women delivering in the chair, and this remained significant even when forceps deliveries were excluded. Most women delivered in the chair found it to be comfortable, were able to take an active part, and remained in control. The only apparent disadvantage of delivering in the chair appeared to be the higher mean blood loss at delivery. This was especially marked amongst multigravidae.

According to the above study, the benefits of the physiologic upright posture for delivery, and the use of the birth chair appear to be highly favourable. However, when we consider recent studies around the world on the effect of birth chair deliveries on maternal well-being and length of second stage labour, researchers have reported mixed and sometimes conflicting results.

Six major studies using the Birth E-Z Chair have reported inconsistent findings.

In Japan, Nagai (1982) compared 100 women delivering in the supine position with 184 women delivering in a birth chair. Blood loss, estimated in cubic centimetres was less in the birth chair group in both primiparae and multiparae. The number of lacerations and episiotomies was not reported.

In England, Stewart et al (1983) randomly assigned 189 women to a birth chair or a recumbent position for second stage labour. Primiparae in the birth chair group had significantly fewer lacerations and episiotomies than those who delivered in the recumbent position ($p < .01$). Blood loss was measured by the actual amount of blood drained into a receptacle. Multiparae in the birth chair group had a higher mean blood loss at delivery ($p < .001$).

In the United States, Shannahan and Cottrell (1985), conducted a retrospective chart review of 60 primiparae women - 30 delivering on a traditional delivery table and 30 in a birth chair. Blood loss was determined by comparing mean haemoglobin and haematocrit values. The birth chair group was found to have significantly more blood loss ($p < .025$), than the delivery table group.

In another prospective quasi-experimental study to examine the effects of delivering in a birth chair on duration of second stage labour, perineal swelling, incidence of episiotomies, lacerations, hemorrhoids, and maternal blood loss - for 55 primiparae deliveries, 33 in the birth chair and 22 on the delivery table - they found that: there was no difference in the amount of blood loss between the two groups as measured by the mean difference in the pre and post delivery haemoglobin. No significant difference was

found between groups for mean duration for second stage of labour. The incidence of instrument-assisted deliveries, episiotomies, lacerations and hemorrhoids was also similar between groups. The incidence of perineal swelling was statistically greater in the birth chair group (Cottrell and Shannahan, 1986). These findings contrast with results of their retrospective study (Shannahan and Cottrell, 1985), when they reported significantly more blood loss in the birth chair group. Both studies were conducted in the same medical centre only 12 months apart.

In England Hillan et al (1984) compared 500 women randomly assigned to a recumbent position or a birth chair. Blood loss in multiparae was significantly higher in the birth chair group. Perineal damage was significantly less for women in the birth chair, even when forceps deliveries were excluded.

In Sweden Berg and Selbring (1984) compared 49 women using the birth chair with a control group of 48 women using a recumbent position. No difference in blood loss was found between the two groups. The number of episiotomies was similar. However, it was reported that there were fewer lacerations in the birth chair group ($p < .02$).

Findings regarding duration of second stage labour between birth chair deliveries and traditional recumbent deliveries are also inconsistent. Nagai (1982) reported that primiparae delivering in a birth chair had significantly shorter ($p < 0.01$) duration of second stage than those delivering in the recumbent position. No differences were found for multiparae. Other studies (Stewart et al, 1983; Berg and Selbring, 1984) reported only a trend toward shorter duration of second stage in birth chair deliveries. Shannahan and Cottrell (1985) found a trend toward longer duration of the second stage in the birth chair deliveries. However, they were quick to

point out that this may be due in part to a sample selection bias. The sample was not randomly assigned, and "physicians sometimes encouraged women to use the birth chair when difficulty was anticipated while pushing". And Hillan (1985) reported that women delivering in the birth chair had a shorter mean duration of active pushing and this was statistically significant.

Thus, while the investigations have established many highly favourable outcomes, the effect of the birth chair on maternal blood loss and maternal perineum has yet to be clearly established. Further research to minimise these problems, especially in areas regarding the management of birth chair delivery is warranted.

3.11 THE EFFECTS OF BIRTH CHAIR DELIVERY ON FOETAL WELL-BEING

A major goal in the management of childbirth is to establish practices which promote optimum foetal well-being, especially in management that supports foetal oxygenation. The supine position for labour has been found to impede foetal descent because it cannot take advantage of the force of gravity (Howard, 1958; Mendez-Bauer, 1975). It is biomechanically less efficient for 'bearing-down' (Mengert and Murphy, 1933). It also restricts possible maternal pelvic cavity expansion (Liu, 1979; Roberts, 1980; Russell, 1969).

The gravid uterus - in the supine position - can compress the aorta, diminishing blood flow through uterine arteries. Decreased blood flow to the heart, and diminished cardiac output and blood pressure can also occur when the inferior vena cava is compressed. Compression of both blood vessels compromise blood supplies to the uterus and placenta (Carr, 1980;

McKay, 1981; Roberts, 1980). The use of the birth chair for upright delivery helps to avoid or minimises these circulatory problems and has been associated with decreased transient umbilical cord compression (Carr, 1980).

Despite this knowledge, the effects of birth chair delivery and foetal well-being are not well documented (Cottrell and Shannahan, 1987). However, specific aspects of foetal outcome with respect to upright and birth chair deliveries have been reported in several investigations.

In a study involving 219 deliveries - 52 primiparae and 167 multiparae women - in the modified sitting position, Howard (1958) reported that no residuals of birth trauma were known to him among any of these 219 infants. He concluded that by the use of the physiologic position for normal deliveries and even borderline deliveries, the mother should have an easier delivery, the baby should have a better chance of survival, and the physiologic position should result in less intracranial damage to the baby than is now encountered by the use of the various recumbent positions. The Cerebral Palsy Association has established a tentative rate of the incidence of cerebral palsy as between 1 in 50 to 1 in 200 live births. This study of 219 deliveries with no such sequelae compares favourably with these figures.

Caldeyro-Barcia (1979a) investigated the well-being of the newborn by measuring blood-gas analysis. In his study he compared two groups of primigravidae with normal term pregnancies - 40 in an upright position and 51 in the recumbent position. He found that umbilical artery and vein pO_2 and pH in babies delivered in the upright position were higher, and pCO_2 values were lower than values reported for spontaneous low-risk deliveries established by Barnett and Humenick (1982).

Nagai (1982) in Japan compared primiparae and multiparae using the birth chair for delivery with a control group at another hospital who have delivered in the horizontal position. Analysis of umbilical artery and venous blood revealed significant higher pO_2 and pH, and significant lower pCO_2 vein and artery values for the birth chair group. Time of first cry - indicating establishment of active respiration of the newborn was found to be earlier in birth chair infants than those delivered in the horizontal position (9.3 and 17.9 seconds, $p < 0.01$).

Other studies have reported only subjective findings on infant outcome. Kesby (1982) reported that the Apgar scores of all 50 infants delivered in the birth chair were "satisfactory". Valenti et al (1982) reported that the condition of infants delivered in a birth chair ($n = 123$) was "excellent"; criteria for assessment were not mentioned.

A retrospective chart study of 60 primiparae - 30 delivering on a traditional delivery table and 30 in a Birth E-Z birth chair - was conducted by Shannahan and Cottrell (1985). No difference in the infants' one- and five-minute Apgar scores were found between groups. Stewart, Hillan and Calder (1983) - in a randomised comparison of 99 birth chair deliveries with 90 delivery-table deliveries, also found no difference in one- and five-minute Apgar scores or in umbilical artery pH between groups. Berg and Selbring (1984) compared 49 women using a birth chair with a control group of 48 women using the recumbent position. All five-minute Apgar scores were found to be either 9 ($n = 10$) or 10 ($n = 87$), with no difference between groups. It was also reported that the general condition of infants was similar between groups.

Cottrell and Shannahan (1987) conducted a quasi-experiment to compare 33 birth chair deliveries with 22 upright deliveries using the delivery-table.

The angle of the chair or table may be adjusted to the following positions: less than 30°, 30-45°, 46-60°, 61-75° or greater than 75°. As might be expected, since both the experimental and control groups were delivered more or less in the upright position - there were no significant differences in Apgar scores between chair- and table-groups. However, for both groups, mean one-minute Apgar scores were reported to be significantly higher when the angle of the chair or table was more than 30° upright (8.00 vs 8.59, $t = 2.15$, $p = 0.038$). There were no significant differences between birth chair and delivery-table groups for maternal haemoglobin, breath-holding while pushing, duration of second stage, time of first cry of infants, time of cord clamping or incidence of cord around the neck. An unexpected finding in this particular study was that the mean umbilical artery $p\text{CO}_2$ was significantly lower in the birth chair deliveries than the control group. Within the birth chair group, mean venous $p\text{O}_2$ was significantly higher when the angle of the birth chair was more than 45° upright ($n = 16$) than when the angle was less than 45° upright ($n = 15$); (22.3 and 28.3mm Hg, $t = 3.01$, $p = 0.007$).

Consistent with other studies - evaluating foetal well-being via Apgar scores - mentioned above (Berg and Selbring, 1984; Caldeyro-Barcia, 1979a; Kesby, 1882; Nagai, 1982; Shannahan and Cottrell, 1985; Stewart et al, 1985), these findings support the use of a birth chair as a safe alternative to the delivery table or bed, with respect to foetal outcome.

Perhaps more significantly, the lower umbilical artery $p\text{CO}_2$ in the birth chair group found in these studies were also consistent with those found by Caldeyro-Barcia (1979a) and Nagai (1982). Low arterial $p\text{CO}_2$, with unchanged $p\text{O}_2$ and pH, supports the belief that less transient cord compression occurs in the upright position (Carr, 1980). A higher vein $p\text{O}_2$ when the upright angle of the birth chair is increased - from 45° indicates

that there is increased oxygen supply to the foetus with an upright delivery position. Shannahan and Cottrell (1987) also found significantly higher one-minute Apgar scores when an upright angle of greater than 30° was used for delivery in either the birth chair or the delivery table. This indicates that the upright position for childbirth is more beneficial to the foetus. This is also consistent with previous findings that even at an upright angle of 30°, the gravid uterus can put direct pressure on the abdominal aorta, reducing blood supply to the uterus and foetus (Carr, 1980).

3.12 FACTORS OTHER THAN POSITIONING THAT AFFECT MATERNAL AND FOETAL WELL-BEING

A number of studies on the effect of birth chair delivery on maternal and foetal well-being have been analysed above. Overall results appear to support the birth chair as a safe and beneficial alternative to the bed or the traditional delivery table for childbirth. Very positive findings with respect to maternal emotional satisfaction and foetal outcome have been reported in deliveries using the birth chair. The findings also suggest that birth chair deliveries are safe in terms of maternal well-being - but the results have been mixed. Some studies have indicated that the birth chair may increase the incidence of perineal edema and post-partum haemorrhage in some women.

Among the six experiments using the "Birth E-Z Chair", mentioned above, the results in terms of post-partum haemorrhage have been inconsistent, Berg and Selbring (1984) reported no difference in maternal blood loss between the experimental and the control groups in their study. Nagai (1982) reported that maternal blood loss, estimated in cubic centimetres, was less in the birth chair group (n = 184) in both primiparae and

multiparae than the control group (n = 100). Stewart et al (1983) reported that multiparae in the chair group (n = 95) had a higher mean blood loss at delivery ($p < .001$), but no significant difference was found for primiparae. Both Hillan et al (1984) and Shannahan and Cottrell (1985) reported higher blood loss in the chair group. However, in another study conducted a year apart in the same medical centre, Cottrell and Shannahan (1984) reported that there was no significant difference in maternal blood loss between the birth chair group (n = 33) and the control group (n = 22).

With respect to the inconsistent findings - even in experiments using identical equipment, and especially in the two studies conducted in the same place, using the same birth chair and carried out by the same researchers, 12 months apart, but producing conflicting results - one cannot help but question whether factors other than the birth chair or the delivery position might have contributed to the mixed outcomes.

Inconsistent findings may be attributed to a variety of factors. As in most research involving human subjects, it is often not possible to arrive at identical results. Methodological problems may arise in research design and variables are often difficult to control. Inappropriate practices can also confound birth outcomes.

Thomson (1988) conducted a literature review on the management of the women in the second stage of labour and reported that there was no scientific evidence to support current practices recommended by many authorities. However, the available literature suggests that three factors are closely interrelated. They are: the techniques the maternal mother is exhorted to utilise in order to bear-down; the delivery position; and the length of time that the second stage is allowed to last.

3.13 VALSALVA MANOEUVRE

Current close-glottis pushing or valsalva manoeuvre, during bearing-down appears to be incongruent for upright deliveries using the birth chair. According to Noble (1981), exertion - whether in exercise, karate, weightlifting or childbirth - is performed on the outward breath. This allows the muscles to contract efficiently. In terms of maternal physiology, prolonged close-glottis pushing longer than 5-6 seconds increases intrathoracic pressure, diminishes venous return and causes blood to pool in the pelvis. Kitzinger (1984) states that prolonged close-glottis pushing also puts great stress on the perineal tissues.

Since the upright position has been shown to promote more efficient uterine contraction (Mendez-Bauer, 1975), to enlarge the pelvic outlet (Liu, 1979; Roberts, 1980; Russell, 1969), to use the forces of gravity (Howard, 1958), and to increase the biomechanical advantage of the women's bearing-down effort (Mengert and Murphy, 1933), it could be hypothesised that women who deliver in the birth chair would have a higher incidence of perineal swelling, laceration, episiotomy and haemorrhage - if close-glottis exhortation is encouraged. It could be further hypothesised that with a dependent maternal perineum, bleeding from episiotomies and lacerations would also be greater - if women are forced to strain during the second stage.

Hence, it prompts one to speculate whether most of the problems in birth chair deliveries in terms of maternal blood loss and perineal swelling, are in some way caused by incompatible practices in the management of second stage of labour, and not caused by the upright position per se.

Many authorities are now advocating a more appropriate management of the second stage, and a more creative use of the birth chair in order to enhance maternal and foetal well-being.

3.14 OPEN-GLOTTIS VS CLOSE-GLOTTIS DELIVERY

In a "non-prescriptive environment", Rossi and Lindell (1986) conducted an observational study of 50 women in the second stage of labour. The women were given no instructions or constraints, used three pushing techniques, "open-glottis, close-glottis, and/or intermittent expulsive efforts". All 50 women achieved a spontaneous delivery. The length of the second stage varied between 24 and 103 minutes for primiparae, and between 2 and 109 minutes for multiparae. Both Barnett and Humenick (1982), and Knauth and Haloburdo (1986) found no significant difference in length of second stage with open-glottis pushing.

Beynon (1957) believes that if the woman is "left entirely to her own intuition" there is very little voluntary effort until the foetal head begins to "actively distend the pelvic floor", that the commencement of the straining mechanism does not coincide with the beginning of the contraction and that there is considerable variation in the amount of push with each contraction. She conducted an experiment with 100 consecutive normal primigravidae. They were allowed to follow their own inclination with no suggestion when they should push. The outcomes of the second stage were compared with 393 other normal primiparae. There was no difference in the length of second stage of labour between the two groups; there were fewer forceps deliveries in the "no pushing group" (6 out of 100 compared with 47 out of 393), and the perineal repair rate was also reported to be significantly less in the experimental group (39% compared with 63% in the control group).

Knauth and Haloburdo (1986) state that the "breath-holding-pushing" technique results in aorto-caval compression which leads to restriction of utero-placental blood flow and thus compromises the foetus.

Noble (1981) recommends that vocalisation be encouraged in childbirth. However, Newton and Newton (1962) have likened aspects of second stage of labour to sexual orgasm and noted that the similarity of sounds makes care providers uncomfortable, and led them to find reasons to promote close-glottis pushing and its accompanying silence during the second stage. Pushing with the glottis closed (Valsalva manoeuvre) causes high intrathoracic pressure that prevents venous return to the heart and causes a falling blood pressure, a fall in cardiac output, and diminished blood flow to the uterus. This in turn has been hypothesised to potentially lead to foetal hypoxia. The "Consequences of the Valsalva Manoeuvre" (Noble, 1981) is shown on Figure 3.4 overleaf.

Caldeyro-Barcia (1979b) and Caldeyro-Barcia et al (1979) found that when a woman was allowed to "bear-down" spontaneously, the 'push' lasted 5-6 seconds and there were no decelerations in the foetal heart rate. In an experiment comparing two groups of primigravidae with normal term pregnancy: 40 delivered in a vertical position and 51 delivered in the horizontal position, it was found that the women used spontaneous, open-glottis bearing-down efforts of less than six second duration. Foetal outcome, measured by blood-gas analysis showed that umbilical artery and vein pO_2 and pH in vertical deliveries were higher and pCO_2 values were lower than values accepted for spontaneous low-risk deliveries. When women were asked to sustain the pushing effort - which lasted between 9-15 seconds - there was significant deceleration of the foetal heart rate. Caldeyro-Barcia (1979b) stated that it was possible it was the pushing techniques which were employed in order to expedite delivery which were actually "embarrassing the baby".

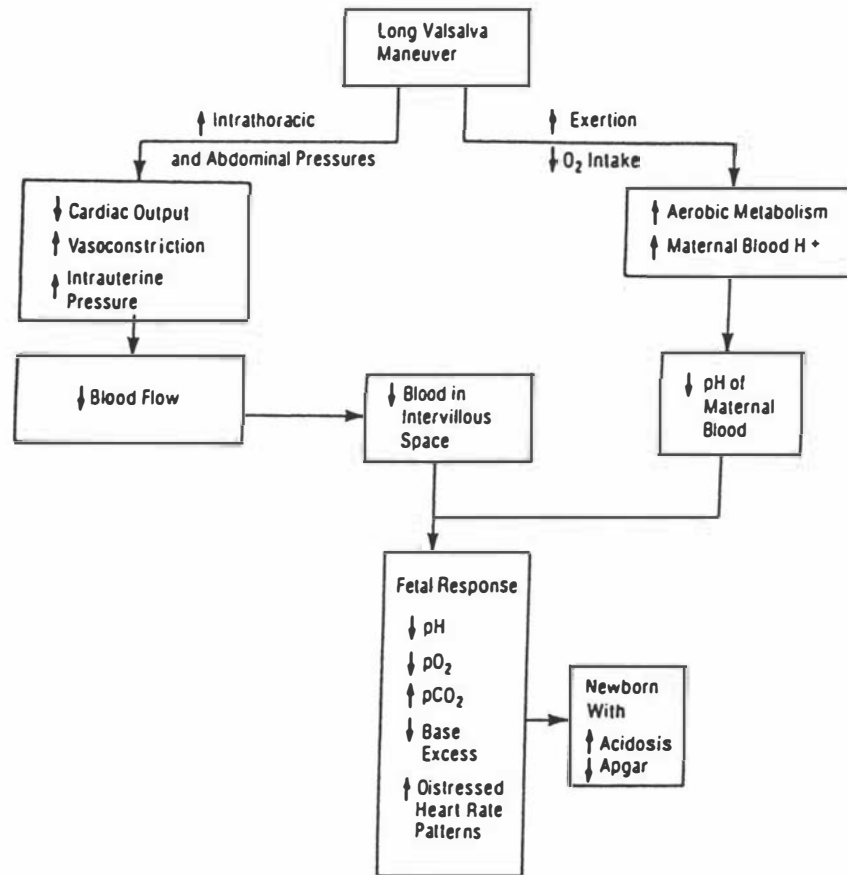


FIGURE 3.4 CONSEQUENCES OF THE VALSALVA MANOEUVRE

Gaskin (1977) questions the wisdom of the traditional instruction given to women in childbirth. She claims that a forced breathing technique is likely to lead to a tightening-up of the pelvic floor when it should be relaxed. She suggests that slowness of breathing should be emphasised, not deepness. Kitzinger (1972) states that childbirth is more a matter of breathing and coordination than straining and making terrific muscular efforts to expel the baby.

Savage and Simkin (1987) sum up the situation well: they state that perineal problems are not the fault of the chair, but of the pushing technique. Birth aided by gravity requires less forceful pushing and more controlled delivery than those in the lithotomy position. A doctor must be able to guide a woman through a gentle delivery, and she must be responsive to his instructions.

From the evidence alluded to above it appears that traditional management techniques for second stage of labour - originally designed to expedite delivery in the lithotomy or supine position - have not adapted, or invented new practices to cope with the new demands of upright maternal physiology.

3.15 INTERVENTION STRATEGIES

For the purpose of implementing risk- or hazard-prevention strategies, childbirth may be considered as a complex process in which the maternal and foetal well-being are affected by the interrelationship of the human-equipment-environment system. The human factors are those related to the anatomical, psychological and physiological characteristics of the maternal mother, the foetus, and the birth attendants; the equipment is the hardware used by the obstetrician, midwife and the maternal mother; and the environment includes the physical environs, customs and the management practices used in the process.

Risks or hazards may be analysed as human-equipment-environment interactions - as sets of conditions and actions - with predictable interactions and results. According to basic ergonomics principles, risks in obstetrics, as in all epidemiological risks, are preventable. It is possible to intervene in any risks by effective removal of the risk-inducing hazards at a number of points in the childbirth process. Obstetricians and midwives must improve new technics and implement creative interventions in the management of second stage labour to promote maternal and foetal safety and well-being in birth chair deliveries.

Brown (1982) suggested that the position of the birth chair after delivery needs examination because maternal bleeding from the placental site or episiotomy could be significant if the mother remained upright. As alluded to above, Cottrell and Shannahan (1986) who conducted two studies at the same medical centre a year apart, had reported significantly more blood loss in the chair in the first study (Shannahan and Cottrell, 1985), but no significant difference in blood loss between the chair users and the control groups in the second study. They reported that unlike the first study, the angle of the birth chair in the second study was tilted to a more horizontal position "during and immediately after the delivery" in 88% of the births. They suggest that tilting the birth chair to a more horizontal position during or just after delivery might have decreased the effect of gravity, reducing blood loss from episiotomies and lacerations. Nagai (1982) has also found that a significant decrease in blood loss when the angle of the birth chair, in his study, was adjusted to the horizontal position just after delivery of the baby ($p < .001$). Nelsson-Ryan (1984) suggested that the birth chair should be reclined to a 20° angle after delivery.

Episiotomies and lacerations tend to bleed more in the upright position when the perineum is the most dependent part (Stewart et al, 1983). The timing of an episiotomy may also have an effect on maternal blood loss (House, 1984), with early episiotomy increasing bleeding.

Unergonomic birth chair design, and its inappropriate usage may also contribute to the incidence of perineal problems and blood loss. Women who use the "Birth E-Z" chair are often encouraged to pull up on the handgrips while bearing-down. This action pushes the buttocks into the rim of the birth chair and may have resulted in greater numbers of perineal edemas. Moreover, the "Birth E-Z" birth chair is too small to accommodate the larger women. Women with heavy thighs may find their soft tissues

compressed, resulting in static loading of the affected parts and resulting in circulatory problems and edemas when labour is prolonged.

3.16 DURATION OF THE SECOND STAGE OF LABOUR WOMEN ARE ALLOWED FOR SPONTANEOUS DELIVERY

Past records over the years have indicated that the criterion on how long the second stage of labour is permitted to last has varied from only expediting delivery with forceps if the woman was "in extremis" in the 18th century (Niswander and Gordon, 1972) to not allowing women to be in the second stage for more than 30 minutes today in some hospitals (Thomson, 1987).

As alluded to earlier, Reynolds and Yudkin (1987) have found a lengthening of the second stage of labour over a three-year-period with concurrent reduction in the forceps delivery rate; and a significant reduction of episiotomy rate from 69.7% in 1981 to 44.7% in 1984 (see Tables 3.1 and 3.2 on the next page).

In the prospective study, Duigan et al (1977) analysed the length of labour in 1,306 women experiencing spontaneous, normal labour. All women did not receive epidural analgesia, and the delivery was achieved spontaneously. They found that the mean duration of the second stage in primiparous women was 41.5 minutes with a range of 3-115 minutes. For multiparous women, the mean duration for second stage was 17.4 minutes with a range of 2-80 minutes.

Concerns for the well-being of the mother and the well-being of the foetus and its subsequent growth and development appear to be the primary criterion in deciding how long the second stage of labour should be allowed. Cohen (1977) conducted a retrospective study on the outcome of

TABLE 3.1 Length of Second Stage for Primiparae 1981-84 (Reynolds & Yudkin, 1987)				
Length of 2nd stage minutes	Year % of Primiparae			
	1981 N = 2134	1982 N = 1965	1983 N = 2007	1984 N = 2032
<60	61.5	62.1	55.3	51.3
61-90	20.2	20.2	19.8	12.3
91-120	11.1	10.5	12.3	12.5
121-150	3.8	4.1	6.7	7.3
>150	3.4	3.1	5.8	7.6

TABLE 3.2 Rates of Spontaneous Delivery in Primiparae by Length of Second Stage 1981-84 (Reynolds & Yudkin, 1987)				
Length of 2nd stage minutes	Year % of Primiparae			
	1981	1982	1983	1984
<60	80.4	83.8	88.4	91.0
61-90	59.7	64.2	80.4	76.4
91-120	39.0	41.7	47.2	56.5
121-150	14.6	22.2	33.3	36.9
>150	9.5	18.3	16.1	31.8
Total	66.7	70.9	73.8	75.0

4,403 labours of primiparae in order to assess the effect of the length of the second stage of labour on maternal and perinatal mortality and morbidity. The actual duration of the second stages were not given, but were grouped into 30, 60, 90, 120, 150 and 180 minute periods. Those lasting 180 minutes or more were grouped together. No significant increase in perinatal mortality was found with progressive lengthening of the second stage. There was also no significant increase in the incidence of low Apgar scores at one-minute post-delivery among the newborns subjected to a long second stage of labour. Cohen (1977) reported that long second stages were terminated by operative deliveries (forceps or Caesarean sections). The women who were delivered operatively had a significantly increased incidence of post-partum haemorrhage and post-partum pyresia. However, it was felt that these were due to the type of delivery rather than to the long second stage.

Due to the effects of gravitational forces, the length of the second stage of labour in birth chair deliveries deserves special attention. Although birth chair deliveries have been shown to shorten the duration of second stage (Liu, 1974; Nagai, 1982); or no significant difference in duration (Berg and Selbring, 1984; Cottrell and Shannahan, 1986; Stewart et al, 1983) incidences of post-partum perineal edema have been reported in women who were left in the birth chair for too long during the second stage (Beardsell, 1983). Goodlin and Frederick (1983) reported 11 of 118 women who used the birth chair for excessively prolonged duration had experienced massive vulva edema. All 11 women had pushed for more than 120 minutes in an upright position.

Cottrell and Shannahan (1986) believe that there are three practices that may contribute to perineal problems: earlier transfer to the birth chair, voluntary coached pushing and prolonged breathholding. They caution that practices that increase venous stasis in the dependent perineum should be avoided. To prevent prolonged pushing in the chair, women should not be transferred until there is good foetal descent and presence of involuntary bearing-down reflexes. Other interventions that decrease perineal swelling may also be appropriate when the chair is used for delivery. Swedish midwives have developed an insert for the birth chair to help support the perineum in an attempt to minimise perineal problems. The Century Manufacturing Company, the makers of the "Birth E-Z" birth chair, are currently recommending women not to use the handgrips for leverage while pushing (Nelsson-Ryan, 1984).

3.17 HOLISTIC CHILDBIRTH

Since its inception some 50 years ago, ergonomics and work posture has played a central role in workplace design and industry development. Akin to this, much discussion of the mechanism of childbirth - between clinicians and patients - appears to have always been concerned with the still controversial questions regarding the optimal posture of the woman during labour and delivery, the appropriate management of the second stage of labour and the concern of routine obstetric interventions.

Childbirth is a complex process which affects the woman physiologically, psychologically and spiritually. The event of conception, pregnancy, labour and delivery - and the transition to parenthood have significant meaning that affects the woman far beyond the physiological processes that occur on these occasions. The experience of childbirth has the potential of affecting the woman's mental and social health - which in turn may affect her relationship with other members of her family (Areskog et al, 1984; Doohar, 1980; Grimm, 1967; Mercer, 1985; Moore, 1983).

The processes of labour and delivery - because of their significance in a woman's life - have long been viewed by some researchers as a development process of the pregnant woman. However, childbirth has also been considered as a crisis or an illness (Bibring, 1959; Doering, 1980; Doohar, 1980; Inch, 1985; Korte and Scaer, 1984; Standley, 1984).

In fact, much of the current research on childbirth has focused primarily on "problems" such as pain or obstetric complications rather than on the positive aspects such as enjoyment, feelings of participation, control and other emotional and subjective accomplishments of the labour (Gennaro, 1988).

Humenick (1988) and other researchers have questioned the prevailing norm among health care professionals that the critical element responsible for a good birth experience is the reduction of pain per se. They advocate that childbirth should be accomplished in a manner that not only promotes biological safety but enhances the emotional and spiritual aspects inherent in birth as well.

While the physiological aspects of childbirth are universally similar, labour and delivery are accomplished in significantly different ways. These differences are determined by the existing culture, custom or prevailing practice - according to the available technology - rather than by the actual physiological process of birth (Dunn, 1976; Howard, 1958; Notelovitz, 1978; Caldeyro-Barcia, 1979).

Conceptually similar to macroergonomics - holism as a practical concept in health care was introduced to modern medicine in the late 1970s and early 1980s. The concept that the whole is greater than the sum of its parts and that the body, mind and spirit have an effect on the body is gaining acceptance among health care professionals (Keegan, 1987).

Holism is a consumer movement which is an offshoot of the American self-help movement of the 1970s - to protest against institutions such as the government corporations, the education system and the medical establishment. In terms of health-care and medicine, self-help is taking responsibility for health habits, the environment and lifestyle. The consumer-patients are demanding to be treated holistically. They are asking to be treated as a whole person - body, mind and spirit - by medical practitioners.

Holism has been reclaiming control over the mysteries of life and death from the medical establishment through the hospices movement, natural childbirth, home births, and an increase in midwives and birthing centres where whole families participate in the birth experience in a homelike, low-technology setting (Naisbitt, 1984).

As the holistic movement actualises, and the evidence continues to reveal the synergism of the power of mind, body and spirit (Naisbitt, 1984) - the management of childbirth in the Western world, including New Zealand is gradually adapting to provide a more holistic approach for the care of women in labour and childbirth (Costello, 1988; England, 1995).

In particular, many maternity hospitals - such as the Wellington Women's and the Kenepuru Maternity hospitals - are providing more conducive environments and facilities for labour and birth. Many obstetricians and midwives are responding well to the aspirations of women who wish to labour in the upright posture.

However, the lack of well-designed equipment in both hospitals for the more physiologic labour is endangering women and babies as well as hindering clinicians. The use of unergonomic birth stools and poor improvisations - such as the use of two chairs tied together to support the maternal mother, the use of beanbags, bedpans, toilet seats or the floor for labour - are making childbirth hazardous and undignified for the women, and difficult and "back-breaking" for the obstetricians and midwives.

3.18 THE PRESENT STUDY

The principle of macroergonomics, system approach and holism are in many ways synonymous with one another. This research study will analyse the physiological, psychological and biomechanical aspects of childbirth in a systematic approach. The study will consider the human-equipment and human-environment systems to design the appropriate equipment and procedure for safe, dignified and physiologic childbirth; besides ergonomically enhancing the tasks and work posture of obstetricians and midwives.

This study will in many ways contribute to the current aspiration and desire of the child-bearing women who have made the informed decision to labour in the upright, physiologic posture.

CHAPTER FOUR

ERGODESIGN

4. ERGODESIGN APPROACH AND THE ACQUISITION OF DATA - THE OPTIMISATION OF ERGONOMICS AND DESIGN TECHNOLOGIES

Ergodesign is a new concept, conceived and used here for the first time. Ergodesign signifies the fusion of the theoretical and practical foci of the two disciplines: ergonomics and design. As systems become more complex, it is becoming increasingly difficult to differentiate between the two disciplines. In contrast with the more traditional "human-machine interface technology", "human-environment interface technology", "human-computer interface technology" and macroergonomics, which seek to ensure optimal ergonomic compatibility of system components with the overall system goal (Hendrick, 1991); ergodesign ensures the optimisation of ergonomics and design technologies in the creative process.

Through the use of the ergodesign approach in research, acquisition of data and design development, the flow of ergonomic theory into design practice should be greatly enhanced.

During the past several decades, there have been many worldwide debates (Cross, 1984; Jones, 1974; Bonsiepe, 1995) within the two disciplines to define whether they fall into the realms of science, technology or art. My personal view is that both ergonomics and design embrace all three domains - of art, science and technology. Perhaps ergonomics is more science than art, and conversely, design is more art than science! When the two disciplines are combined into ergodesign they complement each other to form a powerful, enhanced technology, with

capabilities of solving multi-dimensional problems that will be demonstrated in the present study.

The need for incorporating ergonomic principles in the design of equipment and systems is universally accepted. While the integration of theory and practice from ergonomics and design - as separate disciplines - can each contribute to the improvement of equipment and system design, ergodesign as a conjoint discipline is a significantly improved tool for solving human factors and design problems encountered in all complex systems.

The proliferation of advanced technologies has witnessed the development of new ergonomic tools to address the subsequent expansion of more complex systems. These include the "interface" ergonomics mentioned earlier, the more recent Sociotechnical System, Macroergonomics, Human-Computer Interaction or HIC, Organisation Design and Management or ODEM, and others.

In equipment and system design our understanding and application of ergonomics in the creative process has developed to a point that it is now too vast for it to be subsumed in its existing form. It is becoming increasingly impossible and confounding to delineate the human factors and design elements separately. Nor is it necessary to do so. It is becoming impossible to decide when ergonomics ends and when design begins during system development.

The Ergonomic Approach - even under its expanded form - Macroergonomics, still presents problems in terms of accessibility for the designers. Disciplinary barriers remain: ergonomists solve problems by analysis; designers solve problems by synthesis. The two activities are at opposite ends of the design process. Perhaps this is the reason why ergonomics has established itself remarkably well as a science. As a technology, however, the contribution of ergonomics has been less successful.

4.1 ERGONOMIC THEORY TO DESIGN PRACTICE

There are still considerable difficulties within the discipline in transforming much of its theories into sound design practice. One of the main reasons for these difficulties is that most ergonomists are not interdisciplinary and are trained to develop knowledge about human performance capabilities and limitations, as they relate to the design of the interfaces between humans and other system components. As scientists, they are not trained to participate in design or organise their findings in a format that is useful to the designers. Ergonomists are researchers and problem describers in the human-machine-system - they are not problem solvers in the design process.

Van Cott (1971) believes that the application of ergonomics research to system design has been less than optimal. He reviewed Volumes 7 to 9 (1965-67) of the "Human Factors" Journal and estimated that:

25% of the human factors (ergonomics) reported were professional affairs

35% were new knowledge/methods not suitable for direct application

13% were theory not directly applicable to design

25% of research has some potential of ever being applied to the design of improved human-machine systems. However, only 12% or half of the 25% were actually implemented applications.

While this review was done a long time ago, the situation appeared not to have improved to any significant extent in the 1980s and 1990s. For example, of the 70 papers delivered at the Joint International Ergonomics

Association/Nordic Ergonomics Society Conference held in Oslo, Norway in 1980, only 11 were published in full. Despite the conference theme - "Ergonomics in Action: From Theory to Practice", only four of the published papers were actual implementations applied in human-machine system designs (Ergonomics, 1980, Vol.23, No.8).

Likewise, out of 607 papers presented at the 11th Congress of the International Ergonomics Association in Paris in 1991 (Queinnec and Daniellou, 1991), less than 10% of the papers were actual implementations in equipment and system design. The theme of the Congress was "Designing for Everyone"!

Probably, most ergonomists will agree that both researchers and practitioners are required for the growth of the discipline. Hence, ergonomics must function both as a science and a technology.

However, the success of any science must invariably be measured by the degree it is implemented in tangible and useful applications. In this respect, the potential of ergonomics as an applied technology has been grossly under utilised.

Ergonomic methods, procedures and techniques that have been designed to help designers solve ergonomics problems are well documented. However, much of the methodologies that were conceptualised in the war years (the formative stages of the discipline) - whatever value they might have served - have seemed to outlived their usefulness and are requiring urgent reviews (Cross, 1984).

Ergonomic methods, procedures and techniques are often complex, and at best are theoretical in nature. They usually consist of a series of "sub-

routines" in hierarchical order. In many cases, methods, procedures and techniques, because of their complexity - will actually obstruct rather than aid the design process.

Generally, methods, procedures and techniques for solving ergonomic design problems tend to consist of four main steps - problem-identification and formulation, experimentation, application of proposed answer to the problem, and validation. While this is all very logical, there are still many obstacles or constraint that hinder the smooth flow of ergonomic theory into design practice which demand urgent rectification (Lawson, 1980; Jones, 1974).

Whether the problem of application is in fact a failure of the designer to synthesise and integrate ergonomic data into design solutions remains questionable. But, if our main goal is to support the design profession, and if ergonomics is to function as an effective technology that supports system designs - then it is the responsibility of the profession to cast its data in a format that is suitable for design applications. Alternatively, the profession should set higher goals and establish more effective strategies in order to improve the profile of ergonomics as a sound technology. It is believed that we must do both, and the proposal of "Ergodesign" as an ergonomic-design tool is a development in this direction.

Ergonomics in its present form is not usually compatible with the creative process. One must not assume that design is a logical, systematic, step-by-step process. Design is not merely a process governed solely by technical equations (Meister, 1971). It is the designer and not the equation, method or data who does the designing. Methodology and data are usually considered by designers as obstacles because they constrain the intuitive creative process during design and system development (Yap, 1987).

It is considered that, in its present form, ergonomics is not integrative or holistic enough to merge seamlessly into design and vice versa. This is often merely an artificial barrier that divides two closely-related disciplines with almost similar aims, objectives and scope.

4.1.1 Ergodesign : Its Synergy and Symbiosis

Akin to the development of system ergonomics, macroergonomics, Human Computer Interaction (HCI) and Organisational Design and Management (ODEM), and indeed the birth of ergonomics as a discipline itself, Ergodesign is an important concept developed to bridge and to streamline the interactions between the two disciplines. Ergodesign effectively erases the artificial barriers between the two disciplines and consequently improves their applicability in the design process. The synergy and symbiosis of this union will result in a significantly improved inter-discipline technology for the creation of equipment and environment in a complex system, such as the one under study.

Throughout this study, the term ergodesign is used to describe common human and design factors where they are deemed unnecessary to be considered separately. However, ergonomics and design will also be used in their original meaning where appropriate.

4.1.2 Ergodesign Approach

The creation of new ideas, concepts and solutions to problems are both inventive and design activities. The ergodesign approach is a creative macroergonomic approach which addresses human and system attributes simultaneously with conceptualisation and design development. As a technology, ergodesign has a design orientation which makes it an important tool, both in scope and implementation for the design and evaluation of the obstetric system under study.

4.1.3 Ergonomics and Design Criteria

The ergonomics and design criteria for the design of the obstetric system have been acquired from detailed research and analyses involving literature reviews; potential user surveys; opinions from obstetricians, midwives and birth educators; and concept developments and mockup evaluations to ensure human-equipment interface compatibility.

Conceptually, the ergonomics criteria for the design of a body support system for "active" childbirth must be based on the analysis of each activity involved in the birth process. Firstly, the safety of the mother and the baby - the complex physiological, biomechanical, anatomical and postural considerations of the mother. Secondly, the physical tasks, capabilities and limitations of the caregivers (obstetricians and midwives), and the clinical factors arising, if any from the use of the body support system. And lastly, the importance of the less tangible, but equally relevant psychological factors surrounding the cultural aspects, birth attitudes, comfort and confidence that may inhibit active spontaneous birth and confidence in the use of the equipment or posture.

4.2 DEVELOPMENT OF USER AND SYSTEM DATA

For most equipment and system development in industry, the ergonomist's or the designer's tasks are made significantly easier with the amount of published information and data as well as tools and methodologies currently at his disposal.

Unfortunately, this is not the case for the present study. While the literature pertaining to obstetrics, nursing and midwifery is extensive, there appear to be very few published ergonomics or design-related studies on the subject. Therefore, most of the ergodesign data has to be generated

through inquiries, discussions and through the process of conjecture and refutation.

The ergodesigner plays a critical role in equipment and system design and development. Besides being the sole researcher in the acquisition and selection of ergonomic and design data, he represents the mother, baby, midwife and obstetricians with respect to their safety, comfort and ease-of-use of the obstetric system. He also acts as a change agent to ensure that the system is implemented smoothly and enthusiastically.

In conventional systems, design is derivative. Each successive design being an improvement on a previous one. The ergodesign development cycle is reasonably straightforward and short. Existing knowledge gained from past developments reduces trial and error (Van Cott and Kinkade, 1972). The ergodesigner is predominantly concerned with optimisation through minor modification of the hardware. For example, the development of a new task light for use with a computer workstation, or a new ergonomic keyboard, or the redesign of a VCR, would fall into this category of traditional human-machine optimisation.

In the present study, the ergodesign criteria that are required are not only much more complex and difficult to acquire, they have to be generated. For new and original system development - such as the obstetric system would be - new insights, approaches, techniques and data are required. Analytical models must be developed and exploited before detailed design can commence (Van Cott and Kinkade, 1972).

In the present study, the ergodesigner is concerned with many aspects of the system - ranging from consideration of the role played by obstetricians and midwives, the management of labour and childbirth, the clinical

ramification, and the conceptualisation of an obstetric system that will make delivery more efficient for the caregiver and, labour and childbirth safer, more physiologic and enjoyable for the mother. He is also concerned with describing and analysing the less tangible contextual needs in the system, such as psychological and emotional needs of the caregiver and the mother.

At the start of the system design process the task of the ergodesigner is primarily as a researcher, generator, organiser and provider of information, to provide the necessary data for system development. For the development of a traditional system the information and design tools required may be readily available in case studies and published materials. For the development of a new system - such as the present obstetric system - the ergodesigner must not limit his options to these sources, but to be alert to other sources, particularly those which bear on the cultural context in which the equipment is to be used, and the design characteristics of the design itself. Thus, it was deemed necessary in the present study to undertake detailed analytical studies in the historical, cultural, medical, technical, psychological, physiological and biological aspects of childbirth and its management. These have been reviewed in Chapters Two and Three of this thesis.

4.2.1 Acquisition of Data : Its Challenges and Problems

The acquisition of the required data for system development presented considerable challenges, problems and time involvement. As has been mentioned before, there is very little published work specific to childbirth in the ergonomics literature. The complexity and cultural aspects of childbirth which assumes total privacy have precluded observation and other direct involvement. Until recently even the mother's partner or

husband was not permitted into the labour ward. The situation is exasperated by strict hospital protocol regarding human research and experimentation, especially in childbirth.

Professional posturing between obstetricians and midwives, and the Department of Health in the years just before and after the implementation of the Nurses Amendment Act in October 1990 coincided with the critical research period of this study and provided extra challenges to the researcher. The Act increases the choices available to women and their family in childbirth services by restoring autonomy to midwives, who were hitherto limited by legislation which allowed only medical practitioners to take full responsibility for the care of the women during labour and childbirth.

4.3 CHILDBIRTH AND WORK : A COMPARISON OF "PHYSICAL LOADS"

Labour and childbirth is a multidimensional and critical experience. The psychological stresses and pain have been described by some women as "excruciating". In an attempt to draw a comparison between the relative "loads" of childbirth and physical work, it would appear that common ground is difficult to establish. However, some interesting indicators of extreme physical work are summarised below.

Luczak (1992) outlines several methods for determining "work under extreme conditions" such as climate, acceleration and air pressure. While these are related to work in industry, and do not seem to have any practical use for the present study, he highlighted situations that have parallel in labour and childbirth. He asserts that any survey of work under extreme conditions is an extreme task in itself. It is extremely wide as it is not

possible to delineate all extremes. It is extremely specific because an extreme has to be considered in ergonomic terms with respect to its cause and effect. Thus any evaluation requires extreme expertise. This relationship between breadth and depth creates a dilemma that requires the researcher to either give up expert status in order to cover all extremes, or to restrict work to themes which lie within the span of the researcher's scientific area of expertise!

Laczak defines work under extreme conditions as "not normal" stressor conditions. While childbirth and physical work share some common grounds with respect to the fact that both are physiological functions of the body, it would appear inappropriate to measure the "physical loads" of childbirth with formulae that are designed specifically to measure work in industry. However, in ergonomic terms, the definition of "extreme" load requires some common and meaningful description, in order to facilitate a quantitative or qualitative meaningful reporting.

Work under extreme conditions is determined, to a considerable extent, by notions of "deviation" and "adaption". There must be a certain distance from what is considered as normal, prescribed or acceptable. Also, there must be a mismatch between the objective situation, such as external demands, etc on one side and subjective capability, such as reactions, behaviour, (pain?) on the other. He went on to describe "extremes" in psychological, technological, economical and sociological terms that have been used to measure work in industry situations.

In scientific terms the responses that best describe the "extreme" in childbirth is the phenomenological aspect in physiological terms. Phenomenological aspect of physiological "extreme" may be the organic system of control of physiological functions or deviated/destabilised until

near their stability reserve, the dynamics of responses to a stressor are completely or approximately exhausted. Life functions reach the limits of their possible ranges or exceed preset tolerability standards. The phenomenological extreme described above appears to characterise the extremes in labour and childbirth. However, the "extreme" psycho-physiological experience in childbirth is both more complex and "more extreme" and painful.

While it is useful to make inferences on the methods and criteria used to measure extreme load in industry, the example cited above may not be applicable to childbirth - since labour and birth are "normal" processes. Although the physiological and psychological efforts are usually at their "extreme", labour and childbirth are nonetheless normal processes. Unlike the "extremes" experienced in industrial work which could be reduced or completely eliminated by mechanisation, the "extremes" experienced in childbirth are not imposed by external stimuli. Childbirth is a "live-phenomenon", and the associated "extremes" are "natural". Many authorities are of the opinion that childbirth is part of the developmental process of women and the "extremes" are to be experienced if childbirth is to remain natural. Obstetrical interventions are "attempts" that have been designed during the past several decades, to reduce the "extreme loads" in childbirth. The iatrogenic risks and other ramifications of "invasive" obstetrics ^{have been} ~~will be~~ discussed in Chapter ^{Two} ~~Three~~ and Chapter ^{Three} ~~Four~~.

It is beyond this study to probe much more deeply into the "physical loads" of childbirth. However, the present study is undertaken with the belief that it will reduce, relieve or abate some of the "extremes" that are inherent and essential to childbirth.

CHAPTER FIVE

SYSTEM DESIGN AND DEVELOPMENT

5. DEVELOPMENT OF AN OBSTETRIC BODY-SUPPORT SYSTEM

The functional quality of the obstetric system will depend primarily on the ergodesigner's ability to create the overall "good-fit" between user and hardware in the human-equipment interface. The range of use and user is extensive and complex. To accommodate this range optimally, consideration of the caregiver's, mother's and baby's needs, safety and function are paramount, and have to be carefully researched and incorporated into the system during the design development process.

The ergodesign approach provides an effective interdisciplinary system design and implementation instrument that is both scientific and creative.

The design philosophy that is considered to be of paramount importance for the design and development of a system for childbirth had been established before system design began. The principle embraces three fundamental design criteria that will guide and determine system design and implementation.

Firstly, the most important criterion is the focus on the safety, wellbeing and the role of caregivers in the obstetric care system.

Secondly, the ergodesign objectives which have their origin from the above human needs, must benefit the mother, baby and caregiver, in a way not only in terms of how labour should be managed, but the psychological and physiological qualities of birth must also improve.

Thirdly, the system will be designed with the aim that it will result in widespread use. The study and the subsequent system implementation will play a major catalytic role that supports and participates in the establishment of natural and physiologic birth culture.

5.1 SOME TRADITIONAL DESIGN MODELS AND METHODS

Before we consider on the design and developmental aspects of the obstetric body-support system through the ergodesign approach, it is both worthwhile and necessary to assess some traditional industrial design and system design models and their methodologies.

Models of design activities, their characteristics and effectiveness, are few and patchy. However, concepts such as "user-centred design", "person-centred design", "human-centred design", "user-friendly systems", "ergonomically-designed system" and so on are some recent design developments that have an ergonomic orientation.

Models of design have been around for almost as long as ergonomics. They appear in different forms to describe different methodological frameworks according to their area of application.

The most significant and well known model which had been used extensively for system development in the early 1960s and beyond, explains the process of design in three activities (Jones, 1974):

- Analysis:** the investigation of the problem, the finding and the articulation of requirements to be fulfilled, and the assembling of data
- Synthesis:** the using of requirements and data and the conceptualising of a design
- Evaluation:** the checking of the design against the requirements and the provision of feedback for future designs

Lawson (1980) in his book "How Designers Think" summarises the creative process as consisting of five stages as follows:

- First Insight:** recognising that a problem exists and determining how to tackle it
- Preparation:** attempts to understand the problem and to produce a solution
- Incubation:** periods of relaxation allowing subconscious thoughts
- Illumination:** sudden emergence of the idea - the act of insight or creative leap
- Verification:** conscious development and testing of the idea into a workable solution

Perhaps more akin to the present study is the four-phase system development process proposed by Van Cott and Kinkade (1972). It is in a form of a series of questions to prompt the designer to consider the important actions during system development. The major points are summarised below.

Preliminary Design Phase:

- Why is this system being sought? How is the system to fulfill its mission?
 In what environments must the system function? Who will benefit by system operation? What are the major technological options?

Advanced Design Phase:

What functions should be assigned to humans? What information is required by operators? How many humans are needed to operate the system? How should the assigned functions be distributed? What specific devices, tools or controls are most appropriate to the tasks?

Mock-up to Prototype Fabrication Phase:

What options are available for eliminating, combining or simplifying any of the instrumentation? What will be the effect, if any, on human performance safety or moral of any proposed changes in configuration or instrumentation? What safeguards, if any are required to ensure adherence to the design plan and functional requirements of the system?

Test and Evaluation Phase:

By what means can test and evaluation be made as realistic as possible in terms of the ultimate operator and support personnel and in terms of the operational conditions? What criteria are logical in terms of the mission and functions assigned? What form of test design will yield unequivocal answers to questions of the effectiveness, operability and maintainability of the system?

With the benefit of hindsight and experience in our design and developmental study of the computer system for intensive care (Galer and Yap, 1983), and the present study, it is important to emphasise that the design process is not a linear process. Design is a random and cyclical process. The models and methodologies presented above should not be taken as being prescriptive, in the sense that they must be followed in rigid sequence.

Design models, methods and tools are merely theoretical guides for the novice. Hendrick (1991) maintains that it is possible to design an outstanding system component, modules and subsystem, which may yet fail to reach relevant system effectiveness goals because of inattention to macroergonomic design of the system. However, used creatively, such as ergodesign would be, and with adaptation to suit the system design requirements on hand, the models provide the invaluable methodological frameworks and design procedures that will lead to better equipment and systems that are compatible with the users. This is achievable particularly if the framework proposed by Van Cott and Kincade (1972) is followed.

5.2 THE SEVEN ERGODESIGN PHASES

The present study could be delineated into seven phases in the system development. While in many areas the various phases overlap, they nevertheless can be categorised as follows:

- 1) Rapport Building Phase
- 2) Feasibility Studies Phase
- 3) Concept Design Phase
- 4) Mock-up and Interim Evaluation Phase
- 5) Detail Design and Specification Phase
- 6) Development of Prototype Phase
- 7) Evaluation Phase

5.2.1 Rapport Building Phase

In a technological world, we are all faced with developmental changes in the way we play, work and give birth to our babies as consequences of improvement and better ways of doing things.

The essence of the present study is about changes that will affect mothers, midwives and obstetricians profoundly in the way mothers labour and give birth and in the way caregivers manage labour and deliver babies. The extent to which mothers and caregivers will accept or reject these changes and the ways they cope with the changes will depend largely on how the changes are introduced and implemented.

As a change-agent, the ergodesigner generates the new birthing system, the success of which is dependent entirely on the participation of the midwives and obstetricians as change-implementers, and the mothers as change-adopters.

The process of system development and planned change is a collaborative process between the ergodesigner, midwives, obstetricians and mothers. Because childbirth is usually conducted in almost absolute privacy, the ergodesigner had to establish a consultative approach to acquire relevant information and insights before system development could commence. There are a variety of aspects - ranging from customs, preferences, postures, management styles in obstetrics, drugs and technology, to safety and wellbeing issues affecting mothers, babies and caregivers - that need to be considered and discussed. The establishment of a consultative process whereby rapport and trust is built between mothers, caregivers, ergodesigner and hospital boards, and their subsequent participation is indispensable for ensuring successful data acquisition, system development and system implementation.

The rapport building phase occupied a considerable length of time and patience and consisted of the following activities:

- Realising that problems exist in the management of labour and childbirth, a series of letters were written and sent to 12 obstetricians in the Wellington region to explain the nature of the study and to solicit their advice and participation. The response was disappointing. Only one obstetrician replied upon receipt of the first letter; four replied upon receipt of the second letter and three more obstetricians responded upon receipt of the third letter. As the study has progressed, some 10 obstetricians have expressed their interest to participate, in particular, to assist in the evaluation of the prototype. Five obstetricians have subsequently been interviewed and have provided invaluable advice on the subject.
- Met and discussed the nature of the study with a physiotherapist and three other birth educators and parents at the Mana Parents Centre, Kenepuru Maternity Hospital. As mothers and parents, they were very enthusiastic and provided vital information on many aspects of active birth.
- Consulted the charge nurse, obstetricians and midwives at the Maternity Unit, Wellington Hospital.
- Consulted the charge nurse, staff midwife and staff nurse at Kenepuru Maternity Hospital, Porirua.
- Consulted obstetricians Dr Philip White, Dr Larry Jordan, Dr Robinson and Dr McLennen in their respective surgeries.

- Attended a six-week antenatal class at the Kenepuru Maternity Hospital with 12 expectant mothers. This provided an excellent opportunity to solicit an in-depth understanding from a group of potential users. Very useful information regarding labour, birth and birth postures, drugs, labour pain and most important of all the development of good rapport for mutual discussions.
- Attended a One-day Home Birth Seminar where mothers, midwives, and obstetricians presented papers on a range of issues regarding childbirth.

Besides the numerous aspects that would need to be considered, it is essential that everyone involved and affected by the change process are consulted not only at this initial stage but at every stage of system development. It is generally considered that change generated from the "bottom up" approach is more likely to succeed than one that is imposed from the "top down". Therefore the time and effort spent on this phase of the study was quality time well spent.

5.2.2 Feasibility Studies Phase

This phase of the study may be described as a continuation of the fact-gathering rapport building phase. These initiating phases provided an invaluable opportunity to introduce the nature of the project to the various users, and of equal importance, this phase of the study enabled the ergodesigner to gather more concrete and detailed information to ensure that the subsequent design would have adequate compatibility between users needs and system features.

From the literature reviewed and opinion expressed by midwives, obstetricians and mothers themselves, there is now unequivocal agreement that the most physiologic and preferred birth postures are the upright postures including sitting, squatting, kneeling and supported semi-standing. There is no existing scientific study, especially in the ergonomics literature on how these postures might be supported without confounding the birth process. There is also no example of well-designed equipment in the hospitals in Wellington. Up until now, mothers who choose to labour in the upright postures have to improvise by sitting on toilet seats, beanbags, chairs tied together, or held by friends and partner to assume the upright posture.

Discussions concerning the type of "desired" systems, different stages of the birth process, caregivers expectation and task requirements, safety and wellbeing of mothers and babies were made during the feasibility study phase. The information gathered provided the insight and confidence for the ergodesigner to develop the obstetric system that is expected to meet users and system requirements.

5.2.3 Concept Design Phase

The concept design phase is the creative phase where human factors and clinical information are synthesised and transformed in design solutions through the creative process. This is a critical phase when mistakes can be made, when over-enthusiasm or narrow mindedness and preconceived ideas can prevail and when valid experience, analytical skills and sound judgement are necessary to avoid any misguided investment of human effort (Jones, 1974), that may be confounding to system goals.

At this stage of the study, the ergodesigner was sufficiently informed on the subject, possibly better informed than some caregivers and mothers in both the width and depth on a range of subjects relevant to the study. However, he was still being considered as an "outsider" of the disciplines of obstetrics and midwifery. Naturally he lacked the experience and skills of the mother and the caregivers.

Given the benefits of the new knowledge, gained during the study, the ergodesigner must now work proactively and professionally in his proposal of design concepts. This is a phase when human factors, design elements, value judgement, safety and comfort issues, as well as the scientific and technological aspects of system design are integrated to reflect ergonomic and functional requirements of the proposed system.

The primary aim of this phase of the study was "conceptual", and the objective was to externalise what the ergodesigner was thinking, and about to create, to the parties involved. It was a participatory ergodesign approach where the knowledge, skills, experience and opinion of the caregivers and mothers were enlisted. It was an important phase for soliciting inputs from a divergence of experience and know-how to counteract any false assumptions that the ergodesigner might have held; before the proposed concepts are transformed into reality. This was a phase where the ergodesigner's intentions were tested and criticised, where constraints were recognised, where critical ergonomic and design variables were identified, where ideas were realised, and where the parties involved were synergised.

Jones (1974) maintains that the global system requirements may be split up into sub-problems each of which is judged to be capable of solution in series, or in parallel, and in relative isolation. This is exactly the way this conceptual phase has been delineated.

The concept design phase was broken down into the following six sub-stages to facilitate detailed analyses and design of the various system components:

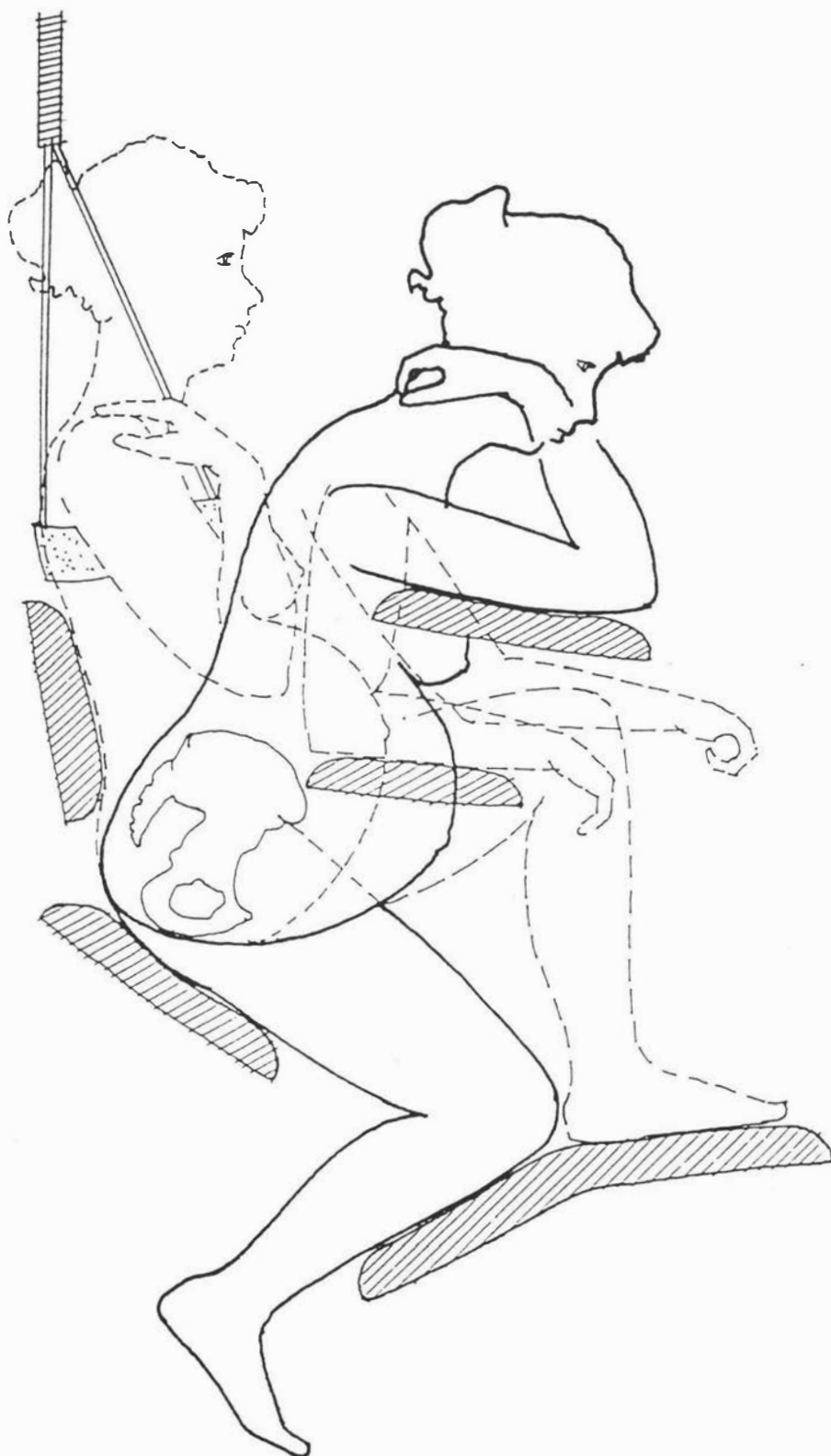
- 1) Exploring Different Birth Postures
- 2) Development of the Pelvic-Support
- 3) Sedentary Anthropometer and Kinestosphere Analysis
- 4) Development of Back and Head-Supports
- 5) Development of Upper Body-Supports
- 6) Development of Foot-Supports

5.2.3.1 *Exploring Different Birth Postures*

The ergodesigner approached this stage of the study with an open mind. Over 20 concepts on paper were presented and discussed with midwives, obstetricians, mothers and birth educators. This was narrowed down to five novel categories of systems whereby a woman could be supported to labour in the upright position. The drawings show the woman in a variety of relaxed kneeling, sitting and semi-squatting positions. They also show different upper body positions and a variety of hand and leg supports. These include:

- 1) A body-harness system whereby a woman is strapped under the arm and suspended on a frame with her hands and legs free. All the four major upright postures - standing, kneeling, squatting and semi-sitting - can be achieved by adjusting the length of the straps. (Figure 5.1)
- 2) A body support system for underwater birth. (Figure 5.2)

- 3) A two-person support system, with the birth partner sitting behind and supporting the woman in labour. (Figure 5.3)
- 4) A simple support system that resembles an office chair. (Figure 5.4)
- 5) A fully articulate and adjustable support system that resembles a dentist chair with pushbutton or foot controls. (Figure 5.5)

**FIGURE 5.1****CONCEPT PROPOSAL: A BODY-HARNESS SYSTEM**

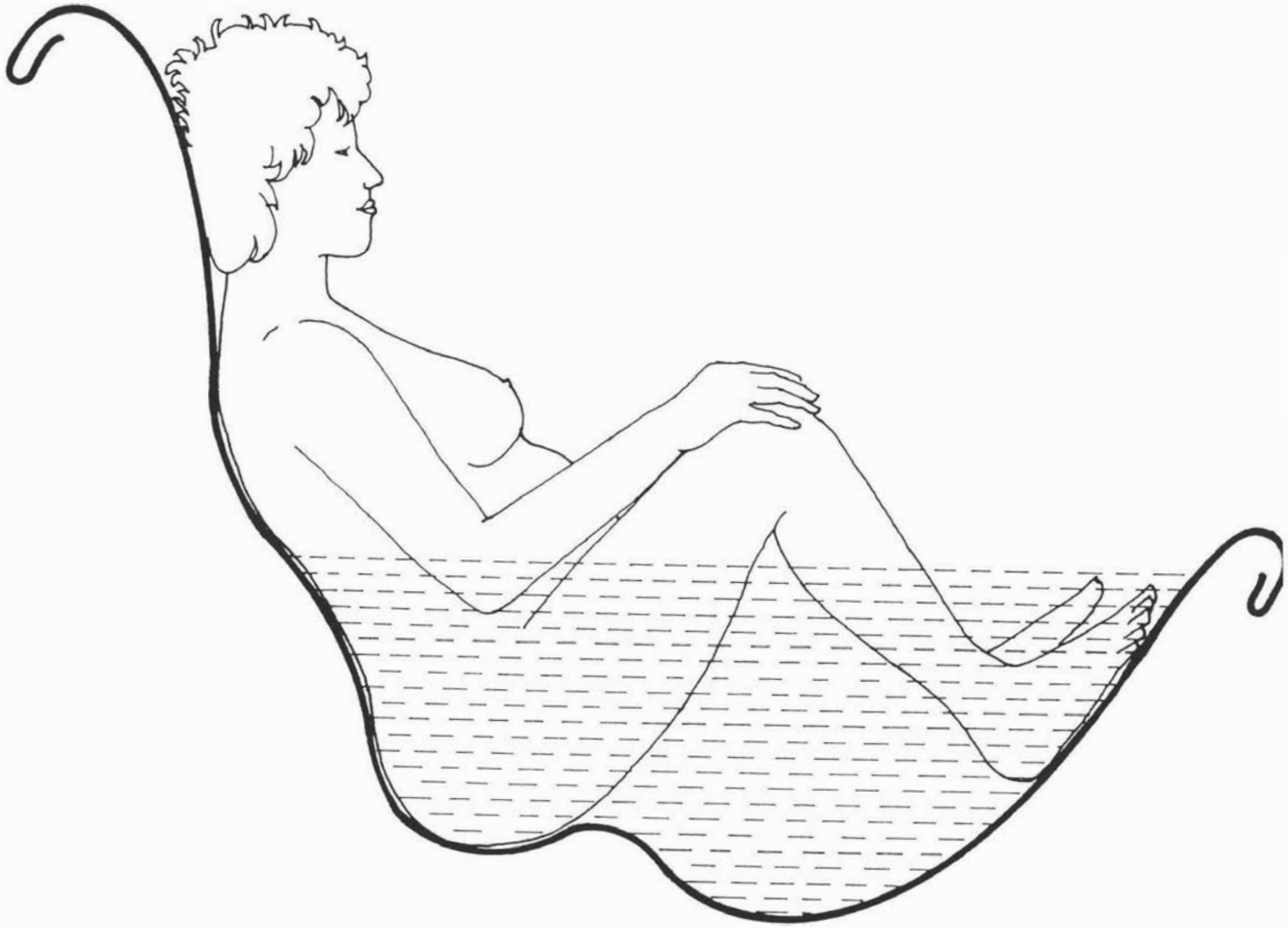


FIGURE 5.2

**CONCEPT PROPOSAL: A BODY-SUPPORT SYSTEM
FOR UNDERWATER BIRTH**

**FIGURE 5.3****CONCEPT PROPOSAL: A TWO PERSON BODY-SUPPORT SYSTEM**

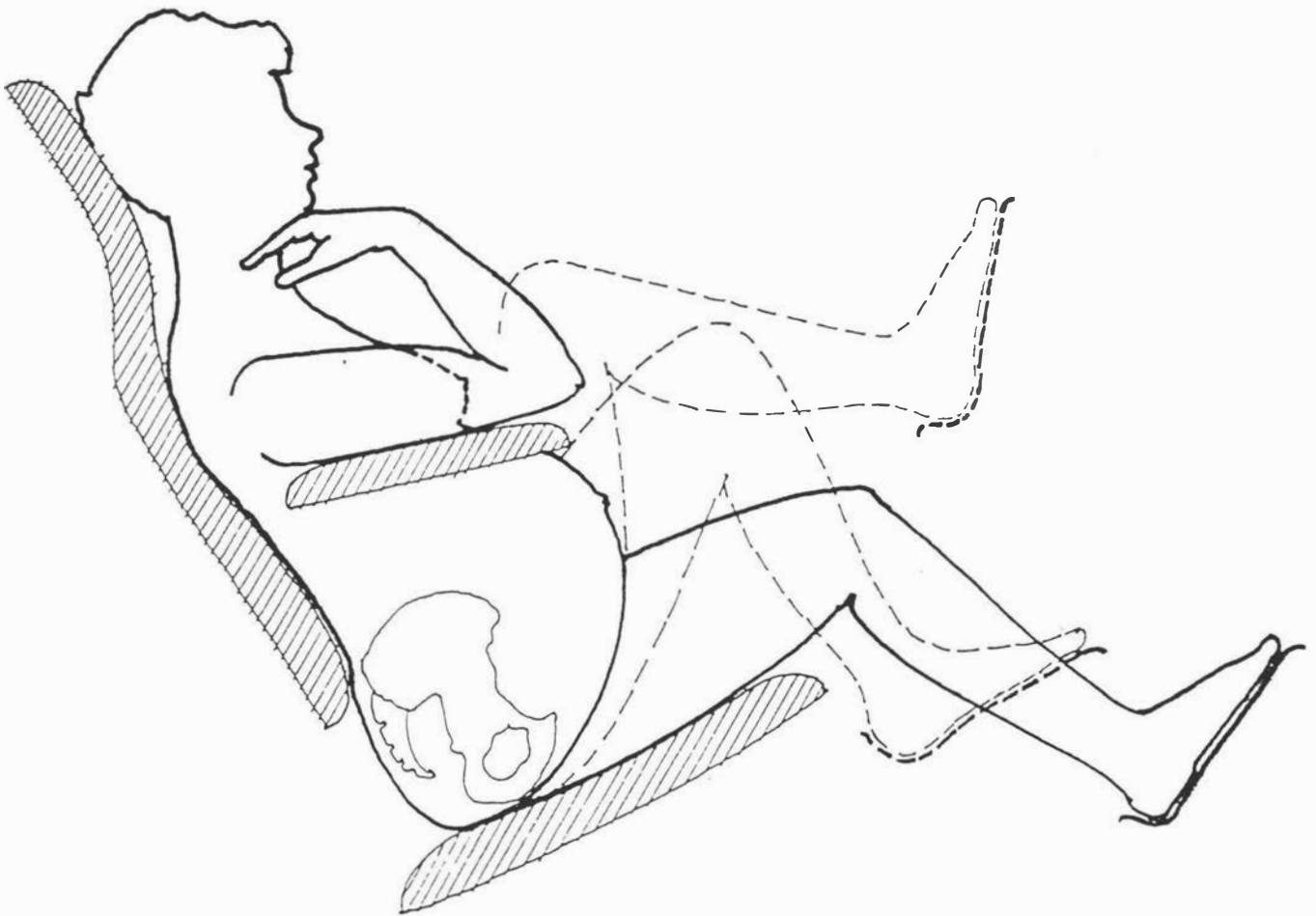
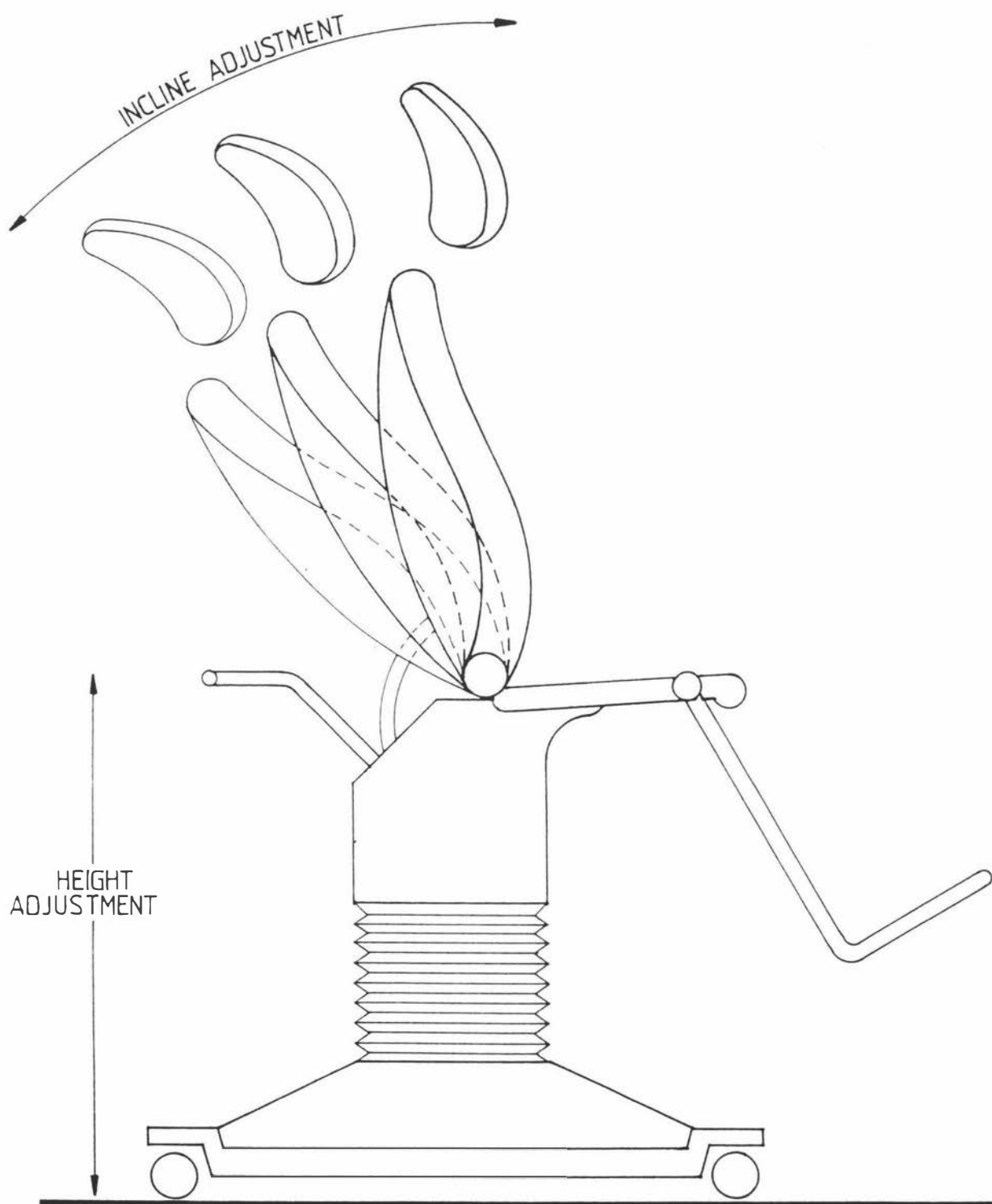


FIGURE 5.4

**CONCEPT PROPOSAL: A SIMPLE MANUALLY
ADJUSTABLE AND ARTICULATE BODY-SUPPORT
SYSTEM**

**FIGURE 5.5**

CONCEPT PROPOSAL: A FULLY ADJUSTABLE AND
ARTICULATE BODY-SUPPORT SYSTEM WITH
ELECTRIC CONTROLS

From the discussions that were generated by these conceptual drawings, the ergodesigner was able to eliminate the kneeling and, possibly, the squatting postures due to safety and "access" problems. Both kneeling and the supported standing postures were considered to be unstable positions for childbirth. While the squatting position had many advantages over the sitting position because the woman's perineum is unobstructed, it also had some disadvantages. Squatting is an unstable posture and for some women, especially women in the developed countries, it can be uncomfortable to squat for more than a few minutes. For ergonomic and safety reasons, a compromise was reached, which involved the design of a system to support the woman in the sitting position.

It is of course possible to develop 5-10 design variations from each of the five categories of support systems, besides other inter-category permutations. With so many latitudes and alternatives to consider, significant blunders could still be made at this stage. For example, industrial designers have a tendency to over-create, to impress and to add in extra features. The consequence, as we know, is the proliferation of complicated consumers and capital products such as watches, VCRs, calculators, computers and other home, office or industry equipment.

Our experience in the study of computer systems for intensive care (Galer and Yap, 1982) indicated that sensitive simplification of system components was the key to successful equipment design.

Of the five possible systems cited above, the harness and underwater systems were considered to be too bizarre. Caregivers have reservations recommending them. The two-person system satisfies

only a small percentage of births. Therefore through the elimination process, only two alternatives remain: a manually-operated body-support system and an electrically-operated system.

At this stage of the study, the ergodesigner has also spent a considerable amount of time and effort in the sourcing and experimenting with linear actuators and controls for a fully electrically-operated body-support system. At the same time manually-operated systems are also being considered.

The final decision to design a manually-operated or electrically-operated system must be weighted against the value system, the sensitive nature of labour and birth and the ease-of-use of the system. Throughout the study, the ergodesigner had focused mainly on the human factor aspects of the system. At this juncture the ergodesigner must take a pause to reflect on the essential criteria for good design, and to inquire sensitively what design is best for a good birth.

5.2.3.2 *Development of the Pelvic-Support*

The design of a support that could both maintain the seated position of a woman in labour comfortably and at the same time allowing for obstetric access and the baby to be born safely, presented many challenges.

To be able to design the support as ergonomically as possible, the birth process was analysed in detail so that the subsequent human-equipment "fit" could be optimised.

As has been alluded earlier there was no published data for the sizing and design of the pelvic support. The ergodesigner had to establish the data and generate the design through the following activities:

- A gynecoid pelvis* (with an anteroposterior diameter of 125mm and a transverse diameter of 135mm) was used in a full-size drawing to show the passage, direction and natural turning of the foetus from the mother's pelvic inlet to the pelvic outlet, to the birth canal and to the outside world to illustrate the foetus being born.
- A full-size plan view of the gynecoid pelvis was prepared to show the pelvic inlet and outlet, the positions of the ischial tuberosities, and the coccyx (tail bone) as well as the femurs (thigh bones). It is vital that the ergodesigner develops a good understanding of these anatomical features, their anthropometry, actual sizes, positions and relationship to each other before any design could take place.
- The ergodesigner was able to make use of these visual simulations and information from the two drawings to extrapolate and construct a third drawing, also full-size, which form the basis for the development of the pelvic-support.

* A Gynecoid Pelvis is the normal female pelvis. Approximately 50% of female pelvises are classified as gynecoid, 25% as anthropoid, 20% as android and 5% as platypelloid.

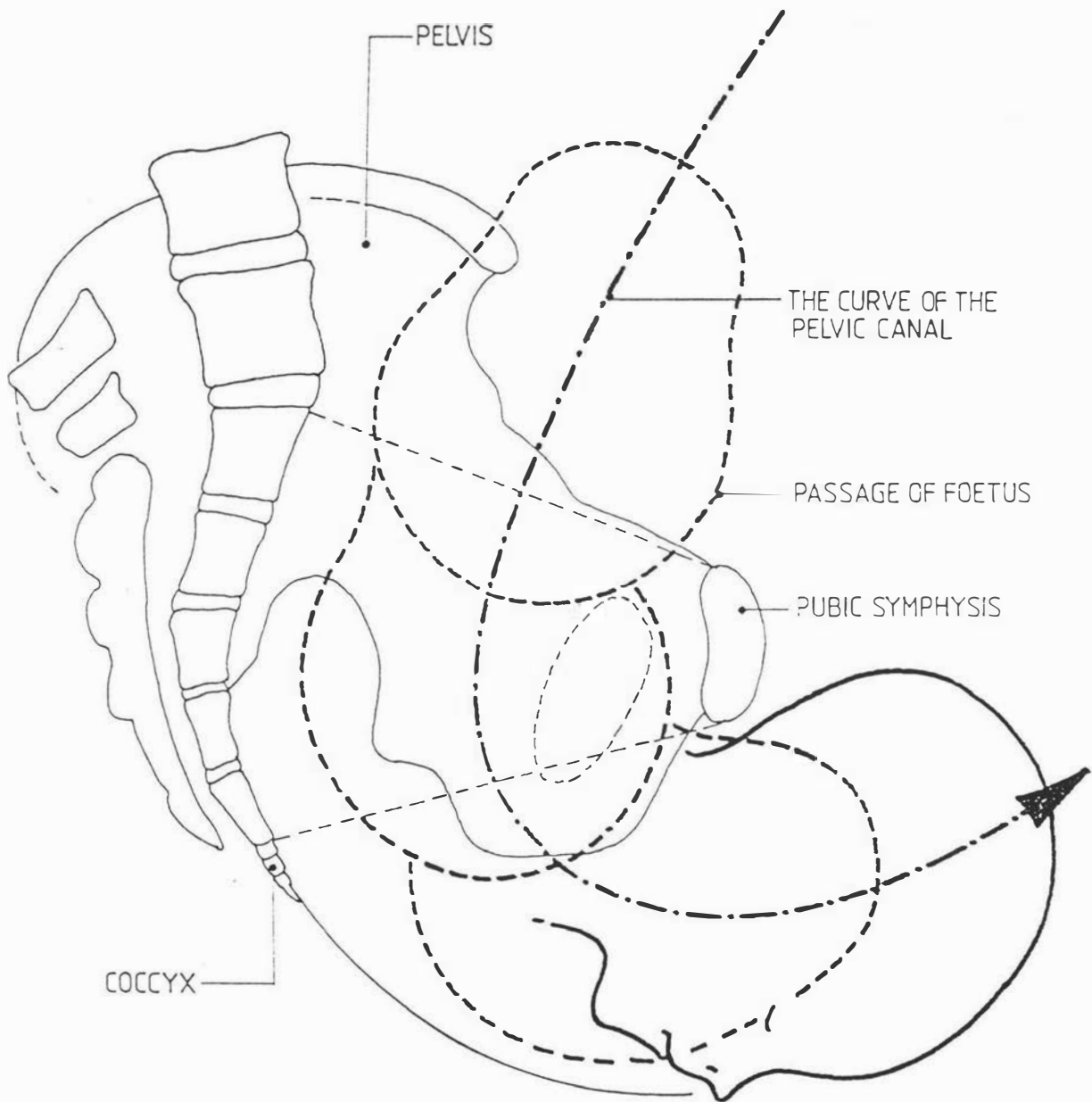


FIGURE 5.6

PASSAGE, DIRECTION AND TURNING OF FOETUS FROM THE MOTHER'S PELVIC INLET TO THE PELVIC OUTLET, TO THE BIRTH CANAL AND TO THE OUTSIDE WORLD
(not to scale)

Armed with these three drawings, a series of consultative discussions were undertaken with caregivers, birth educators and mothers. The feedback from midwives and obstetricians on the clinical aspects was encouraging. It was, however, recommended that the size of the "void" in the support be increased for the safe passage of the baby from the mother to the outside world. The overall concept and dimension were accepted as appropriate.

However, drawings, no matter how accurate they are drawn, are merely two-dimensional representations of the real thing. As dimension and configuration of the pelvic support are likely to play a critical part in influencing the quality and safety of labour and birth, it was considered necessary to conduct more accurate simulation studies.

A full-size, three dimensional model (630mm x 350mm overall dimensions) of the pelvic-support was designed and developed. Using a cadaver female gynecoid pelvis and "baby" - used for teaching midwifery -the model pelvic-support was critically analysed against the pelvis, simulated passage of the baby and other important features, such as ischial tuberosity supports, femur-supports and coccyx clearance. The model was checked to be appropriate by the staff nurse, midwife and manager of the Wellington Hospital Maternity Unit, mothers and birth educators.

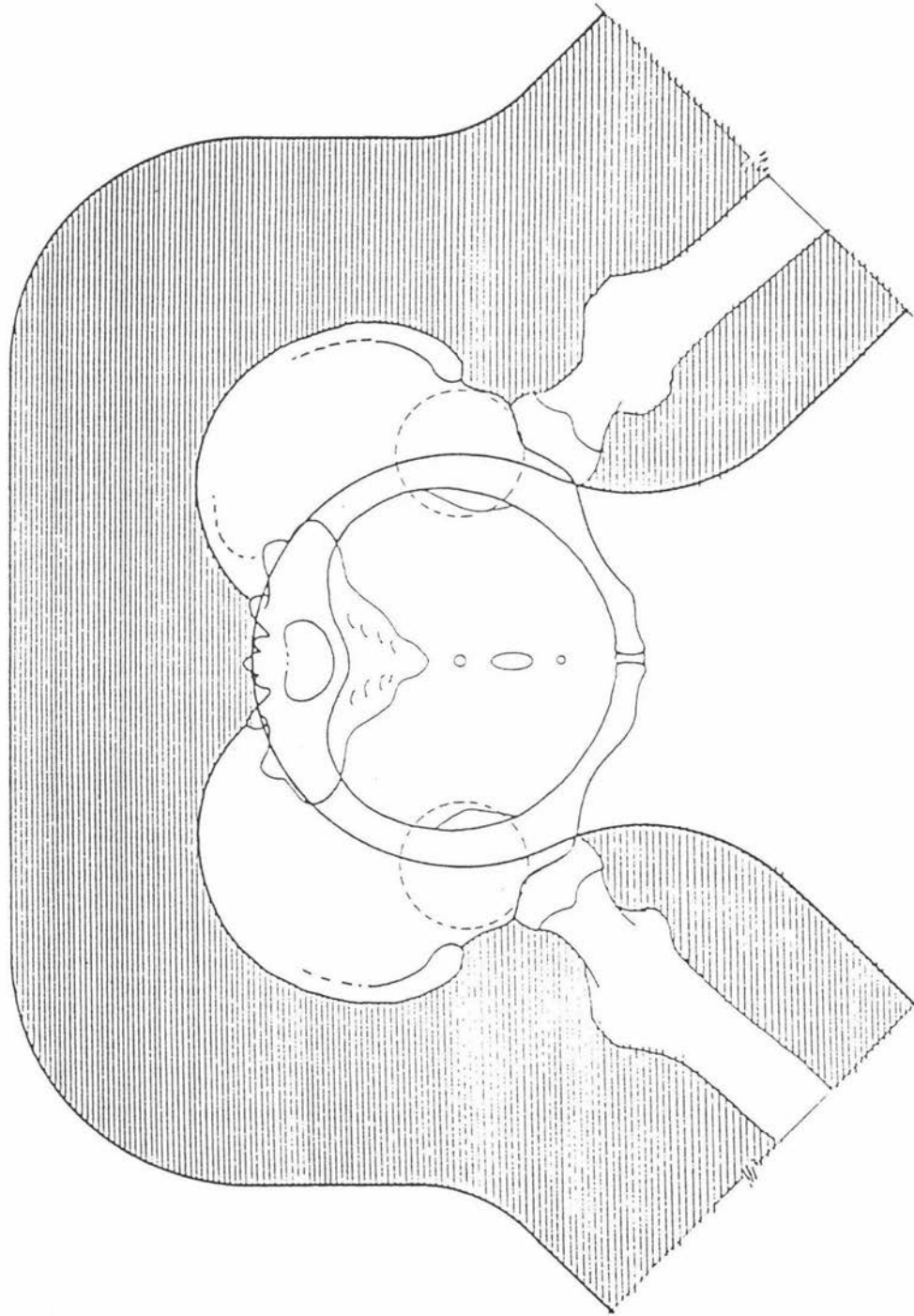
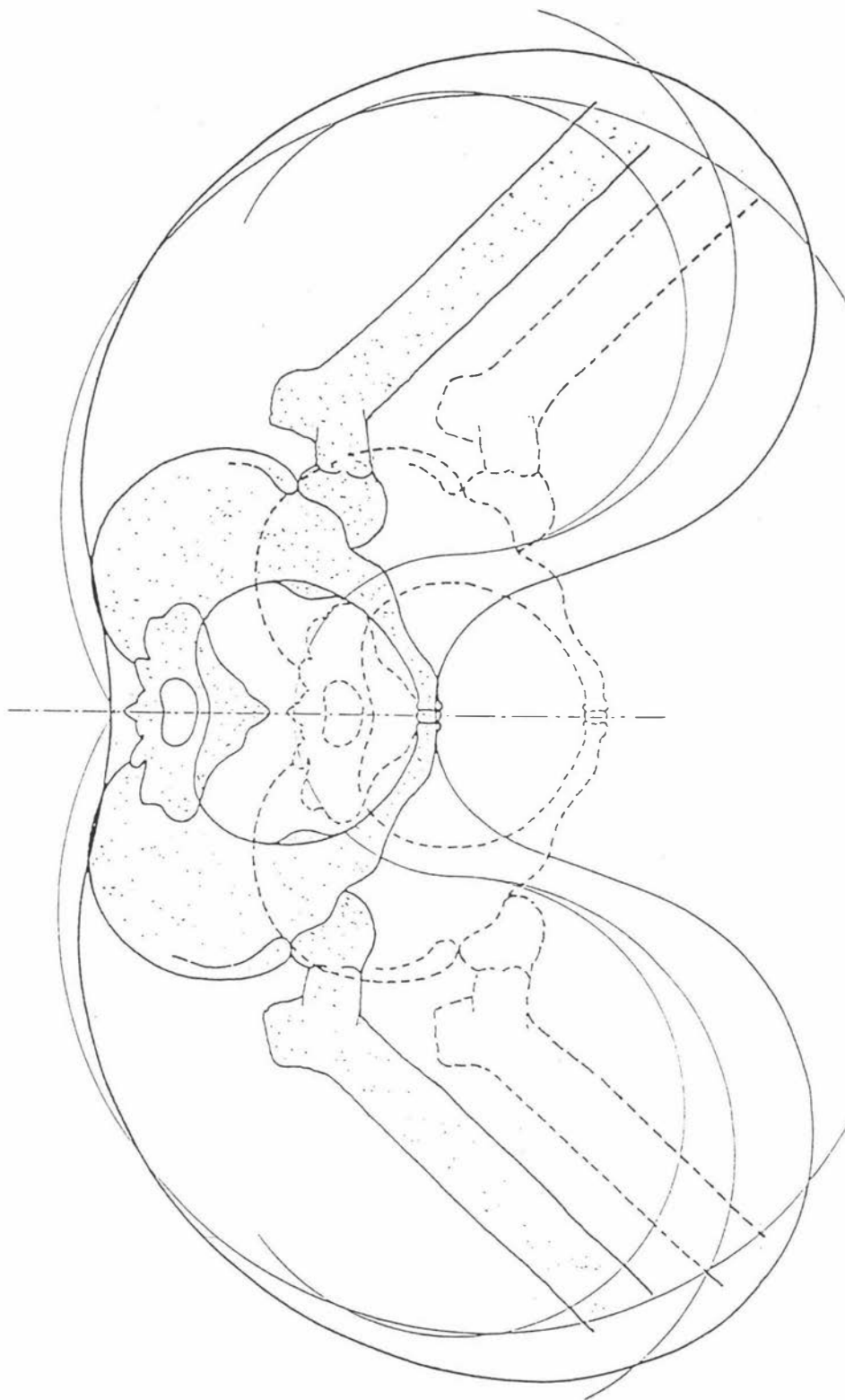


FIGURE 5.7 DESIGN AND DEVELOPMENT OF PELVIC-SUPPORT
(not to scale)

**FIGURE 5.8**

DESIGN AND DEVELOPMENT OF PELVIC-SUPPORT
(not to scale)

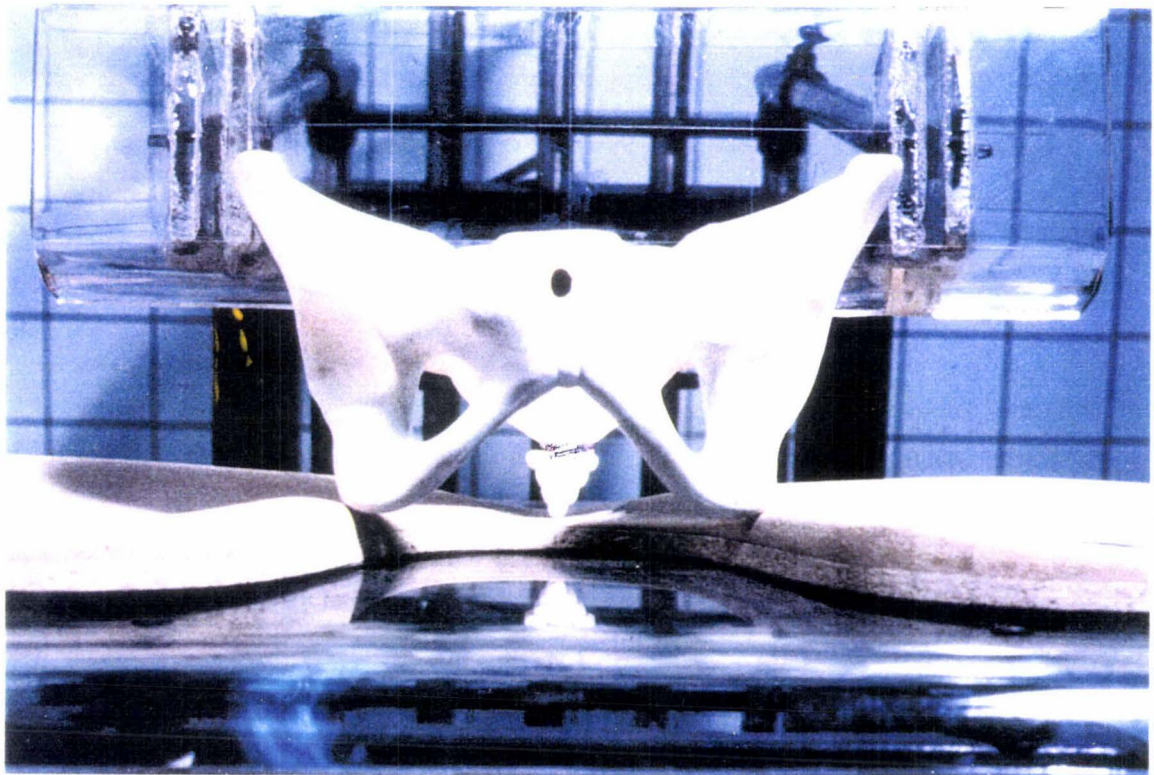


FIGURE 5.9 & 5.10
DESIGN AND DEVELOPMENT OF FULL-SIZE 3D MODELS OF THE PELVIC-SUPPORT - USING CADAVER FEMALE PELVIS



FIGURE 5.11

DEVELOPMENT OF PELVIC-SUPPORT

FIGURE 5.12

CONSTRUCTION OF MOULD FOR PELVIC-SUPPORT

5.2.3.3 *Sedentary Anthropometer and Kinetosphere Studies*

At this stage, it was considered necessary to analyse the whole obstetric system. The *sedentary anthropometer and **kinetosphere at the Wellington Polytechnic School of Design were used to simulate the overall system. A colleague and his pregnant wife volunteered as subjects for the study.

Simulations were made of the woman labouring in various body positions in the sitting postures, and the husband acting as the obstetrician. Such simulations were considered to be important as they enabled the ergodesigner to establish the overall system layout, body clearances, dimensions and configurations of the system. The role-plays of the labour scene, acted out by the "mother" and "obstetrician" in advance enabled the ergodesigner to evaluate and gain confidence of all the system components before the final design was "frozen".

Both the sedentary and kinetosphere studies were recorded on slides to enable the ergodesigner to further study and analysis in more detail at different phases of system development. Following the birth simulations, the back- and head-supports, upper body-supports, foot-supports and the caregiver's body-support were developed.

- * Sedentary Anthropometer - A sedentary anthropometer is a fully adjustable device which resembles a chair. The seat, lumbar-support, thoracic-support, shoulder-support, head-support and the feet-support are adjustable both in angle and in height. It is a very versatile design tool for exploring various sedentary postures - from upright to reclined.
- ** Kinetosphere - A kinetosphere is used to study and measure both static and dynamic biospace or "work-envelope" of a given task or activity. It is a structure with a 2400mm base and two sides of similar size fixed at right angles to each other at one corner of the base. The sides and the base are white in colour and have 100mm square grids on them to aid measurement. A large mirror, approximately 1800mm x 1500mm is positioned at 45° above the base to reflect a plan view of the activity in the kinetosphere. A platform enables a researcher to aim a camera at the centre of the mirror to take photographs in the plan view. Front, side or rear view photographs can be taken at ground level with the sides as background. Three synchronised cameras are usually used to capture an activity in three views at the same time. Video cameras may also be used to record activities in motion.

**FIGURE 5.13**

ANALYSIS OF BIRTH POSITIONS ON SEDENTARY ANTHROPOMETER (TOP)

**FIGURE 5.14**

ANALYSIS OF DELIVERY AND BIRTH POSTURES ON SEDENTARY ANTHROPOMETER (BOTTOM)



FIGURE 5.15 POSTURE AND BIOSPACE ANALYSIS IN THE KINETOSPHERE

FIGURE 5.16 POSTURE ANALYSIS OF BIRTH ATTENDANT IN THE SQUAT-SIT DELIVERY POSITION

5.2.3.4 *Development of the Back- and Head-Supports*

The back-support has two unique features. A vertical "void" is designed just below the lumbar region and runs down the centre of the support to enable the coccyx to move freely during labour and the descent of the foetus. The other feature is the unique configuration of the support. The accentuated "hips" designed into the support on both sides enable the birth partner/s to have freer and unhindered access to the mother. Massages and touches from the birth partner are considered to be soothing and therapeutic for the birthing woman.

5.2.3.5 *Development of the Upper Body-Supports*

The upper body-supports consist of two articulated semi-circular arms that are positioned in front of the mother, just below her shoulder. The supports make it possible for the woman to adopt a variety of postures. They also function as body restraints and posture stabilisers when the woman leans forward to facilitate descent of the foetus. This is an important feature of the obstetric body-support system. When the mother leans forward, usually spontaneously, the baby's head is tipped forward away from the sacrum. This helps to reduce backache during labour and encourages the rotation of the baby's head into the correct position to be born.

5.2.3.6 *Development of the Foot-Supports*

The foot-supports incorporated in the platform were additional features incorporated into the body-support system as the result of the sedentary anthropometer and kinetosphere studies. By providing the foot supports, a woman can raise both feet to assume a semi-squat position besides giving extra support to stabilise herself.

5.3 FLASHES OF INSIGHT

At this stage of the study, the ergodesigner had constructed two 1:5 scale models for an electrically controlled body-support system. More than \$3,000 have also been spent on the purchase of mechanical and control devices.

However, strong inner urges compelled the ergodesigner to reconsider the use of electricity and sophisticated technologies in a process as natural and sensitive as childbirth. This came in the form of "flashes of insights" that many design theorists such as Jones (1972), have endeavoured to explain. There is a desire at subconscious level to re-evaluate the compatibility of using an electrically controlled system in labour and childbirth.

After almost seven years of study, the ergodesigner had now lived through hundreds of "mind-mappings" and visualisations of what a good, joyous birth would be and how the proposed body-support system might perform. To understand the sensitivity of birth, it is necessary to remind ourselves on an account of the spirit of birth.

5.4 THE SPIRIT OF BIRTH

In order to understand what we are about to create, we must understand the intricacies of birth itself. Only eloquent writers and experienced midwives like Armstrong and Feldman (1990), are able to describe childbirth adequately. According to them, childbirth "is infinitely dynamic. We cannot adequately understand it by naming anatomical parts and describing physiological processes, nor are we done when we describe its choreography. Birth functions in the context of mind and spirit. They act directly on birth and give it the complexity we associate with life. We acknowledge this, we invite the power of birth".

"Flexibility complements birth. The muscles and bones are looser. They are well oiled. They are conditioned to give. They are prepared to respond to the changing shape and placement of the baby as he travels through the pelvis."

"Which is what one has to imagine next. When a woman goes into labour, her baby's head is usually stuck down against the cervix (the opening of the uterus) which, conditioned by hormones, is softened. If one touches the unpregnant cervix, it is like touching one's nose; if one touches the ripe cervix it is like touching one's lips."

"Contractions, which start in the upper uterus, move downward. The process is like forcing frosting through one of those fabric cake decorating cones - squeeze at the top end and a coil of frosting comes out at the pointy end. The pressure continues in its wavelike fashion until the baby's head, in search of the path of least resistance, presses against the softened cervix which effaces and becomes fully dilated."

"As soon as the head gets into the birth canal, things change. Up to this point, the labouring woman has been concerned with making herself as comfortable as possible while her body worked for her; lying, sitting, pacing, standing in a shower or wallowing in a bath. When the baby's head enters the birth canal, however, she - the part of her that can "do something" - becomes active. She generally feels a compelling need to push."

"As we imagine the baby moving into and through the birth canal we can understand the value of natural labour. If the mother's pushing is not retarded, as it can be by an epidural, the baby travels fast enough - and the caregiver has less reason to cut a swath to hasten the baby's exit. If the contractions are not over-accelerated, as they can be by Pitocin, the baby

will not come driving down like a boxer's punch, which tears the perineum."

"In natural labour, the baby's head spreads the opening gradually, in keeping with the mother's own musculature and tissue. Moving along at a rhythm and pace defined by the mother's anatomy and physiology, the baby's head serves as a well-timed prod. It burrows along, budging the birth canal open before it as it goes and ultimately stretching the perineum, whose tight aperture gradually gives way, opens up and lets a little light fall on the baby's head. It is quite an amazing thing to see, this yielding. One never imagines it being possible and yet, there it is..."

"Mind you, the midwife has not "done" anything yet, that is not unless you count the education during pregnancy and the support and monitoring during labour, but with the head on the perineum the midwife can act. Her goal is to help the head get past the perineum without tearing. She is working with a bulging head, fierce contractions and a woman who is not sensible in the usual sense of the word."

"From the first time that midwife and client meet, they are creating the "terrain" or ground for this moment. All the conversations, the questions and answers, the touch of the midwife's fingers on a woman's belly, the comfort measures, the respect shown for feeling and belief, all the months of exchange, the little bits of life passing back and forth, the minute human events that seem not worth reporting have been preparation. Having been woven into the relationship between midwife and mother, they finally produce trust. They bind voice to ear and touch to touch."

"Which is necessary because the time between pushing contractions is like the lulling of the sea between waves and the labouring woman seems to drift down into the half light below, where the midwife must reach her.

Her words are simple; her voice is firm, direct, sometimes oracular: "I want you to release your breath through the next contraction. Phuh, phuh, phuh". The woman, her eyes drifting and her head lapped on the pillow, may nod slightly, wasting no strength, before the contraction closes in, claspng the baby's head tight to the perineum, "Phuh, phuh, phuh".

Once again the sea lulls.

The woman grunts once.

"Again", the midwife says.

Twice.

The head, lightly propelled, slips out through the perineal ring.

That, is the process that the body-support system must be designed to complement, to aid, to facilitate. Odent (1985) maintains that childbirth is an instinctive, spontaneous, natural process that is controlled by the hypothalamus. Hypothalamic activities are most efficient when their processes are not impeded by inhibitions and disturbances. Perhaps that was what my subconscious mind was trying to alert me: that an electrically controlled system may be invasive and may disturb the delicate processes of childbirth.

5.5 DISADVANTAGES OF AN ELECTRICALLY CONTROLLED SYSTEM FOR CHILDBIRTH

- Electrical actuators for controlling movements are mainly AC operated.
- Concerns have been raised by caregivers about their safety, especially their use for obstetrics where "birth fluids" and the need for washing and hosing might render the system dangerous.
- The knowledge that the system is plugged into an electrical power source may be disturbing to some women.

- The equipment cannot function in rooms without power plugs.
- When an extension cord is used, it may result in trips and falls and other hazards.
- The system is intimidating.
- Maintenance and failure rates will be higher than a manually operated system.
- The adjustability will benefit only the caregivers.
- Instruction and learning are required to operate the system.
- It is complicated and expensive.

5.6 CRITERIA FOR GOOD DESIGN

Adapted from Dieter Rams (1987).

- 1) Good design is functionally friendly.
Any equipment or product serves a certain purpose. People buy the equipment for its utility. A piece of equipment is well designed when it is optimally usable according to the user abilities and limitations and fulfils its intended functions as conveniently as possible. It enriches our lives.
- 2) Good design is innovative.
Good equipment design must incorporate new solutions to the problem, but not merely different for the sake of being different.
- 3) Good design is as little design as possible.
The most important principle is to omit the unimportant in order to emphasise the important. Simplicity is good design.

- 4) Good design is aesthetic design.
The aesthetic quality of the equipment is part of its utility. The equipment must appeal to your sense of vision and satisfy the user's psychological needs. It must not alienate. It is friendly and fun to use.
- 5) Good design makes the equipment easy to understand.
The design of the equipment should make it self-explanatory. Its design should make the equipment "speak". The user should make the equipment "speak". The user should be able to recognise what the product does and how to handle and operate it, how it performs and what it is worth. This is especially important for new or innovative equipment.
- 6) Good design is honest.
The equipment must not be designed to appear more innovative than it really is. It must not be delusive to hide design faults.
- 7) Good design is unobtrusive.
Design should allot the equipment its proper place in our life. It must not offend or intimidate its users. It must appear friendly.
- 8) Good design is consistent.
A truly integral piece of equipment must be good in all of its various aspects and form a complete and convincing unity. Superficiality and sloppiness in details must be avoided. Details are well thought through and workmanship meticulous.
- 9) Good design is durable.
Modish short-life equipment is unsafe and can no longer be justified.

- 10) Good design is environment friendly.

The equipment must be constructed with materials and processes that do not pollute the air, earth or water. The design must be pleasant to enhance the visual environment.

5.7 FINAL DESIGN AND SPECIFICATION PHASE - DEVELOPMENT OF THE OBSTETRIC BODY-SUPPORT SYSTEM

This phase was the climax of the ergodesign process. It was perhaps the most challenging phase where the ergodesigner had to make decisions and judgements regarding task-fits, user-equipment compatibility, ease-of-use aspects, maintainability of equipment, hygiene requirements, mechanism design, materials and processes, and the construction and costings of a prototype for evaluation.

The primary aim of this phase was to integrate all the system components - both human and technical into a coherent design that reflect the system goals.

The proposed Obstetric Body-Support System consists of two major pieces of equipment.

- 1) **The Maternal Body-Support System** - a body-support sub-system for the mother to labour and to give birth in the upright/semi-squat posture, and
- 2) **The Caregiver's Body-Support System** - a body-support sub-system for the birth attendant to sit or kneel in a variety of positions while examining the mother or delivering the baby.

For clarity to the users the Maternal Body-Support System will also be called the **Active Birth Chair (Figure 5.26)** and the Caregiver's Body-Support System will be called the **Delivery Seat-Kneeler (Figure 5.27)**.

5.7.1 Development of the Maternal Body-Support System

It was decided that a simple, manually operated system is less invasive and more compatible for the spirit of childbirth. The proposed obstetric body-support system for upright active birth has its own innovative look. It has been designed with safety, function and ease-of-use in mind. It incorporates most of the design criteria outlined above, and has the advantage of not having the disadvantages of the electrically controlled concept - without losing any of its functions. The body-support can accommodate at least 95% of the user population. The 95 percentile female body dimensions were used to develop the System (Panero and Zelnick, 1979).

5.7.2 Main Features of the Maternal Body-Support System

- The body-support system is constructed with high tensile steel tube framing, to give it strength and rigidity.
- A platform 260mm above the floor elevates the woman to a height of 500mm to improve the posture of midwives and obstetricians.
- Both the pelvic-support and the back support have features that allow free movement of the pelvis and the coccyx during labour and childbirth.
- The pelvic-support is fixed at 15°. This is considered to be an optimum angle to enable the woman making postural changes without the possibility of slipping forward.
- The position of the back-support is adjustable between 0-30° from the vertical. The range is the most appropriate range for upright labour.

- The head-support is height adjustable.
- The upper body-support is both height adjustable and articulate - it could be swung away.
- The height of the pelvic-support at the ischial tuberosities is 240mm from the platform. This is around the height of lounge chairs and should support the woman in a restful and comfortable position.
- *The foot-supports are positioned at the natural angle of the legs. They assist the mother in maintaining a semi-squat position during labour and childbirth.
- *The foot-supports are articulate and could be swung away when not in use.
- The platform has a depression to channel amniotic and other fluids to a receptacle at the back.
- The pelvic-support is cantilevered from the steel frame to allow for an obstruction-free space around and beneath the entire pelvic-support. This feature is extremely important for the safe delivery of the baby.
- The entire body-support system can be washed or hosed. The "simple" design makes this task relatively easy.
- The design elements and colours - turquoise, terracotta and dark grey - are chosen to impart fun and joy, and to give mothers confidence and a positive feeling.
- The system runs on four castors. The two back castors are brakable.
- The overall dimensions of the obstetric body-support system are:
1000mm length (front to back castors)
940mm width (platform width)
1275mm height (top of headrest at lowest setting to floor)

* This feature is shown on the drawings but was not incorporated in the prototype as they were considered to hinder the birth attendant's tasks.

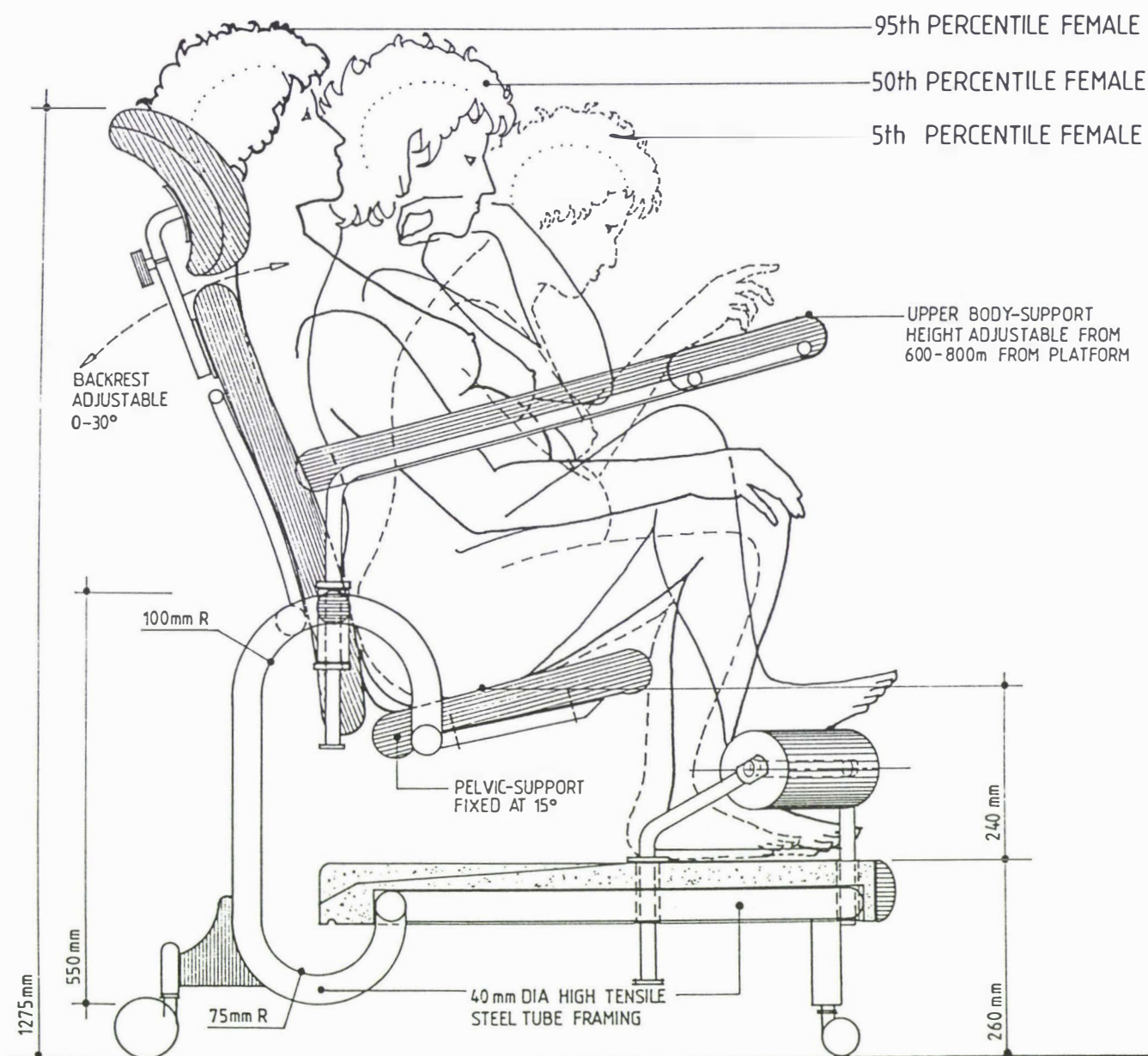


FIGURE 5.17

**SIDE ELEVATION OF MATERNAL BODY-SUPPORT
SYSTEM: THE ACTIVE BIRTH CHAIR
(not to scale)**

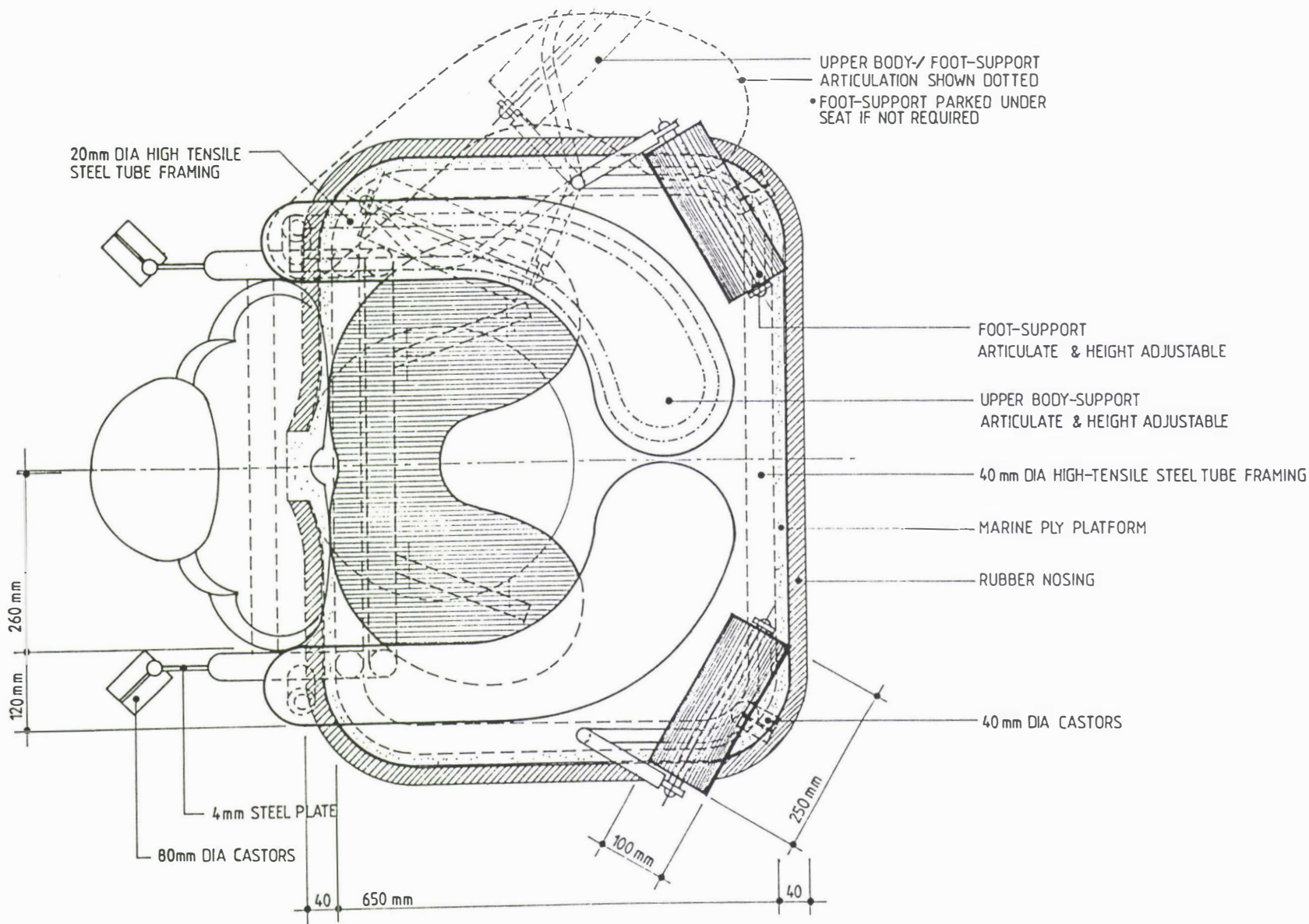


FIGURE 5.18 PLAN VIEW OF MATERNAL BODY-SUPPORT SYSTEM: THE ACTIVE BIRTH CHAIR (not to scale)

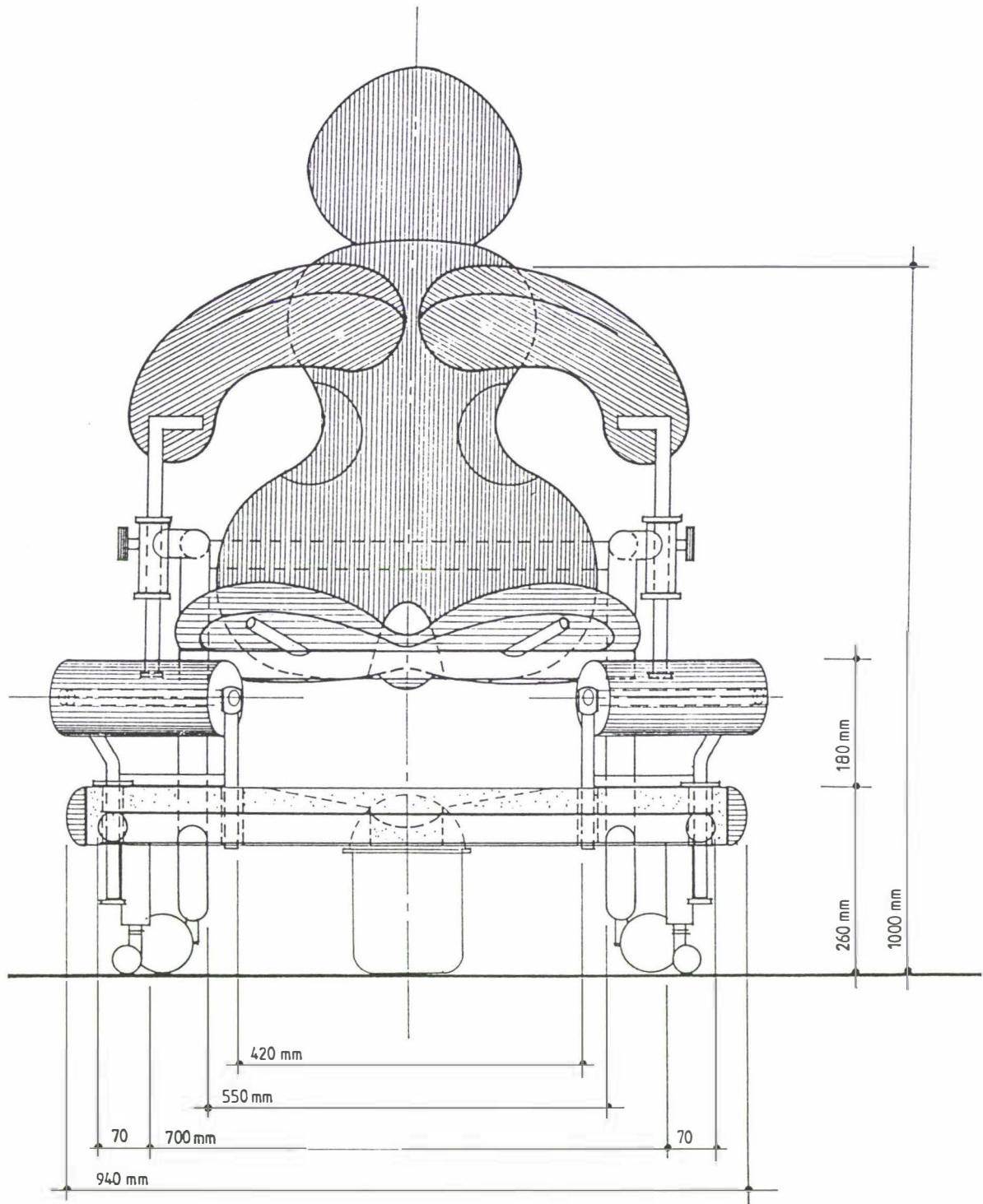


FIGURE 5.19 FRONT ELEVATION OF MATERNAL BODY-SUPPORT SYSTEM: THE ACTIVE BIRTH CHAIR (not to scale)

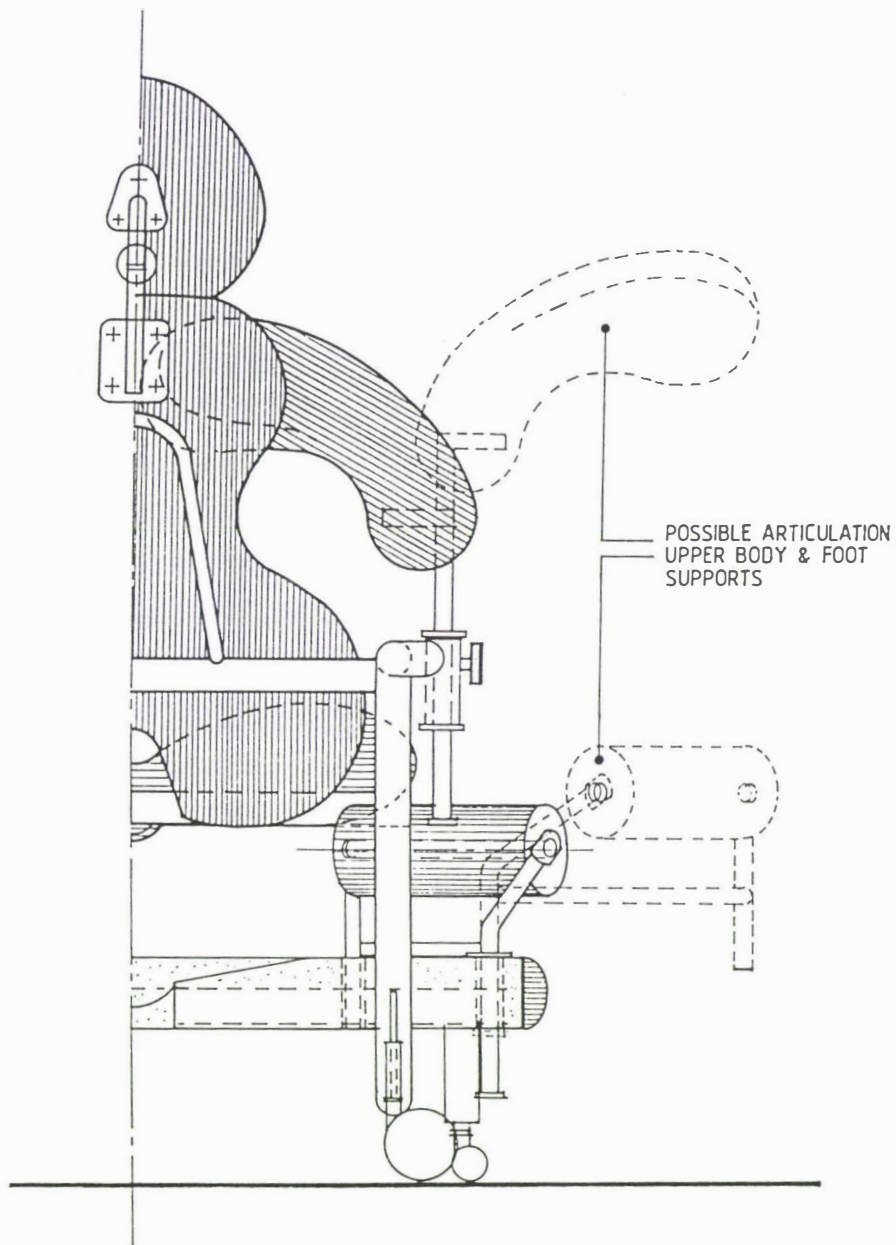


FIGURE 5.20 BACK ELEVATION OF MATERNAL BODY-SUPPORT SYSTEM: THE ACTIVE BIRTH CHAIR (not to scale)

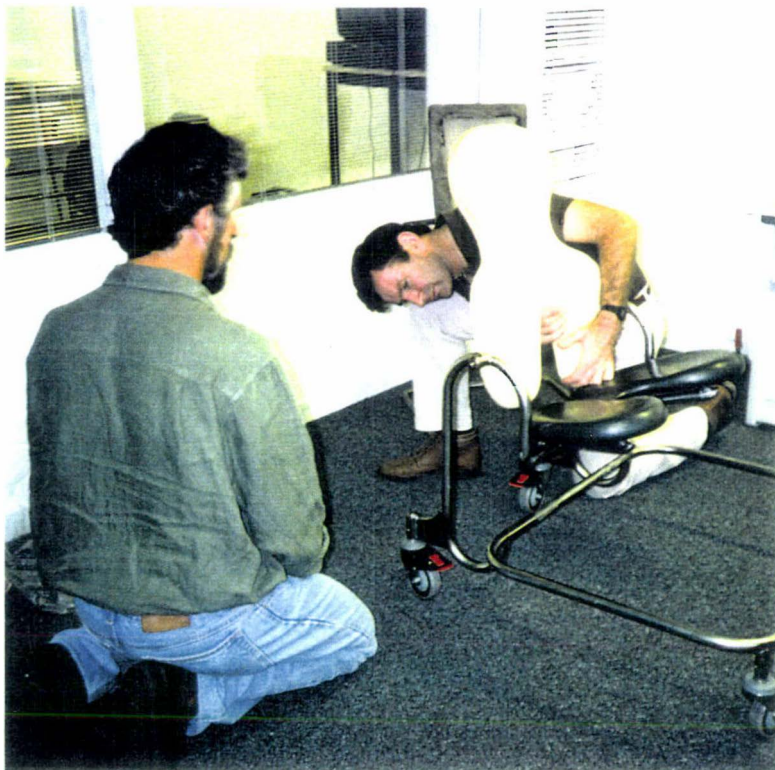
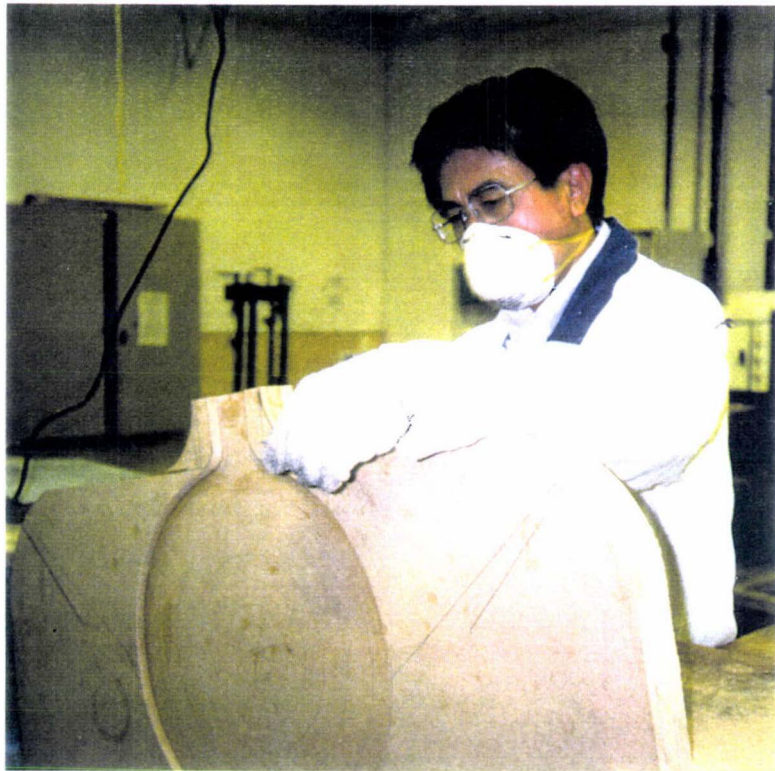


FIGURE 5.21 DEVELOPMENT OF THE PLATFORM

FIGURE 5.22 DEVELOPMENT OF ADJUSTMENT MECHANISMS FOR THE BACK-SUPPORT

5.8 DESIGN AND DEVELOPMENT OF THE CAREGIVER'S BODY-SUPPORT SYSTEM

The design and development process for this piece of equipment has been less demanding compared with the design and development of the maternal body-support system. The caregiver's body-support system is designed to complement the maternal body-support system in terms of size, dimension and configuration.

The pelvic-support on the maternal system is positioned relatively low to convey the sense of security for the birthing woman. A piece of equipment must be safe and strong not only technically but it must also be perceived to be safe and secure during use. It is recognised that a higher maternal system could ensure a more optimum posture for the caregiver. However, a higher system is intrinsically more dangerous for the mother and baby. Consequently, it may also result in a sense of insecurity that may disturb the natural process of labour and childbirth.

The design decision was to "compromise", the working posture of the caregivers. This, however, was done with consultation with the users. Many midwives and obstetricians are happy to crouch, squat or kneel in front of the mother during delivery. A few do not. Some prefer to sit on a stool or chair. If stools or chairs are used for delivery, the birthing mother will have to be elevated to a height of between 800-950mm - a height the ergodesigner considers, albeit intuitively, to be too high, dangerous and give the mother a sense of insecurity.

The caregiver's body-support system is rather unique! It is designed to support a variety of bodily positions close to the ground. The equipment slopes gently from a height of only 75mm to 160mm. The configuration enables the caregiver to maintain the crouching, sitting and kneeling

positions during the delivery of the baby. The caregiver may choose to sit at the higher or lower end of the support, or adopt a combination of crouch-squat, kneel-crouch, sit-squat or crouch-sit positions.

The 40mm thick medium density foam and upholstery makes kneeling, crouching, sitting and variations of these positions very comfortable, without undue pressure points.

The high end of the equipment is supported by two castors, while the low end is supported by two "glides". This combination gives the equipment some movement, without the danger of sliding uncontrollably away - as it could if four castors were used.

The arm supports on either side of the equipment have two functions: to support the arms and to be used as stabilisers and aids for the caregivers to get in as they lower themselves into the working position, or out of the equipment.

It is not compulsory for the midwife or the obstetrician to use the caregiver's body-support system. Some caregivers are happy to simply kneel or squat on the floor to deliver babies. A handgrip is incorporated at the lower end of the equipment to facilitate handling of the equipment.

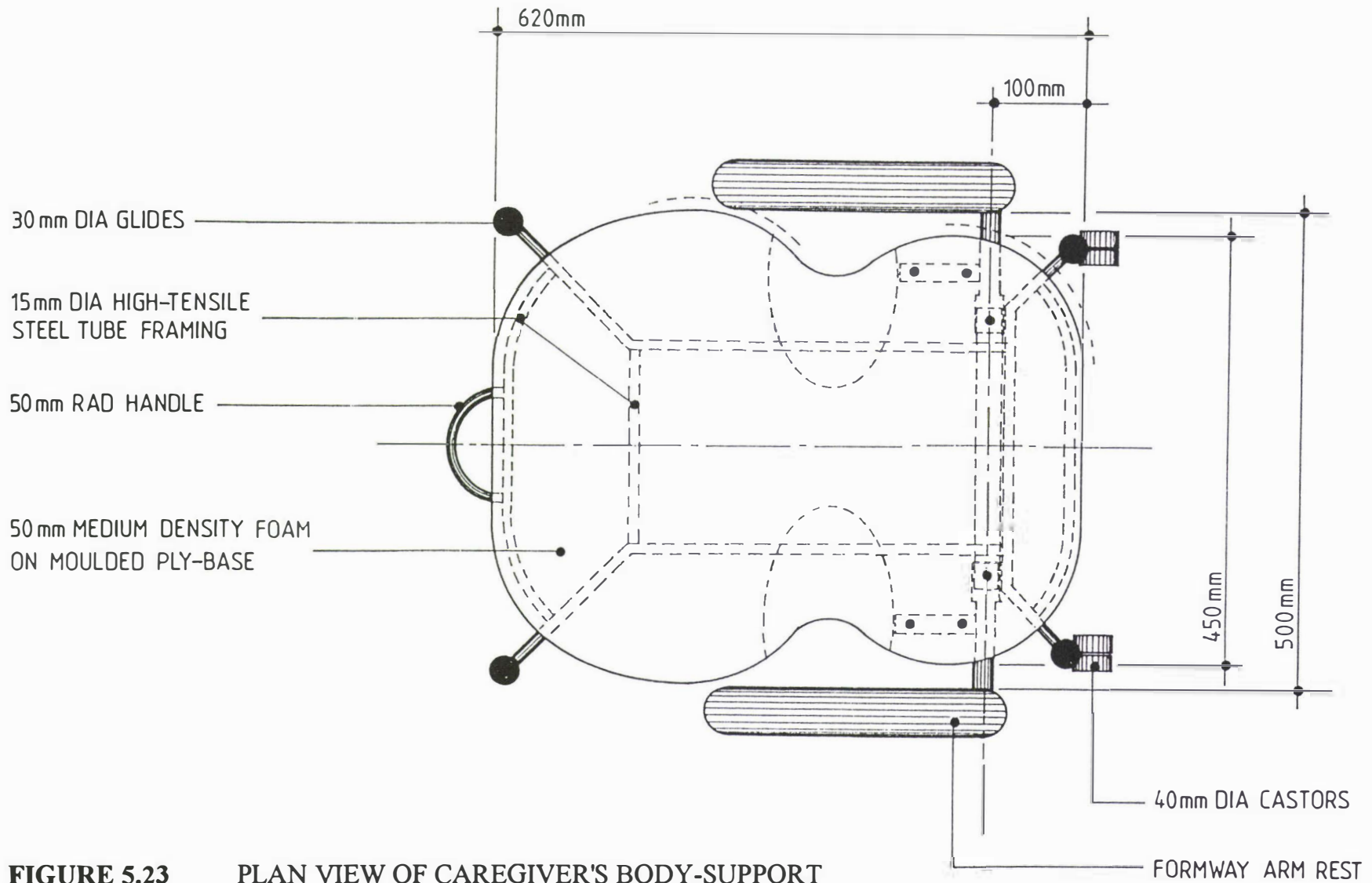


FIGURE 5.23 PLAN VIEW OF CAREGIVER'S BODY-SUPPORT SYSTEM: THE DELIVERY SEAT-KNEELER (not to scale)

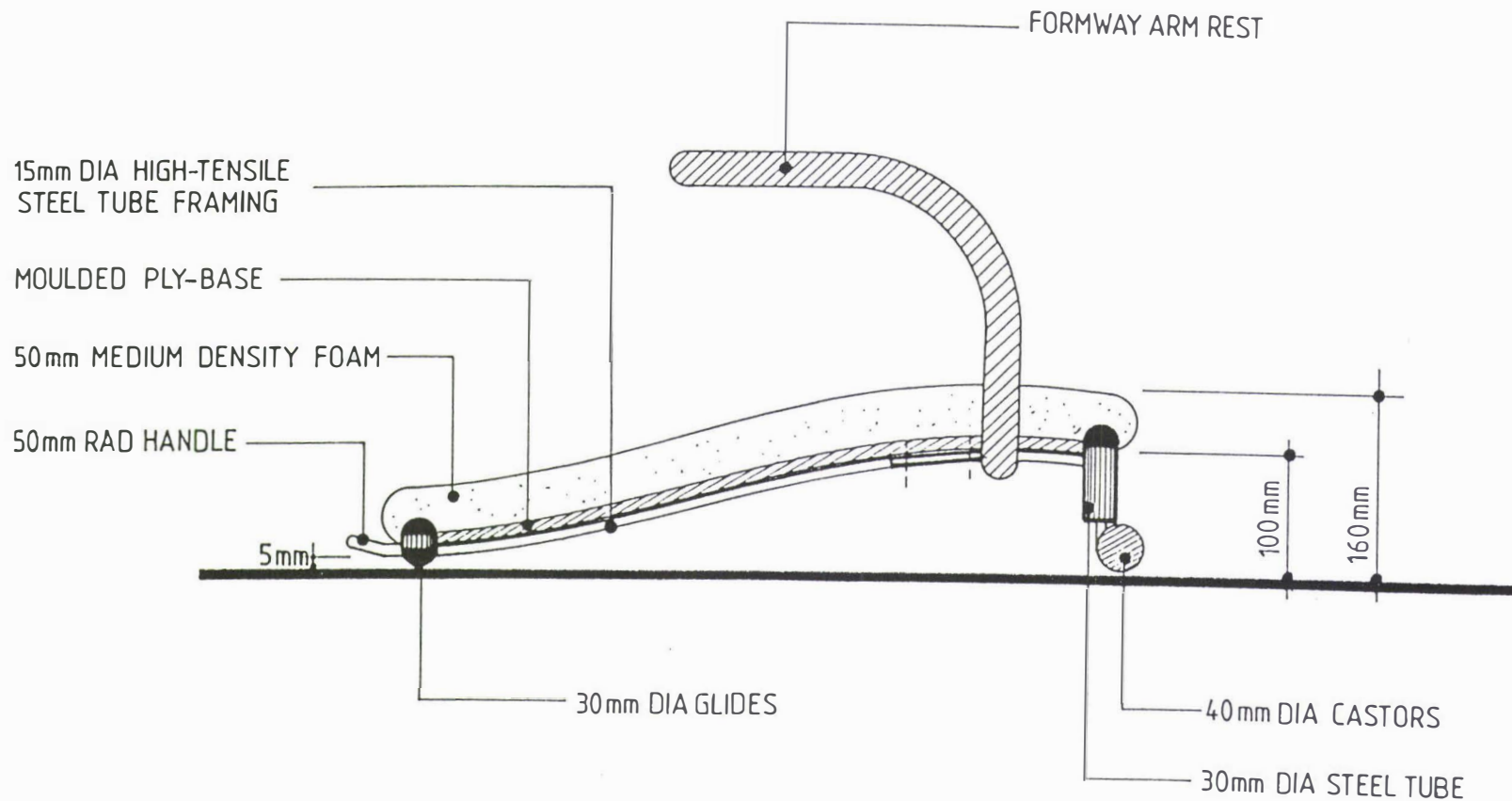
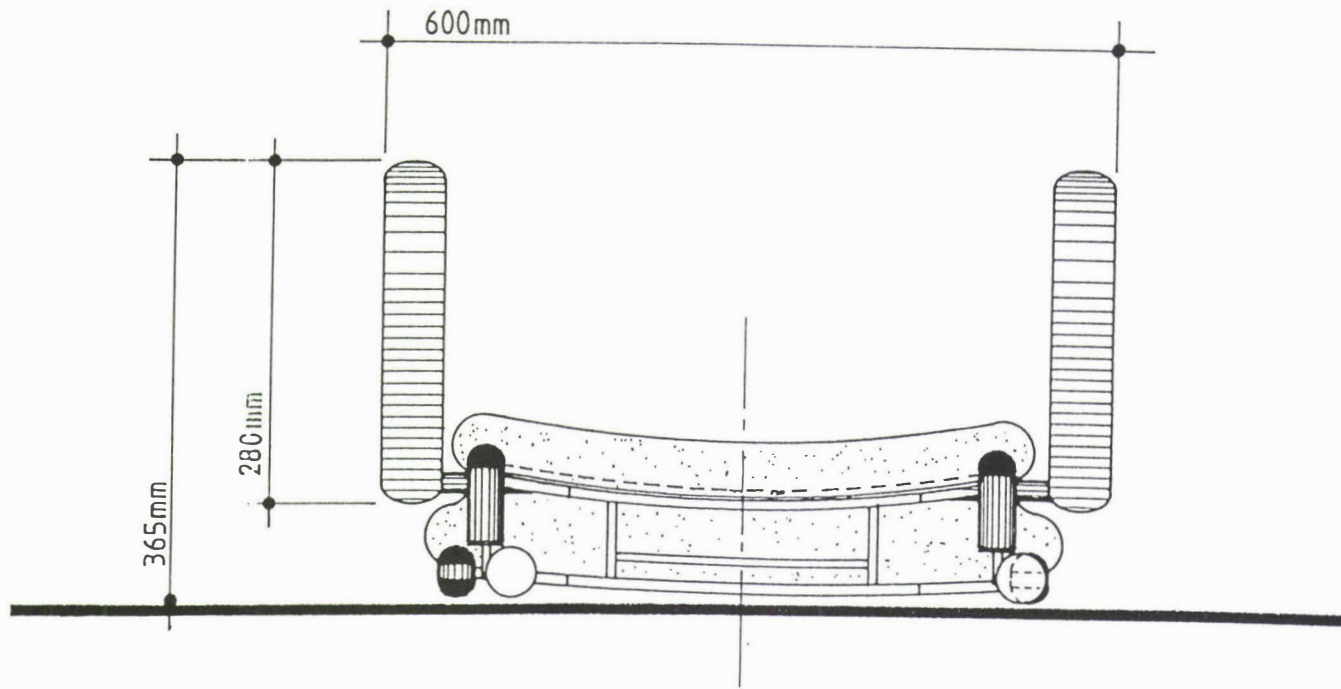


FIGURE 5.24 SIDE ELEVATION OF CAREGIVER'S BODY-SUPPORT SYSTEM: THE DELIVERY SEAT-KNEELER (not to scale)



FRONT ELEVATION

FIGURE 5.25 FRONT ELEVATION OF CAREGIVER'S BODY-SUPPORT SYSTEM: THE DELIVERY SEAT-KNEELER (not to scale)

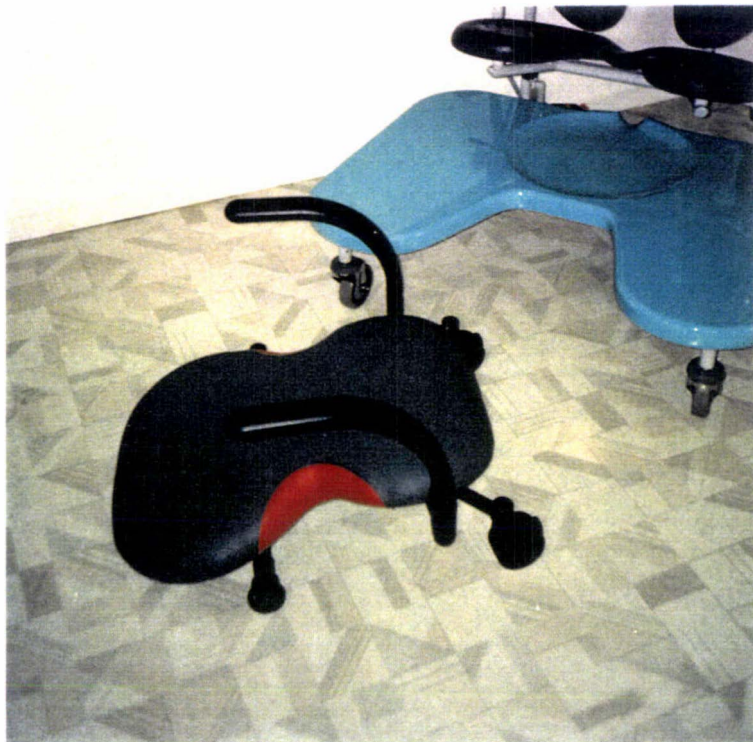


FIGURE 5.26

THE ACTIVE BIRTH CHAIR

FIGURE 5.27

THE DELIVERY SEAT-KNEELER



FIGURE 5.28 THE OBSTETRIC BODY-SUPPORT SYSTEM WITH ARMRESTS

FIGURE 5.29 THE OBSTETRIC BODY-SUPPORT SYSTEM WITHOUT ARMRESTS

CHAPTER SIX

SYSTEM EVALUATION

6. EVALUATION OF THE OBSTETRIC BODY-SUPPORT SYSTEM

The Active Birth Chair and the Delivery Seat-Kneeler were tested in a comprehensive evaluation process, involving 19 participants from six different user-groups over a four month period. Three user-groups participated in the prenatal evaluation; and another three user-groups participated in the postnatal evaluation.

The system has been designed with ease-of-use and user-friendliness that are expressed in the forms, colours and configuration of the Active Birth Chair and the Delivery Seat-Kneeler. Design features follow the "natural mappings" between functions and required actions (Norman, 1988). The forms have been designed not only to be anthropometrically correct, but they have also been designed to express their meanings. Outcomes of actions are visible, placement of function logical and simple. The functional aspects of the system are "transparent" - visually understandable. Users should need no more than 5-10 minutes of instruction to use the system confidently. These system features - as well as others - were tested in the Evaluation.

6.1 METHODS AND PARTICIPANTS

A comprehensive evaluation process, involving 19 participants from six different user-groups was carried out over a period of four months (early September 1995 to mid January 1996). Three user-groups participated in

the prenatal evaluation; and another three user-groups participated in the postnatal evaluation.

The participants who took part in the prenatal evaluation came from the following user-groups:

1. Four independent midwives
2. Seven midwives from the Wellington Maternity Hospital
3. Three expectant mothers

The participants who took part in the postnatal evaluation consisted of the following user-groups:

1. An independent obstetrician
2. Two midwives from the Kenepuru Maternity Hospital, Porirua
3. Two postnatal mothers

The ages of midwives who took part in both the prenatal and postnatal evaluations ranged from 20 to 50 years old and the length of their experience ranged from 2 to 22 years, with a mean of 8.8 years. Body dimensions of the participants were not taken, however they appeared to have represented a wide range of body sizes and heights, between the 20th and 90th percentiles. A midwife who took part in the prenatal evaluation, and the independent obstetrician were the only male participants.

6.1.1 Personal Information of Prenatal Mothers

The following is general personal information of the three mothers who participated in the prenatal evaluation. For clarity and brevity, Mother One

will be identified as M1, Mother Two M2 and Mother Three M3, in the following analyses.

M1 was between 35-39 years old, expecting her first child. While she was "likely to use" the birth chair, she was "unsure" whether to use it for her first, second or third stage labour.

M2 was between 25-29 years old, also expecting her first child. She was "likely to use" the birth chair and would use it for her first, second and third stages of her labour.

M3 was between 35-39 years old, not expecting at the time of the evaluation. A mother of three young children. She was a "birth educator" at the Wellington North Parents Centre. Her next child will probably be delivered by elected Caesarean section, but as a mother and birth educator she was able to evaluate the birth chair with maternal and obstetric knowledge.

6.1.2 Personal Information of Postnatal Mothers

The following is general personal information of the two mothers who used the System for the birth of their babies. Throughout this part of the report Mother One will be identified as M01 and Mother Two as M02.

M01 was between 20 and 24 years old. This was her first child. She used the Active Birth Chair for her second stage and third stage labour.

M02 was between 15 and 19 years. This was also her first child. She also used the Active Birth Chair for her second stage and third stage labour.

6.2 SETTING UP

To enable each of the user-groups or individual participant to evaluate the system or sub-system reliably, introductory talks and demonstrations on the concept, design features and functions of the system were made clear to the participants (see photographs on the following pages).

The ergodesigner set up the System with the help of a colleague at the user-group premises. In the case of the four independent midwives and the three expectant mothers, who took part in the prenatal evaluation, the system was set up in the Newtown Community Hall, where the midwives conducted weekly antenatal classes for prenatal mothers. Likewise, the System was set up at the Maternity Ward of the Wellington Hospital for the seven midwives there to evaluate. The postnatal evaluation was conducted at the Kenepuru Hospital in Porirua.



FIGURES 6.1 & 6.2
EXPECTANT MOTHERS EVALUATING THE ACTIVE BIRTH CHAIR
DURING THE PRENATAL TEST WITH INDEPENDENT MIDWIVES AND
THE ERGODESIGNER

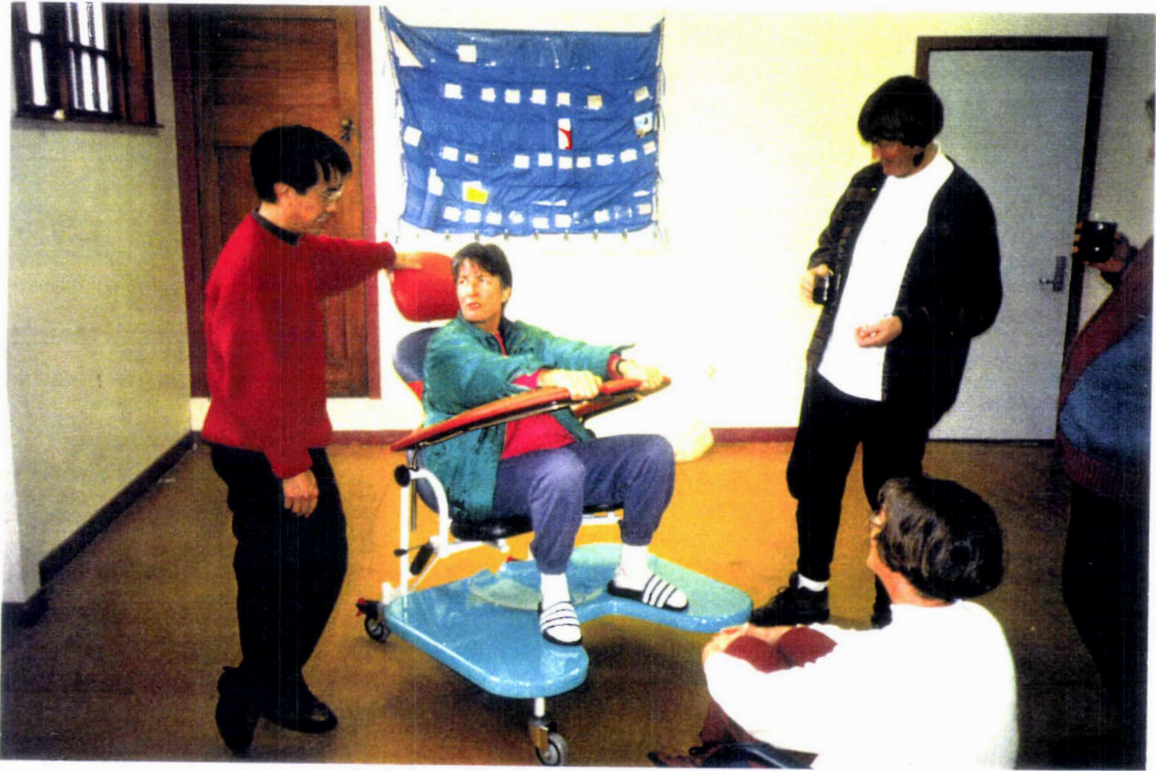


FIGURE 6.3

ERGODESIGNER BRIEFING "DOMINO" MIDWIVES
DURING PRENATAL TEST



FIGURE 6.4

ERGODESIGNER BRIEFING MANAGER OF
MATERNITY UNIT, KENEPURU HOSPITAL ON
DETAILS FOR POSTNATAL TEST



FIGURE 6.5 MANAGER OF MATERNITY UNIT, KENEPURU HOSPITAL AND STAFF MIDWIFE EVALUATING THE SYSTEM WITH ERGODESIGNER

FIGURE 6.6 "DOMINO" INDEPENDENT MIDWIVES TESTING THE SYSTEM WITH ERGODESIGNER

6.2.1 Briefing and Demonstration

After explaining to the group in detail on the focus of the research study - with drawings and photographs, the design features and functions of the Active Birth Chair and the Delivery Seat-Kneeler were also explained and demonstrated to them. It was a collaborative and interactive process - with midwives and mothers manipulating and running their hands on the equipment - punctuated by questions and answers, and deep thoughts.

At the Newtown Community Hall, all participants took their turn to sit on the Active Birth Chair and the Seat-Kneeler. They experimented with different variations of birth-postures by adjusting the back-support lever and discussed amongst themselves on the concept, problems and possibilities. When they were satisfied that they had a "good feel" of how the System works, each one of them was given a questionnaire and they sat down to complete it individually. The whole session, including setting up time, took slightly over three hours.

Similar setting up and familiarisation sessions were repeated for the remaining user-groups. However, in both the Wellington and Kenepuru Maternity Hospitals, not all participants could attend the briefing/demonstration sessions. In both cases the Managers of the Maternity Units were fully briefed. They acted on behalf of the ergodesigner to pass the knowledge on, regarding the use of the System, to other participants who missed the original briefing/demonstration.

The Active Birth Chair and the Delivery Seat-Kneeler were left at the labour ward at the Wellington Hospital for a duration of three weeks to enable as many midwives as possible to participate. This timespan provided an opportunity for the midwives to become thoroughly familiar with the design features and their use, before answering the questionnaire.

6.3 QUESTIONNAIRE DESIGN

The subjective estimate methods - embracing both absolute and relative judgements were used for the evaluation. The questionnaires were structured to evaluate predetermined areas of interest. All questions were constructed on seven-point "graphic" rating scales. This was chosen to enable the accurate evaluation of fine psychophysical discrimination of sensations that were deemed important to this evaluation. From the point of view of administration, graphic rating scales were also chosen because they are more interesting for the participants, simple to fill, and do not require the rater to bother with numbers (Guilford, 1954 and Chushman and Rosenberg, 1991).

Four different sets of questionnaires were used for the evaluation. Two sets of System questionnaires and two sets of Active Birth Chair questionnaires. The System questionnaires were used by the birth attendants - one set for the prenatal test another set for the postnatal test. The Active Birth Chair questionnaires were used by mothers - one set used by prenatal mothers, the other set used by postnatal mothers.

The questionnaires for the prenatal and postnatal tests were almost identical, except that the prenatal questions were worded predominantly in the future tense and the postnatal questions in the past tense. All questionnaires had been critically reviewed and modified to arrive at their current structure. The reviews were done informally by eight female workers and colleagues of the ergodesigner at the Wellington Polytechnic. They included two midwifery lecturers, a lecturer in communications and presentation, the director for remedial studies, three clerical staff and a library assistant.

6.3.1 System Questionnaires

The System Questionnaires - "Obstetric Body-Support System Evaluation" questionnaires were designed to gather information on the function, usability and design features of the whole obstetric body-support system for the delivery of a baby. The questions were designed to solicit comments and criticisms, with the aim of improving the compatibility of the system with the various tasks midwives and obstetricians have to perform in the delivery of a baby.

The System Questionnaire consisted of three major parts.

- Part A - Gathered general information on the use of the whole system.
- Part B - Evaluated design features of the Active Birth Chair.
- Part C - Evaluated design features of the Delivery Seat-Kneeler.

6.3.2 Active Birth Chair Questionnaires

The Active Birth Chair Questionnaires were designed to gather information on the perceptions, feelings and opinions of the mothers on the use of the Active Birth Chair for labour and childbirth.

The questionnaire consisted of six major parts.

- Part A - Gathered personal information on the mother.
- Part B - Gathered information on the feelings and perceptions of the birth experience using the Active Birth Chair.
- Part C - Evaluated general postural comfort during labour and childbirth.
- Part D - Evaluated body-parts sensations of the mother while using the Active Birth Chair.

- Part E - Evaluated design features of the Active Birth Chair.
- Part F - Evaluated multiparous women's maternal perceptions between the Active Birth Chair and the previous birthing device/s they had used.

Besides responding to the "graphic" questions, participants also had the opportunity to comment on any issues or express an opinion in the spaces provided at the end of each section.

The System Questionnaire is shown on pages 157 to 165. The Active Birth Chair Questionnaire is shown on pages 166 to 177.

SYSTEM QUESTIONNAIRE

OBSTETRIC BODY-SUPPORT SYSTEM EVALUATION

Dear Doctor/Midwife/Nurse

Thank you very much for your support and collaboration in making this research study and the evaluation of the Obstetric Body-Support possible.

This System Questionnaire is designed to find out your opinion on the functions and features of the Obstetric Body-Support System you have used for the delivery of a baby. The questions are designed to solicit comments and criticisms - with the aim of improving the compatibilities of the System with the various tasks you have to perform in the Delivery.

The System Questionnaire is divided into three parts:

Part A - Gathers general information on the outcome of the Birth, Delivery and the use of the whole Obstetric Body-Support System.

Part B - Evaluates Active Birth Chair Features

Part C - Evaluates Delivery Seat-Kneeler Features

Please answer all the questions as honestly as you can as your comments and opinions will assist me to improve the Body-Support System for the benefit of all mothers, midwives and obstetricians who want to use the System in the future.

The whole questionnaire will take about 20 minutes to complete.

Thank you very much for your assistance and cooperation.

Yours sincerely

B. Leong Yap

Ergonomist/Designer

EVALUATION OF OBSTETRIC BODY-SUPPORT SYSTEM

DOCTOR/MIDWIFE NAME: _____

RANK: _____

(Sister, Staff Nurse, Staff Midwife, etc)

AGE: _____

I have been an obstetrician/midwife for _____ years.

PART A

General Outcome of the Birth and Delivery

The following questions are designed to find out the general outcome of the Birth, Delivery and your opinion on the use of the Obstetric Body-Support System.

Please take your time and place a tick (✓) above the phrase or word that best describes your response. Please answer all questions as honestly as you can.

Strict confidentiality will be observed.

1. How would you describe the Active Birth Chair in terms of providing support for the mother for childbirth.

Extremely Good	Very Good	Good	Indifferent	Bad	Very Bad	Extremely Bad

2. Do you feel that the system is compatible or incompatible with the tasks of delivering a baby.

Extremely Compatible	Very Compatible	Compatible	Indifferent	Incompatible	Very Incompatible	Extremely Incompatible

3. Do you think that delivering the baby with the system would be easy or difficult.

Extremely Easy	Very Easy	Easy	Indifferent	Difficult	Very Difficult	Extremely Difficult

4. Do you feel using the System for delivery would be comfortable or uncomfortable.

Extremely Comfortable	Very Comfortable	Comfortable	Indifferent	Uncomfortable	Very Uncomfortable	Extremely Uncomfortable

5. Would you like delivering babies using the System.

Extremely So	Very Much So	Much	Indifferent	Little	Very Little	Not At All

6. Now that you have "used" the Obstetric Body-Support System; do you prefer using it or the hospital bed.

Definitely the System	Very Likely the System	The System	Indifferent	The Bed	Very Likely the Bed	Definitely the Bed

7. Approximately how many babies have you delivered while the maternal mother is on a birth chair/stool.

This is my First One	Less Than 10	Between 10-20	Between 20-30	Between 30-40	Between 40-50	Over 50

8. Please write down any comments you think would help me to improve the design of the System or help other mothers or birth attendants in labour or delivery.

PART B**Active Birth Chair Features Evaluation**

The following questions are designed for you to comment on the features of the Active Birth Chair.

Please place a tick (✓) above the phrase or word that best describes your opinion above the chair feature.

1. Seat Height

Far Too High	Too High	High	Just Right	Low	Too Low	Far Too Low

2. Seat Length

Far Too Long	Too Long	Long	Just Right	Short	Too Short	Far Too Short

3. Seat Width

Far Too Wide	Too Wide	Wide	Just Right	Narrow	Too Narrow	Far Too Narrow

4. Seat Shape

Extremely Poor Fit	Very Poor Fit	Poor Fit	Just Right	Good Fit	Very Good Fit	Extremely Good Fit

5. Seat Slope (Angle)

Much Too Far Towards Back	Too Far Towards Back	Towards Back	Just Right	Towards Front	Too Far Towards Front	Much Too Far Towards Front

6. Hole in Seat

Extremely Good	Very Good	Good	Just Right	Poor	Very Poor	Extremely Poor

7. Size of Hole in Seat

Far Too Small	Too Small	Small	Just Right	Big	Too Big	Far Too Big

8. Shape of Backrest

Extremely Poor Fit	Very Poor Fit	Poor Fit	Just Right	Good Fit	Very Good Fit	Extremely Good Fit

9. Width Between Armrests

Far Too Wide	Too Wide	Wide	Just Right	Narrow	Too Narrow	Far Too Narrow

10. Upper Body-Support

Extremely Good	Very Good	Good	Just Right	Poor	Very Poor	Extremely Poor

11. Foot Support

Extremely Poor	Very Poor	Poor	Adequate	Good	Very Good	Extremely Good

12. Appearance of Birth Chair

Extremely Attractive	Very Attractive	Attractive	Just Right	Unattractive	Very Unattractive	Extremely Unattractive

13. Range of Adjustability on Birth Chair

Extremely Poor	Very Poor	Poor	Adequate	Good	Very Good	Extremely Good

14. Range of Backrest Angle Adjustability

Extremely Poor	Very Poor	Poor	Adequate	Good	Very Good	Extremely Good

15. Height of Platform

Far Too Low	Very Low	Low	Just Right	High	Very High	Far Too High

16. Please write in the space below any points you think would help me to improve the design of the Active Birth Chair to help other women in their labour.

Delivery Seat-Kneeler Features Evaluation

The following questions are designed for you to comment on the features of the Delivery seat-kneeler.

Please place a tick (✓) above the phrase or word that best describes your opinion about the seat-kneeler features.

1. **Seat-Kneeler Height**

Far Too High	Too High	High	Just Right	Low	Too Low	Far Too Low

2. **Seat-Kneeler Length**

Far Too Long	Too Long	Long	Just Right	Short	Too Short	Far Too Short

3. **Seat-Kneeler Width**

Far Too Wide	Too Wide	Wide	Just Right	Narrow	Too Narrow	Far Too Narrow

4. **Seat-Kneeler Shape**

Extremely Poor	Very Poor	Poor	Adequate	Good	Very Good	Extremely Good

5. **Seat-Kneeler Slope**

Much Too Far Towards Back	Too Far Towards Back	Towards Back	Just Right	Towards Front	Too Far Towards Front	Much Too Far Towards Front

6. **Shape of Seat-Kneeler**

Extremely Poor Fit	Very Poor Fit	Poor Fit	Just Right	Good Fit	Very Good Fit	Extremely Good Fit

7. Armrests

Extremely Poor Fit	Very Poor Fit	Poor Fit	Just Right	Good Fit	Very Good Fit	Extremely Good Fit

8. Seat-Kneeler Mobility

Extremely Poor	Very Poor	Poor	Adequate	Good	Very Good	Extremely Good

9. Seat-Kneeler Appearance

Extremely Attractive	Very Attractive	Attractive	Adequate	Unattractive	Very Unattractive	Extremely Unattractive

10. Please write in the space below any points you think would help me to improve the design of the Delivery Seat-Kneeler to help other birth attendants in their work.

Thank you for your participation.

ACTIVE BIRTH CHAIR QUESTIONNAIRE

ANTENATAL EVALUATION

Information on Active Birth Chair

As you are probably aware, many recent studies have indicated that upright birth postures such as sitting, squatting and kneeling are more physiologic and efficient for childbirth than the horizontal postures. Being active and mobile during labour is also more advantageous than lying down in bed.

Many obstetricians, midwives and birth educationists (Parents Centres) are now promoting and encouraging women to labour in the upright posture. However, the lack of well designed equipment has prevented many women to labour in the upright postures satisfactorily.

Following a period of several years of research work, a PhD student (Mr B. Leong Yap) of Massey University has designed the Active Birth Chair (ABC) for women to labour upright. The ABC has been designed with consultations with obstetricians, midwives, Parents Centres, birth educationists and mothers. (Leong is a designer and ergonomist, and is the Head of Industrial Design at the Wellington Polytechnic.)

The ABC is now available for expectant mothers to use. The designer/ergonomist wishes to evaluate the functional aspects of the Chair with the object of improving any shortcomings of the design for the benefit of all future mothers and birth attendants.

Many obstetricians and midwives will be participating in the evaluation. The designer/ergonomist is now inviting expectant mothers to consider participating in the evaluation by using the Birth Chair for the birth of their baby. Your decision to participate is voluntary and your labour will be attended by your own obstetrician and midwife.

The aim of this seminar is to introduce the ABC to you - as expectant mothers, midwives, birth educationists and obstetricians - and to have your comments before the Birth Chair is put to use. The attached questionnaire has been designed to simplify the task. Please spend some time to complete the questionnaire. Your comments will contribute to the improvement of the ABC.

If you are considering to labour in the upright posture and are willing to participate in the evaluation - by answering a short questionnaire - after your baby is born, please discuss your intention with your obstetrician, midwife and partner.

You will have to sign a Consent Form to participate. Your participation is voluntary. You have no obligation to use the ABC. Even if you have signed the Consent Form, you can discontinue the use of the ABC at any time or stage of your labour.

As the designer/ergonomist is not an obstetrician or midwife, only the Chair Features, Ergonomic Factors and your Subjective Feelings on the use of the ABC are evaluated. This is not a clinical study.

EVALUATION OF ACTIVE BIRTH CHAIR ANTENATAL

PART A

Personal Information

1. Code Number _____ Name (optional) _____

2. My age is between Please tick (✓)
 - 15-19
 - 20-24
 - 25-29
 - 30-34
 - 35-39
 - 40-44
 - 45-49

3. This is my 1st baby
 (If this is your first baby you do not 2nd baby
 have to answer questions 5 and 6, 3rd baby
 and Part F on Page 8) 4th baby
 _____ baby
(please specify)

4. I would consider using the Active Birth
 Chair for my 1st stage labour
 2nd stage labour
 3rd stage labour

5. The posture I adopted for second stage labour for the birth of my previous
 baby was: (second stage labour is the stage when the baby is born).
 Sitting
 Squatting
 Prop up on bed - in a reclined position
 Lying on my back with my legs in stirrups
 Other postures please specify

6. The device or furniture I used for second stage labour for the birth of my previous baby was:

- the bed
 delivery table
 a birth chair/stool
 other - please specify

PART B

Feelings and Perceptions of Trial

The following questions are designed to find out the effects of the Active Birth Chair on your feelings or perceptions during the trial.

Please take your time and place a tick above the phrase or word that best describes your feeling. Please answer all questions as honestly as you can. Try not to give your answer as "indifferent" if you can help it.

1. How comfortable or uncomfortable did you find using the Active Birth Chair.

Extremely Comfortable	Very Comfortable	Comfortable	Indifferent	Uncomfortable	Very Uncomfortable	Extremely Uncomfortable

2. Do you think "pushing" on the Active Birth Chair would be difficult or easy.

Extremely Difficult	Very Difficult	Difficult	Indifferent	Easy	Very Easy	Extremely Easy

3. What level of participation you feel you would have during labour using the Active Birth Chair.

Extremely Active	Very Active	Active	Indifferent	Inactive	Very Inactive	Extremely Inactive

4. Do you feel that the use of the Active Birth Chair would allow you to control your labour and the birth of your baby the way you want it.

Total Control	A Lot of Control	Some Control	Indifferent	Little Control	Very Little Control	No Control

5. How safe or unsafe did you feel using the Active Birth Chair.

Extremely Safe	Very Safe	Safe	Indifferent	Unsafe	Very Unsafe	Extremely Unsafe

6. Do you think you would enjoy giving birth using the Active Birth Chair.

Definitely Yes	Very Much	Much	Indifferent	Little	Very Little	Definitely No

7. Would you consider using the Active Birth Chair for the birth of your present baby.

Definitely using it	Highly likely to use it	Likely to use it	Indifferent	Likely not to use it	Highly likely not to use it	Definitely not using it

8. Please write in the space below any points you think would help us to improve the design of the Active Birth Chair or help other women in their labour.

PART C**General Postural Comfort Rating**

This question is designed to rate your general postural comfort or discomfort of the Active Birth Chair you had just "practiced" on.

Please put a tick (✓) in the box beside ONE of the following phrases or words that best describes your feeling.

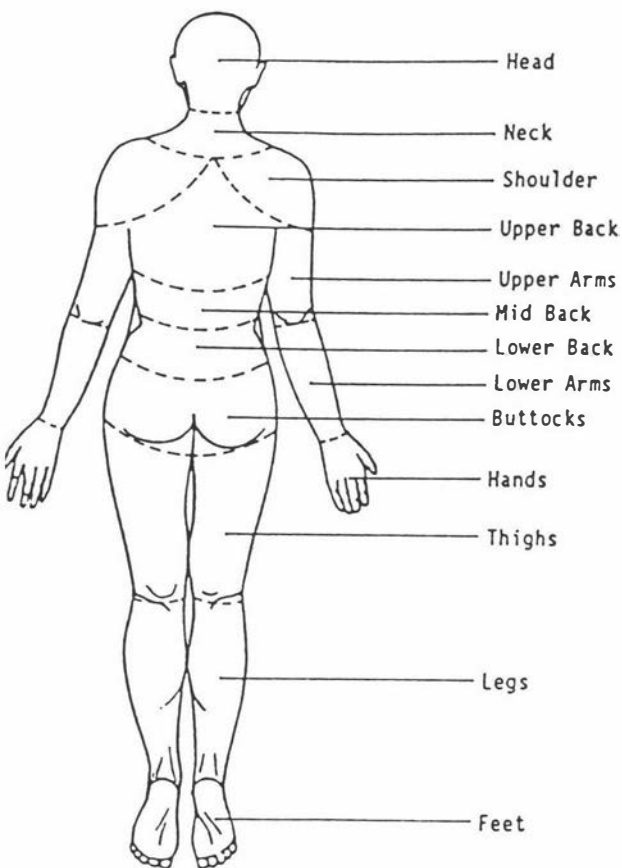
When using the Active Birth Chair, I felt:

(Tick (✓) one box only)

- Painful
 - Sore and tender
 - Numb
 - Stiff
 - Cramped
 - Restless and fidgety
 - Uncomfortable
 - Barely comfortable
 - Quite comfortable
 - Perfectly comfortable
 - Completely comfortable
 - Other comments _____
-

PART D

Body Parts Comfort Assessment



The drawing on the left shows the body parts that are likely to be affected by the Active Birth Chair.

The chart below is designed to find out how comfortable or uncomfortable you have felt in different parts of the body when you were using the Active Birth Chair.

Please place a tick (✓) below the phrase or word that best describes your feeling for each body part shown on the drawing.

	Extremely Comfortable	Very Comfortable	Comfortable	Indifferent	Uncomfortable	Very Uncomfortable	Extremely Uncomfortable
Head							
Neck							
Shoulder							
Upper Back							
Upper Arms							
Mid Back							
Lower Back							
Lower Arms							
Buttocks							
Hands							
Thighs							
Legs							
Feet							

PART E**Chair Features Evaluation**

The following questions are designed for you to comment on the features of the Active Birth Chair you have been introduced to and 'practiced' on.

Please place a tick (✓) above the phrase or word that best describes your opinion about the chair feature.

1. Seat Height

Far Too High	Too High	High	Just Right	Low	Too Low	Far Too Low

2. Seat Length

Far Too Long	Too Long	Long	Just Right	Short	Too Short	Far Too Short

3. Seat Width

Far Too Wide	Too Wide	Wide	Just Right	Narrow	Too Narrow	Far Too Narrow

4. Seat Shape

Extremely Poor Fit	Very Poor Fit	Poor Fit	Just Right	Good Fit	Very Good Fit	Extremely Good Fit

5. Seat Slope (Angle)

Much Too Far Towards Back	Too Far Towards Back	Towards Back	Just Right	Towards Front	Too Far Towards Front	Much Too Far Towards Front

6. Hole in Seat

Extremely Good	Very Good	Good	Just Right	Poor	Very Poor	Extremely Poor

7. Size of Hole in Seat

Far Too Big	Too Big	Big	Just Right	Small	Too Small	Far Too Small

8. Shape of Backrest

Extremely Good Fit	Very Good Fit	Good Fit	Just Right	Poor Fit	Very Poor Fit	Extremely Poor Fit

9. Width Between Armrests

Far Too Wide	Too Wide	Wide	Just Right	Narrow	Too Narrow	Far Too Narrow

10. Upper Body Support

Extremely Good	Very Good	Good	Adequate	Poor	Very Poor	Extremely Poor

11. Feet Support

Extremely Good	Very Good	Good	Adequate	Poor	Very Poor	Extremely Poor

12. Appearance of Birth Chair

Extremely Attractive	Very Attractive	Attractive	Just Right	Unattractive	Very Unattractive	Extremely Unattractive

13. Please write in the space below any points you think would help us to improve the design of the Active Birth Chair and help other women in their labour.

PART F

To be answered by women with more than one birth experience.

The following questions are designed for women who already have had previous birth experience. The aim is to gather information whether you would prefer using the Active Birth Chair for the birth of your next baby or the devices or furniture that you have used for your previous baby.

Please put a tick (✓) in one of the boxes numbered 0-3 against the "Active Birth Chair" or the "Previous Device" - that you used for the birth of your previous baby. If you prefer the "Previous Device" you put a (✓) along the left hand scores. If you prefer the "Active Birth Chair" you put a (✓) on the right hand scores. If you prefer neither the "Previous Device" or the "Active Birth Chair" you place the (✓) above "0".

"3" is the highest score and depending on the question, it represents your like or dislike of either the "Previous Device" or the "Active Birth Chair" to a very high degree. A score of "1" means that you like or did not like the "Active Birth Chair" or the "Previous Device" only slightly. Again please do not (✓) "0" if you can help it.

Example: If you preferred the bed - the "Previous Device" you used for the birth of your last baby - only slightly better than the "Active Birth Chair", you (✓) above the "1" on the left hand scores.

		✓				
3	2	1	0	1	2	3
PREVIOUS DEVICE				ACTIVE BIRTH CHAIR		

1. Please indicate on the scale below whether you preferred the Previous Device or the Active Birth Chair.

3	2	1	0	1	2	3
PREVIOUS DEVICE				ACTIVE BIRTH CHAIR		

2. Which of the two devices do you consider to be more comfortable for childbirth.

3	2	1	0	1	2	3
PREVIOUS DEVICE				ACTIVE BIRTH CHAIR		

3. Which of the two devices do you feel is easier for pushing.

3	2	1	0	1	2	3
PREVIOUS DEVICE				ACTIVE BIRTH CHAIR		

4. Which device would allow you to participate more actively during labour.

3	2	1	0	1	2	3
PREVIOUS DEVICE				ACTIVE BIRTH CHAIR		

5. Which device do you feel would give you more satisfaction.

3	2	1	0	1	2	3
PREVIOUS DEVICE				ACTIVE BIRTH CHAIR		

6. I think I would have more control of my labour using the:

3	2	1	0	1	2	3

PREVIOUS DEVICE

ACTIVE BIRTH CHAIR

7. I felt secure and safe using the:

3	2	1	0	1	2	3

PREVIOUS DEVICE

ACTIVE BIRTH CHAIR

8. Which device do you think is less strenuous for labour:

3	2	1	0	1	2	3

PREVIOUS DEVICE

ACTIVE BIRTH CHAIR

9. If you have the choice would you use the Active Birth Chair or the Previous Device for the birth of your next baby.

3	2	1	0	1	2	3

PREVIOUS DEVICE

ACTIVE BIRTH CHAIR

10. Please write in the space below any comment you would like to make.

6.4 RESULTS

The outcome of the evaluations are presented in two separate sections. Sections 6.5-6.7 examine the prenatal evaluations and Sections 6.8-6.14 examine the postnatal evaluations.

For clarity and brevity, related sections of the prenatal tests completed by midwives and prenatal mothers were pooled in the analysis. Hence, Part B of the System Questionnaire completed by midwives, and Part E of the mothers questionnaire - both evaluating design features of the Active Birth Chair - were combined for the analysis. The pattern of subjective judgement of the two user-groups appeared to be in strong agreement. It was considered not to yield any significant advantages to analyse the two sets of data separately. The remaining parts of the questionnaires of the two user-groups - birth attendants and mothers - who participated in the prenatal test will be analysed separately. Postnatal test results will also be presented separately.

Of the eleven midwives who participated in the prenatal test, two did not answer Part A, and one did not answer Part B and Part C of the System Questionnaire. Many midwives did not answer all the questions because they were unable to make a realistic response to the particular questions. For example seven of the eleven midwives did not respond to Question 6 in Part A of the System Questionnaire because they were unable to answer - "Now that you have "used" the Obstetric Body-Support System, do you prefer using it or the bed". Five out of eleven midwives did not answer Question 7 in Part A which asked "Approximately how many babies have you delivered while the maternal mother is on a birth chair/stool". Does this indicate that 60% of the midwives who participated in the test have not delivered a baby when the mother is on a birth chair/stool before?

The frequency percentages shown in Tables 6.1, 6.2 and 6.3 are percentages based on the actual number of responses to that particular question - not the number of participants.

The following results show the subjective judgement of participants on the use of the Active Birth Chair - in the case of mothers; or the whole System - in the case of midwives and obstetricians.

Both frequency counts and percentages were used in the analysis of all data generated by midwives. It was considered easier to comprehend the "proportion" of participant responses to a question in percentages rather than frequency counts. It must be clarified that a sample of only eleven midwives were used in the prenatal test. This number, however, represents "real expert users". For clarity, no decimal places were used in the percentages. Consequently, some of the responses did not add up to exactly 100%.

The results in favour of the two interfaces and the combined System had been so definite in most cases that, had a larger sample been used, it is likely that it would have more or less followed the same trend.

The use of percentages in the present study, therefore, is considered to be a very apt representation of this trend.

However, due to the smaller sample size of prenatal mothers and participants who took part in the postnatal test, only frequency counts and a more descriptive approach were used to present the results.

6.5 PRENATAL EVALUATIONS

Prenatal evaluation may be considered as preliminary evaluations to verify and ascertain that the System is fully functional and safe before it is put to actual use. For ethical, safety and accountability reasons, it was resolved to fully evaluate the System with the main user-groups - midwives and mothers - before the System is subject to use for labour and childbirth.

6.5.1 Obstetric Body-Support System Evaluation

Part A - Midwives Opinions on the Use of the System for Delivery and Childbirth

Table 6.1 on the next page represents the results of midwives who participated in the prenatal test. This is an account of their expert opinions on the use of the Obstetric Body-Support System for delivery and childbirth.

The expert opinions sought were: the Active Birth Chair as a support for mothers, compatibility of the System for childbirth, ease or difficulty using the System for delivery, comfort on using the System, liking for the System, preference for the System and number of babies delivered while mother was on a birth chair/stool.

TABLE 6.1
RESPONSES OF NINE MIDWIVES TO QUESTIONS ABOUT THE OBSTETRIC BODY-SUPPORT SYSTEM

1. How would you describe the Active Birth Chair in terms of providing support for the mother for childbirth.							
Response	Extremely Good	Very Good	Good	Indifferent	Bad	Very Bad	Extremely Bad
'n'	0	3	5	1	0	0	0
%	0	33	56	11	0	0	0
2. Do you feel that the system is compatible or incompatible with the tasks of delivering a baby.							
Response	Extremely Compatible	Very Compatible	Compatible	Indifferent	Incompatible	Very Incompatible	Extremely Incompatible
'n'	1	3	3	2	0	0	0
%	11	33	33	22	0	0	0
3. Do you think that delivering the baby with the system would be easy or difficult.							
Response	Extremely Easy	Very Easy	Easy	Indifferent	Difficult	Very Difficult	Extremely Difficult
'n'	0	2	2	2	3	0	0
%	0	22	22	22	33	0	0
4. Do you feel using the System for delivery would be comfortable or uncomfortable.							
Response	Extremely Comfortable	Very Comfortable	Comfortable	Indifferent	Uncomfortable	Very Uncomfortable	Extremely Uncomfortable
'n'	0	1	5	1	2	0	0
%	0	11	56	11	22	0	0
5. Would you like delivering babies using the System.							
Response	Extremely So	Very Much So	Much	Indifferent	Little	Very Little	Not At All
'n'	0	1	4	1	2	0	1
%	0	11	44	11	22	0	11
6. Now that you have "used" the Obstetric Body-Support System; do you prefer using it or the hospital bed.							
Response	Definitely the System	Very Likely the System	The System	Indifferent	The Bed	Very Likely the Bed	Definitely the Bed
'n'	0	2	0	1	1	0	0
%	0	50	0	25	25	0	0
7. Approximately how many babies have you delivered while the maternal mother is on a birth chair/stool.							
Response	This is My First One	Less Than 10	Between 10-20	Between 20-30	Between 30-40	Between 40-50	Over 50
'n'	0	2	1	1	1	0	0
%	0	40	20	20	20	0	0

6.5.1.1 *Summary of Results of Midwives Opinions on the Use of the System*

Responses of midwives on the use of the System were mixed. Summarising the positive responses: over 89% of midwives considered that the Active Birth Chair would provide good support for the mother for labour and childbirth; 77% indicated that the birth chair would be compatible with the tasks of delivery; 44% felt that delivering a baby on the System would be easy, while 33% felt that it would be difficult; 67% felt that it would be comfortable to use the System for delivery, while 22% felt that it would be difficult; 55% liked the System, 33% did not like the System, while 11% were indifferent. As mentioned before, the majority of the midwives were unable to indicate whether they prefer using the new System or the hospital bed without having used the System. But, on the basis of the four midwives who responded to the question, two have expressed that they are "Very Likely" to use the System.

6.5.2 **Part B - Evaluation of Active Birth Chair Features**

Table 6.2 represents the combined results of all midwives and the prenatal mothers who participated in the prenatal test/evaluation of the Active Birth Chair.

Participants were asked to select the phrase or word on a seven-point Rating Scale questionnaire, that best describes their opinion on 15 design features on the Active Birth Chair. The features evaluated were:

Seat Height, Seat Length, Seat Width, Seat Shape, Seat Slope
 Hole in Seat, Size of the Hole in Seat, Shape of Back Rest
 Width Between Armrests, Upper Body-Support, Foot-Support
 Appearance of Birth Chair, Range of Adjustability of Birth Chair
 Range of Backrest Angle Adjustability, Height of Platform

TABLE 6.2
COMBINED RESPONSES OF 10 MIDWIVES AND 3 PRENATAL MOTHERS ON 15 ACTIVE BIRTH CHAIR FEATURES

1. Seat Height							
Response	Far Too High	Too High	High	Just Right	Low	Too Low	Far Too Low
'n'	0	0	0	9	2	2	0
%	0	0	0	69	15	15	0
2. Seat Length							
Response	Far Too Long	Too Long	Long	Just Right	Short	Too Short	Far Too Short
'n'	0	0	0	11	2	0	0
%	0	0	0	85	15	0	0
3. Seat Width							
Response	Far Too Wide	Too Wide	Wide	Just Right	Narrow	Too Narrow	Far Too Narrow
'n'	0	1	3	7	2	0	0
%	0	8	23	54	13	0	0
4. Seat Shape							
Response	Extremely Poor Fit	Very Poor Fit	Poor Fit	Just Right	Good Fit	Very Good Fit	Extremely Good Fit
'n'	0	0	2	5	4	1	0
%	0	0	17	42	33	8	0
5. Seat Slope (Angle)							
Response	Much Too Far Towards Back	Too Far Towards Back	Towards Back	Just Right	Towards Front	Too Far Towards Front	Much Too Far Towards Front
'n'	0	0	2	8	0	1	0
%	0	0	18	73	0	9	0
6. Hole in Seat							
Response	Extremely Good	Very Good	Good	Just Right	Poor	Very Poor	Extremely Poor
'n'	1	0	5	6	1	0	0
%	8	0	38	46	8	0	0
7. Size of Hole in Seat							
Response	Far Too Small	Too Small	Small	Just Right	Big	Too Big	Far Too Big
'n'	0	1	2	9	0	0	0
%	0	8	17	75	0	0	0

8. Shape of Backrest							
Response	Extremely Poor Fit	Very Poor Fit	Poor Fit	Just Right	Good Fit	Very Good Fit	Extremely Good Fit
'n'	0	0	0	7	1	3	1
%	0	0	0	58	8	25	8
9. Width Between Armrests							
Response	Far Too Wide	Too Wide	Wide	Just Right	Narrow	Too Narrow	Far Too Narrow
'n'	0	0	2	9	0	0	0
%	0	0	18	82	0	0	0
10. Upper Body-Support							
Response	Extremely Good	Very Good	Good	Just Right	Poor	Very Poor	Extremely Poor
'n'	1	2	5	4	0	0	0
%	8	17	42	33	0	0	0
11. Foot Support							
Response	Extremely Poor	Very Poor	Poor	Adequate	Good	Very Good	Extremely Good
'n'	0	0	1	6	5	1	0
%	0	0	8	46	38	8	0
12. Appearance of Birth Chair							
Response	Extremely Attractive	Very Attractive	Attractive	Just Right	Unattractive	Very Unattractive	Extremely Unattractive
'n'	0	1	5	3	2	1	1
%	0	8	38	23	15	8	8
13. Range of Adjustability on Birth Chair							
Response	Extremely Poor	Very Poor	Poor	Adequate	Good	Very Good	Extremely Good
'n'	0	0	3	6	1	0	0
%	0	0	30	60	10	0	0
14. Range of Backrest Angle Adjustability							
Response	Extremely Poor	Very Poor	Poor	Adequate	Good	Very Good	Extremely Good
'n'	0	0	0	7	2	0	0
%	0	0	0	78	22	0	0
15. Height of Platform							
Response	Far Too Low	Very Low	Low	Just Right	High	Very High	Far Too High
'n'	0	0	0	6	3	0	0
%	0	0	0	67	33	0	0

6.5.2.1 *Summary of Results of Midwives and Prenatal Mothers Combined Responses on 15 Active Birth Chair Features*

On the evaluation of the design features of the Active Birth Chair by midwives and expectant mothers: 69% of the participants were of the opinion that the seat height was "Just Right"; 85% felt the seat length was "Just Right"; 54% considered the seat width to be "Just Right"; 83% considered the seat shape to be "Just Right", "Good Fit" or "Very Good Fit". 73% felt that the seat slope (angle) was "Just Right"; 92% felt that the hole in the seat was "Just Right" or better; 75% felt the size of the hole in the seat was "Just Right"; a unanimous 100% felt that the shape of the backrests was "Just Right" or better; 82% have indicated that the armrests were "Just Right"; another unanimous, 100% favourable response for the upper-body support with 33% feeling that it was "Just Right", 42% "Good", 17% "Very Good", and 8% "Extremely Good"; 92% considered the foot support to be adequate or better; 69% considered the appearance of the birth chair to be "Just Right" or better; 70% felt that the adjustability of the birth chair was "Adequate" or better; 100% considered the adjustability of the backrest to be "Adequate" or better; and 67% considered the height of the platform to be "Just Right".

6.5.3 *Analysis of Midwives Comments on Active Birth Chair Prenatal Tests*

The following are written comments that were recorded in the System Questionnaire of the prenatal tests. An analysis and explanation is given after each comment by the ergodesigner.

6.5.3.1 *Independent Midwife*

"Fixed varied position of armrests, more depth between seat - drip tray (platform), foot pad/rest to elevate feet". "Difficult to evaluate without using it. Looks great - pleasing to look at and very comfortable for me to sit in - not sure how a woman will feel at

second stage. See it as an improvement to present stools - bit large to put in some birthing places - difficult to cart about in our car to a home birth. Hospitals will probably enjoy using it."

Explanation

The midwife felt that the armrests should be "lockable" at selected positions. Currently the armrests rotate at the pivot - the tension of which is adjustable with a knob at each pivot. She was unsure whether the space between the seat and the platform was large enough for a "large baby" to be delivered safely. She felt that an added footrest placed on the platform would improve the birthing position. These concerns have not been mentioned or highlighted in the two real births.

While she has rated the size of the "hole in the seat" as "Good", she adds that she "needs to have a birth before (she) can tell if the hole is adequate".

Both the obstetrician and the two midwives in the postnatal tests felt that the size of the hole in the seat was "Just Right".

6.5.3.2 *Independent Midwife*

"The initial look was very clinical, stepping up to the chair may be off-putting".

Explanation

This is a fair comment. For a new/landmark concept such as the Active Birth Chair, some people will need time to get accustomed to doing things in a new way. This comment has highlighted the fact that a familiarisation programme is of paramount importance to the success of product development and, in particular, system

implementation. This is one of the two midwives who did not complete Part B and Part C of the questionnaire. She rated Part A very unfavourably.

6.5.3.3 *Independent Midwife*

She felt that the seat slope (angle) "should be adjustable", the armrests "should be firmly adjustable" and the foot support "should be adjustable and smaller".

Explanation

These comments are all very logical ideals. However, incorporating them will add costs, complexity and maintenance requirements to the birth chair. Would certainly consider putting in an adjustable seat when a Mark II prototype is built for further study.

6.5.3.4 *Independent Midwife*

"Adjustment for height, foot position, more room under seat to deliver baby, ratchet system for armrests".

Explanation

Again, good logical comments that will improve the functional and usability aspects of the birth chair, barring cost, maintenance and system complexity.

6.5.3.5 *Wellington Hospital Midwife*

"The seat is very hard - if the mother had a long second stage?? would she end up with an oedematous perineum - not sure how practical the chair would be if the delivery became an emergency situation, eg. shoulder dystocia".

Explanation

The seat is actually quite hard for mothers to sit on with a bare bottom while in labour. This has been the concern of many of the participants. The problem was a technical one. When the "integral-skin" seat was moulded, the manufacturer had to pump in foam with extremely high pressure and quantity because of the configuration and size of the seat. The end result was the loss of elasticity in the material. A long labour in an upright posture, does cause swelling (oedema) of the perineum. Women in labour should be ambulant and must not be required to stay in any fixed position for any length of time. The birth chair should always be used near a bed or other facility where emergency needs could be provided quickly. In this case, a woman with a difficult labour or any other emergency should be transferred to a bed, if it is deemed necessary. Likewise, a mother experiencing prolonged labour in the supine position, in bed, should be transferred to the birth chair, so that she can benefit from gravity and her more efficient "bearing-down" effort. The use of the Active Birth Chair must not preclude the use of other hospital equipment, especially in emergencies. Birth attendants must be flexible and use their judgement to solve problems. These are management and professional issues. Only the midwife, obstetrician or doctor is qualified to take appropriate actions.

6.5.3.6 *Wellington Hospital Midwife*

"Don't like armrests, too large."

Explanation

The armrests were designed in their current shape and size to enable the mother, not only to rest her arms, but to lean forward to support the weight of her upper body. The wide armrests are more

comfortable for the mother when she leans forward to accelerate foetal descent.

6.5.3.7 *Wellington Hospital Midwife*

"As we are not permitted to use the chair it has been difficult to make a true judgement of its overall assessment. I also feel that a mother who has used it would be better to answer some of the above questions, eg. Question 1. Seat should be adjustable like the backrest".

Explanation

This statement is only partially true. For any new product evaluation, expert opinions, while "predictive" are very accurate. The midwives in this user-group had the opportunity to familiarise themselves with the system for a period of three weeks. They were able to study each feature in detail - with time, hence are able to evaluate with some certainty, especially when guided by a structured questionnaire. It could be assumed, that if she was actually delivering a baby all her attention would be directed to the care of the mother and the baby, that little attention would be given to the design of the system in the short span of time. Nonetheless, postnatal tests are real, and are considered to be most important for complementing prenatal tests. That is why, both prenatal tests and postnatal tests were undertaken in this study. They are of equal importance and in most cases the outcomes should correlate positively. The seat will be made adjustable if a new prototype is built.

6.5.3.8 *Wellington Hospital Midwife*

"Needs to be more compact".

Explanation

The Active Birth Chair does look rather big. The size was, however, governed by the anthropometry of the 95th percentile women and the optimum delivery posture of the birth attendant.

6.5.3.9

Wellington Hospital Midwife

Seat width "needs to be wider set between legs". The Active Birth Chair "needs to be small all over, especially the base, has to be removable in and out of small birthing rooms". "The design is brilliant - idea really good but the entire chair is too bulky! We have small birthing rooms. The beds would have to be moved out. Perhaps if the platform was modified. Really nice, comfortable, vinyl to wipe for cleanliness. Lovely little kneeling platform, really helpful for midwife/patient". "Appearance - always navy/torquoise, navy possible."

Explanation

The Active Birth Chair was in fact too big for some of the birthing rooms at the Wellington Hospital. The concern for this reason is valid, however, as has been alluded, the size of the birth chair was governed by the body size of the 95th percentile woman. The chair has been designed to fit at least 95% of the female population. The platform of the Active Birth Chair was painted in a bright turquoise. It was thought that the colour will "brighten up" mothers during labour. However, many midwives were not convinced that the colour was right. The colours for the headrest, armrests and body support were also not ideal. The vinyl material which feels like the skin, has to be imported from Hong Kong. There was a limited choice of colours. The response to colours is a very subjective

matter. Perhaps this was the reason why some participants rated the birth chair which is turquoise, dark grey and terracotta "Unattractive". After the completion of the prenatal test, the platform was repainted dark grey to match the back-support, before it underwent the postnatal test at the Kenepuru Maternity Hospital.

6.5.3.10 *Wellington Hospital Midwife*

"The appearance of the chair is offensive and embarrassing to those intending to use it. The size is prohibitive for use in a delivery room where room size is small (doesn't fit through door). Also extensive and difficult to clean".

Explanation

This was a male midwife who was very fixed in his idea that the hospital bed is the only place for childbirth. He rated that he would "Not At All" like to deliver babies using the System. However, he rated both the design features for the Active Birth Chair and the Seat-Kneeler favourably. The design has been designed with hygiene in mind and the Active Birth Chair is extremely easy to clean. The chair could be hosed clean with water after each use.

6.5.4 Part C - Evaluation of Delivery Seat-Kneeler Features

Table 6.3 represents the combined results of all midwives who participated in the prenatal test/evaluation of the Delivery Seat-Kneeler.

After the briefing, demonstration and trial, participants were asked to select the phrase or word, on a seven-point Rating Scale questionnaire, that best described their opinion on nine design features on the Delivery Seat-Kneeler. The features evaluated were:

Seat-Kneeler Height, Length, Width, Shape
Slope, Fit, Armrests, Mobility, Appearance

TABLE 6.3
RESPONSES OF 10 MIDWIVES ON 9 DELIVERY SEAT-KNEELER FEATURES

1. Seat-Kneeler Height							
Response	Far Too High	Too High	High	Just Right	Low	Too Low	Far Too Low
'n'	0	0	0	10	0	0	0
%	0	0	0	100	0	0	0
2. Seat-Kneeler Length							
Response	Far Too Long	Too Long	Long	Just Right	Short	Too Short	Far Too Short
'n'	0	0	0	10	0	0	0
%	0	0	0	100	0	0	0
3. Seat-Kneeler Width							
Response	Far Too Wide	Too Wide	Wide	Just Right	Narrow	Too Narrow	Far Too Narrow
'n'	0	0	0	10	0	0	0
%	0	0	0	100	0	0	0
4. Seat-Kneeler Shape							
Response	Extremely Poor	Very Poor	Poor	Adequate	Good	Very Good	Extremely Good
'n'	0	0	0	6	1	0	3
%	0	0	0	60	10	0	30
5. Seat-Kneeler Slope							
Response	Much Too Far Towards Back	Too Far Towards Back	Towards Back	Just Right	Towards Front	Too Far Towards Front	Much Too Far Towards Front
'n'	0	0	0	10	0	0	0
%	0	0	0	100	0	0	0
6. Shape of Seat-Kneeler							
Response	Extremely Poor Fit	Very Poor Fit	Poor Fit	Just Right	Good Fit	Very Good Fit	Extremely Good Fit
'n'	0	0	0	9	0	0	1
%	0	0	0	90	0	0	10
7. Armrests							
Response	Extremely Poor Fit	Very Poor Fit	Poor Fit	Just Right	Good Fit	Very Good Fit	Extremely Good Fit
'n'	0	0	0	7	1	1	1
%	0	0	0	70	10	10	10

8. Seat-Kneeler Mobility							
Response	Extremely Poor	Very Poor	Poor	Adequate	Good	Very Good	Extremely Good
'n'	0	0	1	4	3	0	2
%	0	0	10	40	30	0	20
9. Seat-Kneeler Appearance							
Response	Extremely Attractive	Very Attractive	Attractive	Adequate	Unattractive	Very Unattractive	Extremely Unattractive
'n'	2	1	4	3	0	0	0
%	20	10	40	30	0	0	0

6.5.4.1 *Summary of Results of Midwives Responses on 9 Delivery Seat-Kneeler Features*

The response to the design features of the Delivery Seat-Kneeler by the midwives was unanimous. Summarising the positive responses: 100% of the midwives felt that the height of the Seat-Kneeler was "Just Right"; 100% felt that the Seat-Kneeler length was "Just Right"; 100% considered the width of the Seat-Kneeler to be "Just Right"; 100% indicated that the Seat-Kneeler shape was "Adequate" or better, with 30% indicating that it was "Extremely Good"; 100% felt that the shape of the Seat-Kneeler was "Just Right" or better; 100% felt that the Seat-Kneeler armrests were "Just Right" or better; 90% felt that the Seat-Kneeler mobility was "Adequate" or better; and 100% considered the appearance of the Seat-Kneeler to be "Adequate" or better, with 40% expressing that it was "Attractive", 10% "Very Attractive" and 20% "Extremely Attractive".

6.5.5 Analysis of Midwives Comments on Delivery Seat-Kneeler

The following are written comments that were recorded in the System Questionnaire of the prenatal tests. An analysis and explanation is given after each comment by the ergodesigner. There were significantly less comments on the Delivery Seat-Kneeler than the Active Birth Chair.

6.5.5.1 *Independent Midwife*

"Great idea. Good idea even on its own without the Birth Chair. A marketable item on its own for delivery units".

Explanation

As has been reported, the delivery seat-kneeler has been rated most favourably in terms of design features, function and usability.

6.5.5.2 *Wellington Hospital Midwife*

"I feel that I would be fairly comfortable for some time sitting and for kneeling on the stool".

Explanation

The thick cushioning and configuration of the seat-kneeler have been designed to support the birth attendant in a variety of postures comfortably.

6.5.5.3 *Wellington Hospital Midwife*

"Not used, but like the idea of keeping us off the floor so it could be very useful".

Explanation

The seat-kneeler is a complementary sub-system used in conjunction with the Active Birth Chair. Many systems fail or function sub-optimally due to neglect of smaller and apparently less important sub-systems. In this study, all system components have been given equal importance. Birth attendants will not use the new system if their needs are not given due consideration. It is very encouraging to see midwives rating the seat-kneeler so highly.

6.5.5.4 *Wellington Hospital Midwife*

"The armrests in the kneeler are great - perhaps could be adapted to the chair..."

Explanation

The armrests on the seat-kneeler would not be suitable for the Active Birth Chair. The armrests on the latter need to be larger to avoid pressure points on the arms and upper body, including the head when the mother leans forward during labour.

6.5.5.5 Wellington Hospital Midwife

"Whilst each of the nine questions scored okay, I personally would not use it because the role of birth attendant is an active one and this would be another piece of equipment to move or fall over".

Explanation

This was the same male midwife who said that he would not use the Active Birth Chair and preferred to use the hospital bed. Clearly he has a very strong personal view against the use of the System and his view, while rather extreme, would be respected.

6.6 PRENATAL EVALUATION OF ACTIVE BIRTH CHAIR BY EXPECTANT MOTHERS

The following analysis is a summary of the findings on the evaluation of the Active Birth Chair undertaken by three expectant mothers.

As has been mentioned above, data on the design features of the Active Birth Chair has been pooled with data generated by the midwives and has been reported in Table 6.2 on pages 164 and 165.

6.6.1 Part A - Personal Information

This information has been presented on page 147 under Methods and Participants.

6.6.2 Part B - Feelings and Perceptions of Trials

The three expectant mothers - M1, M2 and M3 - responded favourably on the use of the Active Birth Chair for labour and childbirth. All three mothers found the chair to be "Comfortable". Other perceptions such as "Ease of Pushing", "Control", "Participation", "Safety", "Enjoyment" and their likelihood to use the Active Birth Chair for the birth of their babies were also positively rated by the participants.

6.6.3 Detailed Analysis of Expectant Mothers Responses

Question 1

On comfort: All three mothers found the Active Birth Chair to be "Comfortable".

Question 2

On pushing: M1 was unsure how to answer this question, but M2 and M3 both felt that pushing on the Active Birth Chair would be "Easy".

Question 3

On participation: M1 felt that participation during labour using the Active Birth Chair would be "Very Active". Both M2 and M3 felt that it would be "Active".

Question 4

On control: M1 and M3 felt that there would be "A Lot of Control" during childbirth using the Active Birth Chair. M2 felt that there would be "Some Control".

Question 5

On safety: M2 and M3 felt that the use of the Active Birth Chair would be "Very Safe". M1 felt that it would be "Safe".

Question 6

On enjoyment: M2 and M3 felt that they would enjoy "Very Much" giving birth using the Active Birth Chair, while M1 felt that she would "Much" enjoy giving birth on the Active Birth Chair.

Question 7

On using the Active Birth Chair:

M1 and M2 would be "Likely To Use It", M3 might have to have an elected Caesarean section.

6.6.4 Part C - General Postural Comfort Rating

M1 and M2 found using the Active Birth Chair to be "Quite Comfortable", while M3 found it to be "Perfectly Comfortable". M1 also found that her buttocks were "Painful" sitting on the Active Birth Chair.

6.6.5 Part D - Body Parts Comfort Assessment

The mothers responses to body parts sensations are shown on the table on the next page. Responses are recorded in the appropriate column spaces below the phrase or word that correspond to the body parts. The maternal codes M1, M2 and M3 are used to identify the three mothers. For example, as can be seen in the table, all mothers in this evaluation felt "Comfortable" on the head, neck and shoulders when using the Active Birth Chair.

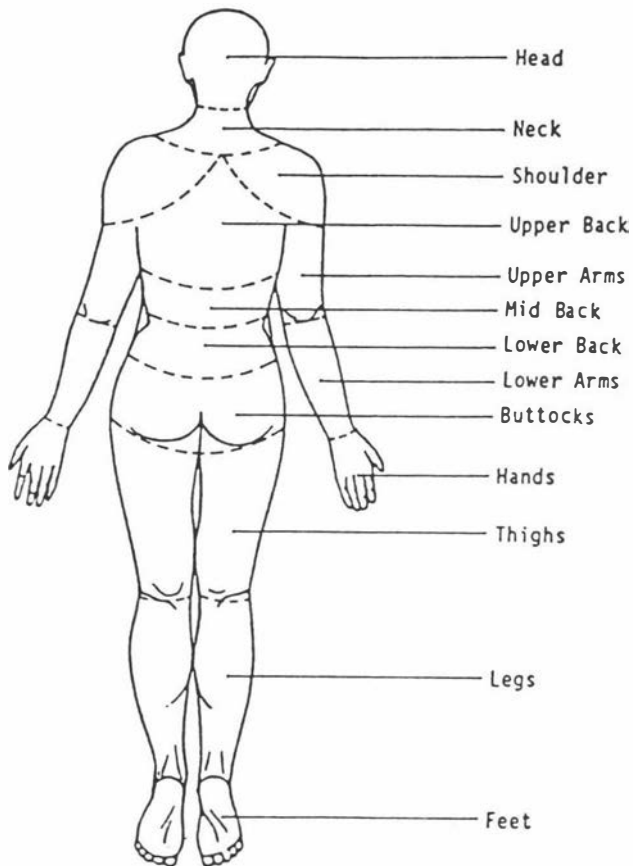


FIGURE 6.7 BODY PARTS ASSESSED

TABLE 6.4							
BODY PARTS COMFORT ASSESSMENT BY M1, M2 AND M3 AT PRENATAL TEST							
	Extremely Comfortable	Very Comfortable	Comfortable	Indifferent	Uncomfortable	Very Uncomfortable	Extremely Uncomfortable
Head			M1, M2, M3				
Neck			M1, M2, M3				
Shoulder			M1, M2, M3				
Upper Back		M1, M3	M2				
Upper Arms			M1, M2, M3				
Mid Back		M3	M1, M2				
Lower Back		M1, M3	M2				
Lower Arms		M2	M1, M3				
Buttocks				M2, M3		M1	
Hands		M2	M1, M3				
Thighs		M2	M3		M1		
Legs		M1, M2	M3				
Feet		M1, M2	M3				

Most responses to body part sensations when using the Active Birth Chair were either "Very Comfortable" or "Comfortable". An exception was the sensation felt by the mothers on the buttocks and the thighs. M1 rated the sensations as "Very Comfortable" and "Uncomfortable", respectively. M2 and M3 were "Indifferent" to buttocks sensation.

6.6.6 Part E - Active Birth Chair Features Evaluation

As has been mentioned, data from this part of the evaluation has been pooled with data generated by the midwives, and has been reported on pages 164 and 165.

6.6.7 Part F - Multiparous Mother's Preference for Birthing Devices

Since M3 was the only mother who participated in the prenatal test, with more than one childbirth experience, only she was able to answer Part F of the questionnaire. This is a "Relative Judgement Questionnaire", designed to compare a woman's birth experiences, using the Active Birth Chair, and other body-support devices used for the delivery of her previous child/ren.

Question 1

On preference: M3 was unable to give a definitive answer on whether she preferred the Active Birth Chair or the previous device without actually giving birth on the Active Birth Chair.

Question 2

On comfort: M3 felt that the Active Birth Chair would be more comfortable than other devices (score "2").

Question 3

On pushing: M3 felt that it would be easier to "push" on the Active Birth Chair during childbirth (score "2").

Question 4

On participation: M3 felt that she would be able to participate more actively during labour using the Active Birth Chair (score "3").

Question 5

On satisfaction: M3 felt that the Active Birth Chair would give more satisfaction for childbirth than other devices (score "2").

Question 6

On control: M3 felt that she would have more control using the Active Birth Chair for childbirth than other devices (score "3").

Question 7

On safety: M3 felt secure and safe using the Active Birth Chair (score "2").

Question 8

On effort: M3 felt that it would be less strenuous using the Active Birth Chair for labour, (score "2")

Question 9

On using the Active Birth Chair:

M3 felt that given the choice she would use the Active Birth Chair for the birth of her next baby, (score "2")

6.7 ANALYSIS OF EXPECTANT MOTHERS COMMENTS ON ACTIVE BIRTH CHAIR

6.7.1 Mother One

"Very nice feel to the material". "I am a small build and feel the seat is too big for my comfort". "Useful to be able to alter footrest". "I like the armrests though when in front of you, you can't see what's happening".

Explanation

True, this mother was very small, probably a 20th percentile female. She found the seat to be uncomfortable and has rated this accordingly in the questionnaire. The use of the armrests does obstruct some of the views in front of the mother.

6.7.2 Mother Two

"Seat - more padding perhaps, adjust angle when back support is reclined, adjust height, allow for different womens heights".

Explanation

Very apt comment on hardness of seat and the need for seat height and seat angle adjustability. As has already been mentioned, these factors will be considered in the redesign of a second prototype for further study.

6.8 POSTNATAL EVALUATIONS

Postnatal evaluations were the most important and realistic tests because they were higher level tests - where labour and the birth of a baby by a mother and the management and tasks of delivering a baby by an obstetrician or a midwife actually took place - using the new obstetric body-support system.

After a critical and thorough analysis on the outcomes of the prenatal tests, it was resolved that no hazards or design faults existed in the Active Birth Chair or the Seat-Kneeler, and no System incompatibilities were highlighted. The decision was made on 19 September 1995 to put the System to the real test - for labour, birth and delivery of a baby.

Unfortunately, over a period of almost three months when the System was put to use at the Maternity Unit of Kenepuru Hospital, only two mothers had used the System for the labour and birth of their babies. With the wisdom of hindsight, it is clear that it was unreasonable to expect a mother to change her "birth plan" and decide to use the new System - at the very moment she enters the hospital for labour. She has to be fully prepared and convinced to make the change to use the new System. However, although the number of mothers who used the System voluntarily is meagre and disheartening, the evaluation, nonetheless, had produced significant information that is very encouraging to the intention of the study, and paved the way for continued research in the subject. The ergodesigner is confident that with the structured education and familiarisation programme detailed in Chapter Seven, the System will attract more widespread use, and will become a viable option for childbirth.

Because of the small number of participants, only a descriptive account of the findings will be presented. For uniformity, the format of presentation used in the postnatal tests will be structured in similar formats as those adopted in the prenatal tests.

An independent obstetrician delivered the first baby on the system. The second baby was delivered by a midwife from the Kenepuru Maternity Unit. The midwife was assisted by another midwife when the baby was born. The principal midwife completed the System Questionnaire in full, but the assistant midwife completed Part B and Part C of the questionnaire. Both midwives' and the obstetrician's questionnaires will be combined for the analysis. Likewise, information from the two mothers will also be combined for the analysis.

We will begin by analysing the obstetrician's and midwives' data on the evaluation of the Obstetric Body-Support System. This will be followed by analysis of the information on the use of the Active Birth Chair by the two mothers.

Data on the design factors of the Active Birth Chair from both the birth attendant's and the mother's evaluations will be analysed together - but not pooled or combined - to highlight differences in opinion, if any, and to provide comparisons.

For brevity and clarity, the obstetrician will be identified as OB, the principal midwife as MW1 and the assistant midwife as MW2. The mother of the first baby will be identified as M01, the second mother M02 - to avoid confusion with the three mothers (M1, M2 and M3) who participated in the prenatal test.

6.9 ANALYSIS OF SYSTEM QUESTIONNAIRE

The postnatal system questionnaire is shown in Appendix A.

6.9.1 Part A - General Outcome of the Birth and Delivery

Question 1

On overall outcome of the birth and delivery:

OB felt that the overall outcome went "Extremely Well", while MW1 felt that the overall outcome went "Well".

Question 2

On providing support for the mother:

OB considered that the Active Birth Chair was "Very Good" for providing support for the mother for childbirth, MW1 was "Indifferent".

Question 3

On compatibility:

OB felt that the System was "Very Compatible" for the tasks of delivering a baby. MW1 was "Indifferent".

Question 4

On ease or difficulty:

OB found that delivering a baby on the System was "Very Easy". MW1 found it "Difficult" delivering a baby on the System.

Question 5

On comfort:

OB felt "Very Comfortable", but MW1 felt "Uncomfortable" using the System for delivery.

Question 6

On liking for the System:

OB liked the System "Very Much". MW1 liked the System "Little".

Question 7

On preference:

OB was "Indifferent" to using either the System or the bed. MW1 prefers using the bed.

Question 8

On number of babies delivered on birth chair/stool:

OB has delivered "Less than 10" babies using a birth chair/stool, whereas MW 1 has delivered "Between 20-30".

Question 9

On morbidity:

Both mothers have required "stitches due to tear".

(As upright birth postures are more physiologic, gravity-assisted and biomechanically more efficient "bearing-down" effort should be spontaneous - not coaxed - to ensure perineum integrity.)

6.9.2 Part B - Evaluation of Active Birth Chair Features

As alluded above, the obstetrician, the principal midwife, the assistant midwife and the two mothers have each completed the questionnaire on the Active Birth Chair Features. In order to aid comparisons, they will be analysed together - but not pooled or combined. Table 6.5 on the next page shows the individual responses.

The responses of the postnatal test on the design features of the Active Birth Chair were also very encouraging. Of the 67 responses to the 15 questions on the design features, 72% or 48 responses were favourable responses. Of the 28% or 19 unfavourable responses, perhaps only those regarding the hardness and angle of the seat would justify a modification or redesign.

TABLE 6.5
USERS RESPONSES TO ACTIVE BIRTH CHAIR FEATURES

No.	Question	OB	MW1	MW2	M01	M02
1	Seat height	Just right	Too low	Just right	Too high	High
2	Seat length	Just right	Just right	Just right	Long	Too long
3	Seat width	Just right	Narrow	Just right	Just right	Just right
4	Seat shape	Just right	Poor fit	Just right	Not answered	Poor fit
5	Seatslope (angle)	Just right	Too far towards back	Towards back	Too far towards back	Just right
6	Hole in seat	Just right	Just right	Just right	Just right	Just right
7	Size of hole in seat	Just right	Just right	Just right	Just right	Big
8	Shape of backrest	*Not answered	Just right	Just right	*Not answered	Just right
9	Width between armrests	Just right	Just right	Just right	Wide	Wide
10	Upper body-support	*Not answered	Just right	Just right	Very good	Adequate
11	Foot support	Good	Adequate	Adequate	Adequate	Adequate
12	Appearance of Active Birth Chair	Attractive	Unattractive	Attractive	Attractive	Just right
13	Range of adjustability on birth chair	Adequate	Poor	Adequate	**N/A	**N/A
14	Range of backrest angle adjustability	Not used	Adequate	Good	**N/A	**N/A
15	Height of platform	Just right	Just right	Just right	**N/A	**N/A

*Backrest not used - mother leant forward

**Questions 13,14 and 15 not on mothers questionnaire

6.9.3 Part C - Evaluation of Delivery Seat-Kneeler Features

Table 6.6 shows the ratings of the Delivery Seat-Kneeler Features by the two midwives who delivered one of the two babies. The obstetrician did not use the Seat-Kneeler and did not fill in this part of the questionnaire.

No.	Question	MW1	MW2
1	Seat-kneeler height	Just right	Just right
2	Seat-kneeler length	Just right	Just right
3	Seat-kneeler width	Just right	Just right
4	Seat-kneeler shape	Adequate	Adequate
5	Seat-kneeler slope	Just right	Just right
6	Shape of seat-kneeler	Just right	Just right
7	Seat-kneeler armrests	Just right	Just right
8	Seat-kneeler mobility	Poor	Adequate
9	Seat-kneeler appearance	Attractive	Adequate

Of the 18 responses to the nine Seat-Kneeler design features, 17 or 94% were highly favourable responses. One of the midwives (6%) found the mobility of the Seat-Kneeler to be "Poor".

While the overall outcome of the use of the System has been described by the obstetrician to have gone "Extremely Well" and "Well" by the midwife, other responses to the System have been split - with the obstetrician responding favourably to most questions and the midwife responding unfavourably to most questions.

6.10 ANALYSIS OF BIRTH ATTENDANTS COMMENTS ON THE SYSTEM

The following are written comments that were recorded in the System Questionnaire of the postnatal tests. An analysis and explanation is given after each comment by the ergodesigner.

6.10.1 Principal Midwife

"I found that using the system the woman's thighs were closer together than if she had been squatting or kneeling. This meant that there was less room for the baby's head to come through the pelvis and the perineum did not stretch up well. I felt that this lack of slow stretching contributed to the perineal tear that the woman sustained."

Explanation

It is a fact that squatting or kneeling opens up the pelvis and the birth canal more than a semi-squat position that a woman has to adopt using the Active Birth Chair. However, the semi-squat position was chosen because most "western" women find it extremely tiring to squat during labour, and in most cases would require one or two "birth partners" to "prop" her up by holding her arms during labour. Squatting and kneeling are unstable positions that may endanger the safety of the baby while being born, if the mother falls. The mother should be able to abduct her thighs as far as required. There is no obstruction to prevent the widest thigh abduction as the seat has been designed to cantilever from its frame to promote free and unlimited thigh abduction. The management of second stage labour must take into account the more efficient upright posture and gravity. "Pushing" should be slower and gentler than the horizontal position. 30-50% of normal births would suffer some perineal tear (White, 1988), and up to 88% would require an episiotomy (Steward, 1977).

6.10.2 Assistant Midwife

"The birth I attended and assisted at is the only birth I am able to comment on as it is the only one I have been at that the chair was used. I did notice that there was nowhere to place the baby when it was born and before the cord was cut. The baby needed suctioning and if there had only been two midwives in attendance it would have been difficult to hold the baby and suction at the same time. At this particular birth there were three midwives (no doctor) and the suctioning was done but for a few moments we didn't know where to place the baby."

Explanation

It would appear that the midwives in this particular birth had not been sufficiently briefed. They obviously had not thought through the process and contingency that could happen at any birth. The birth chair must always be placed next to a bed in case the mother or the baby has an emergency that requires medical attention. Ideally, as soon as the baby is born, s/he should be placed on the mother's chest to promote mother and child "bonding". The back-support should be reclined to an angle of between 20° and 30°. On hindsight, the ergodesigner should have prepared an instruction manual before the Active Birth Chair was put to use. This has been considered, but without the advantage of hindsight and user trials, it was not possible to predict the parameters and extent the system would be put to use. Had a user instruction manual been prepared it could have prevented the problem cited above.

6.10.3 Independent Obstetrician

The obstetrician did not make any comment on the System Questionnaire but in a handwritten letter to the ergodesigner after the birth using the system, he said:

"... a woman in my care was the first to use your chair. She was having her first birth and the second stage was prolonged in that the baby seemed to be not coming out with pushing. The woman had sat on the chair in labour and had felt uncomfortable with the upwardly sloping seat. I persuaded her to try the chair again now that she was actively pushing. She leaned forward over the support arms and then found the seat angle very comfortable. She progressed quickly to a normal delivery with the help of the chair. I think the chair saved her from requiring intervention such as a forceps delivery. I think your chair is a very valuable addition to birthing options and with good marketing would be a commercial success. I have filled out one of your appraisal forms at the hospital but so far have not identified any flaws ..."

Explanation

Obviously, the obstetrician was very wise to persuade the woman to use gravity and her more efficient biomechanical power in the upright birth position to speed up foetal descent using the Active Birth Chair. It is exciting to hear that "the chair saved her from requiring intervention such as a forceps delivery". Making labour more efficient and childbirth safer was one of the major objectives of this research study.

6.11 ANALYSIS OF BIRTH ATTENDANTS COMMENTS ON ACTIVE BIRTH CHAIR

6.11.1 Principal Midwife

"Adjustable seat slope". "Height of chair adjustable to allow for varying degree of suppleness of attendants". "Wider seat width so woman sitting in position with pelvis opened to maximum".

Explanation

With the evaluation of the prototype System now well underway, it is possible to make the Active Birth Chair fully adjustable. This will be taken into consideration when the System is modified or redesigned in light of the findings from the current evaluations. There are no obstructions on the Active Birth Chair that could prevent maximum thigh abduction and full opening of the pelvis. The ergodesigner is of the opinion that the seat is already wide enough. In any event, seat width in this prototype has no influence on the degree of thigh abduction, as the seat is cantilevered from the framework. The slope (angle) of the seat - which is fixed at 15° from the horizontal could have made thigh abduction more difficult and decreasing the seat angle to between 5° and 7° would ease thigh abduction considerably.

6.12 ANALYSIS OF BIRTH ATTENDANTS COMMENTS ON DELIVERY SEAT-KNEELER

6.12.1 Principal Midwife

"Once I had my sterile gloves on, it was not possible for me to adjust my position on the kneeler, as I was required to use my hands to do so. I was in that position for 1½ hours and got a bit uncomfortable towards the end. To adjust my position required me to turn the kneeler around. Perhaps if the kneeler could be flat, without a slope it would be easier for the attendant to change position".

Explanation

The configuration of the Delivery Seat-Kneeler has been designed to enable the birth attendant to adopt a variety of positions - kneeling, sitting, sit-squatting, sitting with legs under the birth chair platform, etc. Sitting in a constraint posture for over an hour in any seat would be uncomfortable.

The ergodesigner is unable to think of the reason as to why she was unable to stand up for a few seconds, turn the Seat-Kneeler around and adopt a new position. The Seat-Kneeler, with two large castors has been designed to be mobile. It could be turned around using a foot, if the hands are to be kept sterile. The above comment has highlighted pertinent usability problems that the midwife has encountered. Again, had an instruction manual on the use of the Seat-Kneeler been written, problems such as this could be minimised if not eliminated.

6.12.2 Assistant Midwife

"I have not used the Seat-Kneeler, so wonder if I can comment. I prefer if I am down that low to kneel on the floor. The Seat-Kneeler would make that a more comfortable position but for me the armrests would be in the way. I would probably not use the Seat-Kneeler for this reason".

Explanation

If a birth attendant is fit and strong kneeling on the floor during delivery could be a good option. It is a matter of preference. The armrest on the Seat-Kneeler would not obstruct or hinder the tasks of the birth attendant. This factor has been very carefully considered during product development. The armrests are positioned well behind the elbows to avoid possible obstructions. Each armrest has a slight slope which measures from 175mm at the lowest point to 200mm at the highest point from the top of the seat. The average sitting elbow height of the average female is about 240mm. Hence, the chances of the armrests coming "in the way" of the midwife's tasks is unlikely. Her assumption is both conjectural and unfounded. The main function of the armrests is not merely to provide a means for the birth attendant to transfer the weight of her arms during prolonged labour to relieve tension and fatigue of the arms and shoulders, but the "armrests" also serve as a "transfer-support" to aid birth attendants in and out of the Seat-Kneeler. Older birth attendants will find this feature very useful.

6.13 POSTNATAL EVALUATION OF ACTIVE BIRTH CHAIR BY MOTHERS

The following analysis is a summary of the findings on the evaluation of the Active Birth Chair undertaken by two mothers who used the chair for the birth of their babies.

As has been mentioned above, data on the design features of the Active Birth Chair have been analysed alongside data generated by the obstetrician and the two midwives who delivered the babies.

Due to the small number of the participants, only a descriptive account of the findings will be presented.

A sample of the questionnaire is shown in Appendix B.

6.13.1 Part A - Personal Information

This information has been reported on page 148 under Methods and Participants.

6.13.2 Part B - Childbirth Feelings and Perceptions

The two mothers who used the Active Birth Chair for labour and the birth of their babies rated their birth experiences on the use of the Active Birth Chair favourably. While the first mother felt "Very Tired", "Extremely Strenuous" and "Severely Painful", and the second mother felt "Numb", "Very Strenuous" and "Quite Painful" during labour; both have found the Active Birth Chair to be "Comfortable", "Easy" to "push" on, "Satisfying" to "Very Satisfying" to use, "Safe" to "Very Safe" to labour on, and able to have "Some Control" to "A Lot of Control" on labour and childbirth the way they wanted it to be. While the first mother had felt "Indifferent" to

the question whether she had enjoyed using the birth chair, she was able to participate "Very Actively" during labour on the chair. The second mother, however, said that she had enjoyed using the birth chair, but was "Indifferent" to participation during labour.

6.13.3 Detailed Responses on Childbirth "Feelings" and "Perceptions" of the Two Mothers

Question 1

On comfort: Both M01 and M02 found using the Active Birth Chair for childbirth to be "Comfortable".

Question 2

On effort for pushing: Both M01 and M02 found that pushing on the Active Birth Chair to be "Easy".

Question 3

On participation: M01 found the level of participation to be "Very Active". M02 was "Indifferent" about it.

Question 4

On effort: M01 found the effort required to be "Extremely Strenuous", while M02 found the effort required to be "Very Strenuous".

Question 5

On birthing experience: M01 considered her birth experience using the Active Birth Chair to be "Very Satisfied". M02 was "Satisfied".

Question 6

On control: M01 said that she had "Some Control" of her labour and the birth of the baby the way she wanted it. M02 had "A Lot of Control".

Question 7

On safety: M01 found that giving birth on the Active Birth Chair to be "Safe". M02 found it to be "Very Safe".

Question 8

On level of pain: M01 felt "Severely Painful" and M02 felt "Quite Painful" when their babies were born.

Question 9

On enjoyment: M01 was "Indifferent" while M02 "Much" enjoyed giving birth using the Active Birth Chair.

6.13.4 Part C - General Postural Comfort Rating

M01 felt "Very Tired" during labour and M02 felt "Numb" during labour using the Active Birth Chair.

6.13.5 Part D - Body Parts Comfort Assessment

The mothers' responses to body parts sensations are shown on Table 6.7 on the next page. Responses are recorded in the appropriate column spaces below the phrase or word that corresponds to the body parts. The alphanumeric codes of M01 and M02 are used to identify the two mothers. For example, as can be seen from the table M01 felt "Very Comfortable" on the head, but M02 was "Indifferent" to head sensation when using the Active Birth Chair.

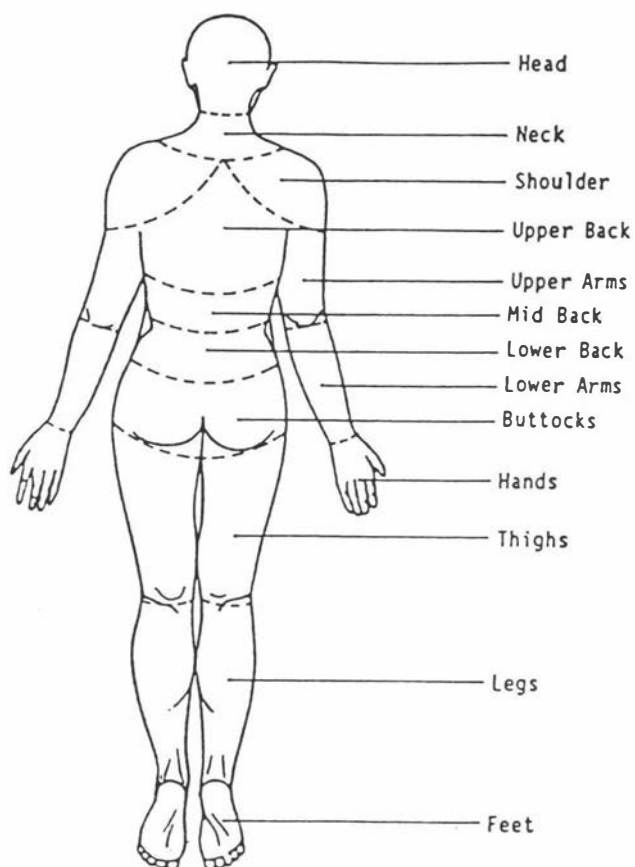


FIGURE 6.8 BODY PARTS ASSESSED

TABLE 6.7 BODY PARTS COMFORT ASSESSMENT BY M01 AND M02 AT POSTNATAL TEST							
	Extremely Comfortable	Very Comfortable	Comfortable	Indifferent	Uncomfortable	Very Uncomfortable	Extremely Uncomfortable
Head		M02		M01			
Neck			M02	M01			
Shoulder		M02	M01				
Upper Back			M01,M02				
Upper Arms			M01,M02				
Mid Back			M01,M02				
Lower Back			M01	M02			
Lower Arms			M01,M02				
Buttocks				M02	M01		
Hands			M01,M02				
Thighs				M02	M01		
Legs			M02		M01		
Feet			M02		M01		

6.13.5.1 *Summary of Responses to Body-Parts Comfort by Postnatal Mothers*

Most body part sensations when using the Active Birth Chair for labour were "Comfortable". However, M01 felt "Uncomfortable" on the buttocks, thighs, legs and feet, and "Indifferent" on the head and neck. M02 felt "Indifferent" on the lower back, buttocks and thighs. M02 also felt "Very Comfortable" on the head and shoulder.

Of the 13 body parts - head, neck, shoulder, upper back, upper arms, mid back, lower back, lower arms, buttocks, hands, thighs, legs and feet - that were evaluated for comfort or discomfort, only the first mother had felt "Uncomfortable" on the buttocks, thighs, legs and feet. The rest of the responses were either rated as "Indifferent" (5 counts), "Uncomfortable" (4 counts), "Comfortable" (15 counts) or "Very Comfortable" (2 counts). All the above factors are important elements for a "Good Birth". Given that childbirth is a natural painful process, the two mothers appeared to have shown considerable tolerance to the sensation of various body parts during labour on the Active Birth Chair.

6.13.6 Part E - Active Birth Chair Features Evaluation

As has been mentioned, this data has been analysed alongside that generated by the obstetrician and midwives.

6.13.7 Part F - Comparison of Active Birth Chair with Other Birth Devices

This part of the questionnaire was to be answered by multiparous women. Since both the mothers who participated in this evaluation were having their first baby, this part of the questionnaire has become irrelevant.

6.14 ANALYSIS OF POSTNATAL MOTHERS COMMENTS ON ACTIVE BIRTH CHAIR

6.14.1 Mother One

"I think making the chair adjustable would be beneficial and also extra padding on the chair".

Explanation

Most valid comments. The angle of the seat at 15° backwards from the horizontal appeared to be too steep for the mother. This and softer cushioning will be incorporated when a new chair is built for further study.

6.14.2 Mother Two

"Pad the seat a bit more".

Explanation

Because of the intimate interfacing between human and equipment, this problem appeared to be the most critical of all the design features on the Active Birth Chair that required modification and redesigning.

6.15 SUMMARY OF THE RESULTS AND DISCUSSION

In terms of achieving the main aim of this study - to Design and Evaluate an Obstetric Body-Support System for Physiologic Childbirth - the results are both positive and encouraging.

First, the two mothers who participated in the postnatal tests have rated their labour and birth experiences using the Active Birth Chair very favourably. Important elements for a "Good Birth" - "Comfort", "Safety", "Ease-of-Push", "Control", "Active Participation", and even "Enjoyment" were felt by the maternal mothers. The active Birth Chair had in many ways contributed to the psychological and physical wellbeing of the maternal mothers, by making their birth experiences more satisfying and holistic.

Second, the obstetrician who delivered the first baby, besides rating the performance of the System very favourably on all questions, was of the opinion that the woman under his care who had a prolonged labour was "saved from intervention such as the forceps" by the Active Birth Chair. This statement is an important confirmation of the research proposition that birth postures aided by gravity and the biomechanical efficiency of the woman is more physiologic for childbirth.

Third, the results on the evaluation of the design features of the Active Birth Chair in the postnatal tests - by the obstetrician, two midwives and two mothers who used the System for delivery and childbirth, respectively - are very encouraging and indicative of a high level of confidence and acceptance of the System.

Fourth, the results on the evaluation of the design features of the Delivery Seat-Kneeler in both the prenatal and postnatal tests by the 13 midwives are even more encouraging. The responses were unanimous, signifying system-task compatibility, useability and functionality of the equipment.

Fifth, the prenatal tests have produced equally reassuring results - with 88% of midwives responding that the Active Birth Chair would provide good support for the mother and 78% indicating that the birth chair would be compatible with the tasks of delivering a baby. Prenatal mothers have also responded to the design features of the Active Birth Chair enthusiastically.

Of the 67 responses to the 15 questions on the design features of the Active Birth Chair, 72% were favourable responses. Of the 28% or 19 unfavourable responses, perhaps only those regarding the hardness and angle of the seat would justify a modification or redesign.

The outcome of the evaluation has been positive and reassuring. While readers are reminded to look at the result with caution because of the small number of participants in the evaluation, however, it is believed that the trends that are indicated in the results are so definite that had a larger sample been involved, it is unlikely that it would alter this trend to any significant extent.

CHAPTER SEVEN

DISCUSSION

7. DISCUSSION

The main findings offer strong evidence for considerable support of the Active Birth Chair, the Delivery Seat-Kneeler and the new System as a whole, by the mothers, midwives and the obstetrician in both the prenatal and postnatal evaluations.

The results indicated that the new System will improve not only intra-partum care, but it will also enrich the birth experiences of the mother with a new dimension of "enjoyment", "control", psychological fulfilments and physiological enhancements.

It is unusual if not unprecedented in system design to achieve such favourable results, especially when we take into account that the evaluations were done on the "first-version prototype" by six different user groups at both prenatal and postnatal levels. Perhaps, more remarkable, the System is new in concept; is multi-featured; complex; interactive and requiring critical optimisation for task-fit, ergonomics, safety, function and usability. Out of a total of 81 questions to be rated in both the prenatal and postnatal tests, by 19 participants, only one design feature - the slope of the seat - was rated, "on average", "Unfavourable" by a combined user-group of obstetrician, midwives and mothers in the postnatal test. This is just 1% of the total, even though 21 or 26% of the questions had only one "Favourable" answer - "Just Right" - and six "Unfavourable" answers.

It is believed that such a favourable outcome can only be achieved with a user-centred ergonomic design approach which focuses on the optimisation of human-equipment compatibilities that are enshrined in ergodesign. The emphasis of this study has been to improve the usability of Ergonomics and Design in the development of an obstetric system for physiologic birth in the upright position. The study has attempted to augment our understanding of the problems facing designers in applying scientific information, such as ergonomics, in the creative process. It has not only identified major obstacles believed to be responsible for the apparent conflicts between rationality and intuition, logic and imagination, and order and choice of the scientist and the designer, but has proposed a barrier-free, interactive and interdisciplinary approach to ensure direct accessibility of scientific information in the design process and to stimulate the smooth interactions of "theory into practice" of the ergodesigner.

At the outset, this study appeared to have as its objective the relatively straight forward aim of applying ergonomics to the design of an Obstetric Body-Support System to promote physiologic labour and childbirth. It became clear during the postnatal evaluation that this alone was not going to be effective in changing current obstetric practices and their management. Despite the favourable outcome of the evaluations, the low level of voluntary use of the System for actual births and deliveries during the postnatal test period suggested that there is a mismatch between System design and System implementation.

This has highlighted the fact that the ergonomics problems in obstetrics are not only confined to the human-equipment interface level, but extend into areas of strongly entrenched beliefs; practices; work ethos; and cultural, ethical and midwifery issues that must be addressed before the new System can be accepted as a viable option for childbirth and its management.

We must take cognisance that midwifery and obstetrics function under a complex and rigid sociotechnical system which is staunchly resistant to change. This aspect points to the need for a well-structured education/familiarisation programme for both the child-bearing women and the birth attendants before the new System can be accepted with confidence and enthusiasm.

Currently, there appears to be a lack of a theoretical base for midwifery and the lack of any models and the use of the nursing model is not fully applicable to midwifery care. "In reality, the majority of the midwives who work in hospitals that are based on a medical model of care, may themselves hold a medical approach to care. Research and anecdotal evidence indicates that mothers feel that their needs are not met by care provided with this model" (Oakley, 1979, 1980).

Many midwives working in hospitals have relegated the concept of individual care for the mother and the baby to merely the provision of physical needs and routine management of labour. They are insensitive to the concept of holistic care.

Barclay et al, (1989) asserts that the role of midwives, identifying professionalisation rather than the place of activity as a factor which dehumanises birth. Much of midwifery work is aimed at meeting the needs of obstetricians: "the midwife frequently acts as the agent that helps transform birth into a medical ritual. It is not surprising that this occurs, as the notion of midwife has changed from one of "women with women", to a professional role in itself".

The Nurses Amendment Act of 1990 which enables a midwife to take responsibility for the care of a woman throughout her pregnancy, childbirth and postnatal period, restored the credibility midwifery deserved, along with the responsibility of professional accountability.

Generating a body of scientific knowledge and developing and testing theories through childbirth research, rather than depending on a knowledge base that has evolved primarily from beliefs, commonsense, intuition and past experience - that have developed into rules (Gortner, 1980) - is deemed indispensable for midwifery to grow.

Midwifery needs to substantiate its practice by scientific outcomes. Research is essential to the development of the profession. Through research a body of scientific knowledge is generated and theories are developed and tested. Knowledge and theories are necessary to provide a scientific foundation for planning, predicting and controlling the outcome of midwifery practice. This is professional credibility.

Knowledge development in the health care disciplines, however, has been established rather unevenly. In clinical medicine, for example, the large compendium of signs and symptoms used in diagnosis was developed informally over several hundred years by thoughtful physicians carefully observing the sick and noting and teaching the characteristic patterns that accompanied patients illnesses. Obstetrics was an exception. Until the last century, male physicians interested in obstetrics had limited access to pregnant and labouring women. For this reason, present day obstetric texts are relatively devoid of description of normal behavioural signs of the progress of labour, with physicians relying on monitors and pelvic examination to determine the stages of labour (Morse, 1994).

It is important that both midwifery and obstetrics begin to develop a strong and keen research culture to enrich their disciplinary knowledge base that is both holistic and beneficial to the mother and her baby. Already, worldwide there have been outcries to humanise obstetric care and such demands are best provided by midwives and obstetricians, who, as "insiders" are able to provide an "emic" perspective of their discipline.

However, it is also healthy, for the sake of knowledge, for the two professions to consider the work of the "outsider" with an "etic" orientation in order to gain interdisciplinary perspectives. Until recently, the investigation of health problems was dominated by the "etic" perspective.

Important questions of etiology and treatment are identified by the medical profession. Studies based on this "outsider" orientation reflect that medical professionals are the authorities on what illness is and that they alone know what questions ought to be asked (De Poy et al, 1994). Perhaps more importantly, it also suggests the lack of know-how or interest of the "emic" professionals to undertake their own research. If the latter is the case they must for the benefit of childbirth, accept the "etic" researcher with sensitivity and open mindedness.

While the study has been undertaken with a participatory approach, the ergodesigner has been regarded as an "etic" researcher: an "outsider". Making connections and employing concepts and methods drawn from ergonomics and design to study obstetrics, and encouraging midwives and obstetricians to address what the researcher regards as important issues or themes in the phenomena of labour and childbirth has been looked upon by many as provocative.

Whatever the good intention might be, the study has been perceived, by some practicing midwives and obstetricians, to challenge their authority as the only group qualified to speak for their profession. The study is also threatening to some, who perhaps fear that expanded discussion will diminish their professional standing, or further cloud an already difficult or controversial subject.

The results of the study must be interpreted in relationship to the factors actually tested. This study has at least two important limitations. First, is the small number of births tested. Second, the study measured only users' subjective reactions to the System. While psychophysical responses are all subjective phenomena, and therefore cannot be measured directly with an objective physiological variable, it

is considered to be of great importance that further studies should be undertaken to evaluate clinical factors of the maternal mother and the foetus to verify the beneficial effect or otherwise of the System, before it is put to general use. A further study plan is detailed in Chapter Eight.

7.1 SYSTEM PLANNING AND IMPLEMENTATION

One of the main reasons for system planning is uncertainty. The obstetric system can develop into a popular option for childbirth when it is eventually put into general use. There are a number of factors that must be taken into consideration. These factors include the reliability and safety of the hardware, validation of the maternal and the baby's clinical wellbeing and safety, the education and validation of midwives and obstetricians skills and knowledge required for the management of labour and childbirth in the new position, acceptance of the System by birth attendants, education and familiarisation programmes for expectant mothers on the principles and advantages of upright birth posture using the Active Birth Chair.

All new tasks created by the new System, no matter how simple they may seem, have to be learnt and incorporated in the primary job of the birth attendants. The process requires changed behaviour at the instant when the System is put in place for use. Sufficient preparation, planning and rehearsal to allow users to adjust to System needs should be well structured and implemented well before the System is put to use.

Bryar (1995) states that the individual builds up expectations and patterns of behaviour of how they view themselves as midwives and how they view childbirth and care of the mother, and any change, whether welcomed or not, will disrupt this understanding.

The new System will involve changes in the way birth attendants manage labour and delivery. This change threatens to invalidate their experience, robbing them of the skills they have learned and confusing their purpose, upsetting the subtle rationalisation and compensation by which they reconcile the different aspects of their situation (Marris, 1986). Changes also require a change in beliefs of the birth attendants, and they must be given the opportunity to develop new skills for the management of labour and birth in the new position using the new Obstetric Body-Support System.

7.2 RESEARCH, SCHOLARSHIP AND DEVELOPMENT

Research, scholarship and development have been the underpinning forces of this study. The study has embraced both basic and applied research in the acquisition of knowledge to devise new applications for the development of a new system for natural childbirth that is potentially beneficial to childbearing women, nationally and internationally. Besides the creation, development and evaluation of the new System, the study has also attempted to deepen and expand our knowledge, scholarship and practice in midwifery, ergonomics and design, and perhaps more significantly, the proposal and experimentation of the robustness of Ergodesign for system design and development.

It is believed that this research study has generated two "landmark" topics - the concept of Ergodesign and the Obstetric Body-Support System for physiologic childbirth. Further studies are needed to empirically test and validate the two concepts.

Ergonomists, designers, midwives, obstetricians and indeed research students reading this report, it is hoped, will find the study interesting and be stimulated to replicate similar research. Readers are encouraged to explore the "Ergodesign Approach" further in other system design, development and implementation. Perhaps more importantly, readers are reminded not to derive inspiration only on what has been achieved in this study, but are alerted to ponder on what more could be done by generating additional research problems that complement as well as extend this exciting area of research.

CHAPTER EIGHT

CONCLUSIONS AND FURTHER STUDIES

8. CONCLUSIONS

The results of the study showed that both the Active Birth Chair and the Delivery Seat-Kneeler have been received with a high level of acceptance by mothers and caregivers as an alternative option for childbirth. Besides providing an ergonomic support for the mother, the system has been found to contribute to the psychological and physical well-being of the maternal mothers by making their birth experiences more "active", "comfortable", "easy to push" and "satisfying". These are important elements for a Good Holistic Birth - the current study has set out to provide. Perhaps more importantly a woman who had a prolonged labour "was saved from intervention such as the forceps" by labouring on the Active Birth Chair. This statement, from the obstetrician who delivered the first baby on the System, is an important substantiation that supports the research hypothesis that the upright birth positions - which take advantage of gravity and the more effective biomechanical power of the woman - are more physiologic for childbirth.

Of the 15 design features on the Active Birth Chair and nine design features on the Delivery Seat-Kneeler that were tested in the evaluations, no major hazards that might disadvantage the birth process, or might endanger the mother and the baby had been found. Only the seat angle of the Active Birth Chair was considered by some mothers and caregivers to be too great and needed modification.

The key to this success is believed to be in the following areas:

First, the system is original. It revolutionalises childbirth and the management of it by allowing the mother to labour in the upright posture and reversing the delivery position of the obstetrician and midwife from looking down at the woman's abdomen, to looking at her perineum. Gravity and effective use of biomechanics by the mother assist the foetus to descend from the birth canal with ease and naturally; while in his/her new ergonomic position - forward facing and with better eyes-hands coordination - the new posture is expected to improve the quality of the birth attendant's tasks and the delivery of the baby significantly. He/she is able to see the baby being born clearly.

Second, mothers, midwives and obstetricians were fully involved in all stages of the design, development and evaluation process. They provided the Ergodesigner with the insight of childbirth and participated in the appraisal and decision-making of the design concepts, mock-ups and the prototype. Third, the judicious application of ergonomics, together with innovative system design had produced a system which is beneficial to the mother and the baby, functional, reliable, safe and easy to use. Fourth, there is an increasing number of well-informed mothers, midwives and obstetricians who are cognisant of the concept of upright physiologic childbirth and were committed to collaboration with the Ergodesigner during the study. And fifth, the use of the ergodesign concept and methods had ensured the smooth flow of ergonomics theory into design practice, thus reducing disciplinary barriers that are often encountered in system design when ergonomics and design are used as separate disciplines.

8.1 MODIFICATION TO THE ACTIVE BIRTH CHAIR

Many participants in both the prenatal and postnatal tests were critical of the seat slope (angle) of the Active Birth Chair. This will be modified for a further study. Besides decreasing the seat angle from 15° to 7°, the seat will also be "spring-loaded" for it to self-adjust slightly when the mother leans

forward and backward. After careful analysis no other design features on the Active Birth Chair or the Delivery Seat-Kneeler justify any modification.

8.2 FURTHER STUDY

The number of participants in the present study is considered to be too small for firm conclusions to be drawn from the results. Further study is needed before the Obstetric Body-Support System could be put into general use. This study will compare maternal and foetal outcomes of 100 primiporous births. A quasi-experiment design with 50 primigravidae to be assigned to the experimental group - using the Active Birth Chair, and 50 to the control group to labour and deliver in the traditional recumbent position is planned.

The clinical factors to be studied will include umbilical artery and vein blood oxygen levels; time of first cry of babies; Apgar Scores; post-partum haemorrhage, frequency of laceration and episiotomy; and length of 2nd stage labour. A plan for a further study is detailed in Appendix C.

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232

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APPENDICES

OBSTETRIC BODY-SUPPORT SYSTEM EVALUATION

Dear Doctor/Midwife/Nurse

Thank you very much for your support and collaboration in making this research study and the evaluation of the Obstetric Body-Support possible.

This System Questionnaire is designed to find out your opinion on the functions and features of the Obstetric Body-Support System you have used for the delivery of a baby. The questions are designed to solicit comments and criticisms - with the aim of improving the compatibilities of the System with the various tasks you have to perform in the Delivery.

The System Questionnaire is divided into three parts:

Part A - Gathers general information on the outcome of the Birth, Delivery and the use of the whole Obstetric Body-Support System.

Part B - Evaluates Active Birth Chair Features

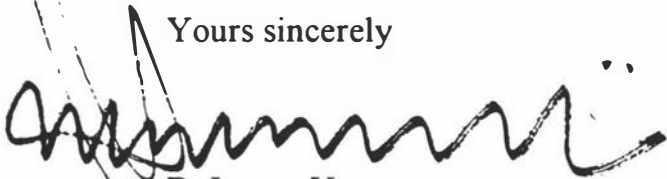
Part C - Evaluates Delivery Seat-Kneeler Features

Please answer all the questions as honestly as you can as your comments and opinions will assist me to improve the Body-Support System for the benefit of all mothers, midwives and obstetricians who want to use the System in the future.

The whole questionnaire will take about 20 minutes to complete.

Thank you very much for your assistance and cooperation.

Yours sincerely

A handwritten signature in black ink, appearing to read 'B. Leong Yap', with a long, sweeping underline that extends across the width of the signature.

B. Leong Yap
Ergonomist/Designer

EVALUATION OF OBSTETRIC BODY-SUPPORT SYSTEM

DOCTOR/MIDWIFE NAME: _____

RANK: _____

(Sister, Staff Nurse, Staff Midwife, etc)

I have been an obstetrician/midwife for _____ years.

Name of Mother: Ms/Mrs (optional)

PART A

General Outcome of the Birth and Delivery

The following questions are designed to find out the general outcome of the Birth, Delivery and your opinion on the use of the Obstetric Body-Support System.

Please take your time and place a tick (✓) above the phrase or word that best describes your response. Please answer all questions as honestly as you can.

Strict confidentiality will be observed.

1. How would you describe the overall outcome of the Birth and Delivery using the Obstetric Body-Support System.

Extremely Well	Very Well	Well	Indifferent	Bad	Very Bad	Extremely Bad

2. How would you describe the Active Birth Chair in terms of providing support for the mother for childbirth.

Extremely Good	Very Good	Good	Indifferent	Bad	Very Bad	Extremely Bad

3. Was the system compatible or incompatible with the tasks of delivering a baby.

Extremely Compatible	Very Compatible	Compatible	Indifferent	Incompatible	Very Incompatible	Extremely Incompatible

4. Did you find delivering the baby easy or difficult.

Extremely Easy	Very Easy	Easy	Indifferent	Difficult	Very Difficult	Extremely Difficult

5. How comfortable or uncomfortable did you find using the System for delivery.

Extremely Comfortable	Very Comfortable	Comfortable	Indifferent	Uncomfortable	Very Uncomfortable	Extremely Uncomfortable

6. Did you like delivering the baby using the System.

Extremely So	Very Much So	Much	Indifferent	Little	Very Little	Not At All

7. Now that you have used the Obstetric Body-Support System; do you prefer using it or the hospital bed.

Definitely the System	Very Likely the System	The System	Indifferent	The Bed	Very Likely the Bed	Definitely the Bed

8. Approximately how many babies have you delivered while the maternal mother is on a birth chair/stool.

This is my First One	Less Than 10	Between 10-20	Between 20-30	Between 30-40	Between 40-50	Over 50

9. This delivery has necessitated:

Please tick (✓)

- Stitches due to tear
- Episiotomy
- The use of forceps
- Other - please specify

10. Please write down any comments you think would help me to improve the design of the System or help other mothers or birth attendants in labour or delivery.

PART B

Active Birth Chair Features Evaluation

The following questions are designed for you to comment on the features of the Active Birth Chair you have used for the delivery of the baby.

Please place a tick (✓) above the phrase or word that best describes your opinion above the chair feature.

1. **Seat Height**

Far Too High	Too High	High	Just Right	Low	Too Low	Far Too Low

2. Seat Length

Far Too Long	Too Long	Long	Just Right	Short	Too Short	Far Too Short

3. Seat Width

Far Too Wide	Too Wide	Wide	Just Right	Narrow	Too Narrow	Far Too Narrow

4. Seat Shape

Extremely Poor Fit	Very Poor Fit	Poor Fit	Just Right	Good Fit	Very Good Fit	Extremely Good Fit

5. Seat Slope (Angle)

Much Too Far Towards Back	Too Far Towards Back	Towards Back	Just Right	Towards Front	Too Far Towards Front	Much Too Far Towards Front

6. Hole in Seat

Extremely Good	Very Good	Good	Just Right	Poor	Very Poor	Extremely Poor

7. Size of Hole in Seat

Far Too Small	Too Small	Small	Just Right	Big	Too Big	Far Too Big

8. Shape of Backrest

Extremely Poor Fit	Very Poor Fit	Poor Fit	Just Right	Good Fit	Very Good Fit	Extremely Good Fit

9. Width Between Armrests

Far Too Wide	Too Wide	Wide	Just Right	Narrow	Too Narrow	Far Too Narrow

10. Upper Body-Support

Extremely Good	Very Good	Good	Just Right	Poor	Very Poor	Extremely Poor

11. Foot Support

Extremely Poor	Very Poor	Poor	Adequate	Good	Very Good	Extremely Good

12. Appearance of Birth Chair

Extremely Attractive	Very Attractive	Attractive	Just Right	Unattractive	Very Unattractive	Extremely Unattractive

13. Range of Adjustability on Birth Chair

Extremely Poor	Very Poor	Poor	Adequate	Good	Very Good	Extremely Good

14. Range of Backrest Angle Adjustability

Extremely Poor	Very Poor	Poor	Adequate	Good	Very Good	Extremely Good

15. Height of Platform

Far Too Low	Very Low	Low	Just Right	High	Very High	Far Too High

16. Please write in the space below any points you think would help me to improve the design of the Active Birth Chair to help other women in their labour.

PART C

Delivery Seat-Kneeler Features Evaluation

The following questions are designed for you to comment on the features of the Delivery Seat-Kneeler you have used for the delivery of the baby.

Please place a tick (✓) above the phrase or word that best describes your opinion about the chair features.

1. Seat-Kneeler Height

Far Too High	Too High	High	Just Right	Low	Too Low	Far Too Low

2. Seat-Kneeler Length

Far Too Long	Too Long	Long	Just Right	Short	Too Short	Far Too Short

3. Seat-Kneeler Width

Far Too Wide	Too Wide	Wide	Just Right	Narrow	Too Narrow	Far Too Narrow

4. Seat-Kneeler Shape

Extremely Poor	Very Poor	Poor	Adequate	Good	Very Good	Extremely Good

5. Seat-Kneeler Slope

Much Too Far Towards Back	Too Far Towards Back	Towards Back	Just Right	Towards Front	Too Far Towards Front	Much Too Far Towards Front

6. Shape of Seat-Kneeler

Extremely Poor Fit	Very Poor Fit	Poor Fit	Just Right	Good Fit	Very Good Fit	Extremely Good Fit

7. Armrests

Extremely Poor Fit	Very Poor Fit	Poor Fit	Just Right	Good Fit	Very Good Fit	Extremely Good Fit

8. Seat-Kneeler Mobility

Extremely Poor	Very Poor	Poor	Adequate	Good	Very Good	Extremely Good

9. Seat-Kneeler Appearance

Extremely Attractive	Very Attractive	Attractive	Adequate	Unattractive	Very Unattractive	Extremely Unattractive

ACTIVE BIRTH CHAIR EVALUATION

Dear Ms, Mrs

Thank you very much for using the Active Birth Chair for the birth of your baby, and agreeing to take part in this evaluation.

The following questions are designed to find out your feelings on your labour and your opinions of the Active Birth Chair you have used for the birth of your baby.

The questionnaire is divided into six parts:

- Part A* - gathers personal information
- Part B* - is designed to find out the feelings and perceptions of your birth experiences using the Active Birth Chair
- Part C* - is designed to find out your general postural comfort during labour using the Active Birth Chair
- Part D* - is designed to find out body-parts sensations - such as comfort and discomfort
- Part E* - is designed for you to comment on the features of the Active Birth Chair
- Part F* - is designed only for women with more than one labour to compare their feelings of using the Active Birth Chair and previous birthing device/s such as bed, delivery table or birth stools

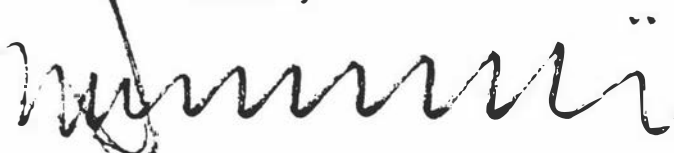
Please answer all the questions as honestly as you can as your comments and opinions will assist us to improve the Active Birth Chair for the benefit of other mothers who want to use the chair in the future.

The whole questionnaire will take about 20 minutes to complete. Please consult your midwife or obstetrician if you need help.

Your identity will not be revealed or published.

Thank you very much for your cooperation.

Yours sincerely



B. Leong Yap
Ergonomist/Designer

EVALUATION OF ACTIVE BIRTH CHAIR

PART A

Personal Information

1. Code Number _____ Name (optional) _____

2. My age is between Please tick (✓)
 - 15-19
 - 20-24
 - 25-29
 - 30-34
 - 35-39
 - 40-44
 - 45-49

3. This is my 1st baby
 (If this is your first baby you do not 2nd baby
 have to answer questions 5 and 6, 3rd baby
 and Part F on Page 8) 4th baby
 _____ baby
(please specify)

4. I have used the Active Birth 1st stage labour
 Chair for my 2nd stage labour
 3rd stage labour

5. The posture I adopted for second stage labour for the birth of my previous
 baby was: (second stage labour is the stage when the baby is born).
 Sitting
 Squatting
 Prop up on bed - in a reclined position
 Lying on my back with my legs in stirrups
 Other postures please specify

6. The device or furniture I used for second stage labour for the birth of my previous baby was:

- the bed
 delivery table
 a birth chair/stool
 other - please specify

PART B

Childbirth Feelings and Perceptions

The following questions are designed to find out the effects of the Active Birth Chair on your feelings or perceptions of your childbirth experience.

Please take your time and place a tick above the phrase or word that best describes your feeling. Please answer all questions as honestly as you can. Try not to give your answer as "indifferent" if you can help it.

1. How comfortable or uncomfortable did you find using the Active Birth Chair for the birth of your baby.

Extremely Comfortable	Very Comfortable	Comfortable	Indifferent	Uncomfortable	Very Uncomfortable	Extremely Uncomfortable

2. Did you find "pushing" on the Active Birth Chair difficult or easy.

Extremely Difficult	Very Difficult	Difficult	Indifferent	Easy	Very Easy	Extremely Easy

3. What level of participation did you have during labour using the Active Birth Chair.

Extremely Active	Very Active	Active	Indifferent	Inactive	Very Inactive	Extremely Inactive

4. Do you consider the effort required for the birth of your baby to be strenuous.

Extremely Strenuous	Very Strenuous	Strenuous	Indifferent	Slightly Strenuous	Barely Strenuous	Not Strenuous

5. How would you rate the birthing experience using the Active Birth Chair.

Extremely Satisfied	Very Satisfied	Satisfied	Indifferent	Unsatisfied	Very Unsatisfied	Extremely Unsatisfied

6. Did you feel that the use of the Active Birth Chair allowed you to control your labour and the birth of your baby the way you wanted it.

Total Control	A Lot of Control	Some Control	Indifferent	Little Control	Very Little Control	No Control

7. How safe or unsafe did you feel using the Active Birth Chair.

Extremely Safe	Very Safe	Safe	Indifferent	Unsafe	Very Unsafe	Extremely Unsafe

8. How would you rate the pain level of this labour when the baby was born.

Painless	Mildly Painful	Painful	Quite Painful	Very Painful	Severely Painful	Most Severely Painful

9. Did you enjoy giving birth using the Active Birth Chair.

Definitely Yes	Very Much	Much	Indifferent	Little	Very Little	Definitely No

10. Please write in the space below any points you think would help us to improve the design of the Active Birth Chair or help other women in their labour.

PART C

General Postural Comfort Rating

This question is designed to rate your general postural comfort or discomfort during labour using the Active Birth Chair.

Please put a tick (✓) in the box beside ONE of the following phrases or words that best describes your feeling. Please try not to confuse "labour pain" with the sensations or feelings resulting from the use of the Active Birth Chair.

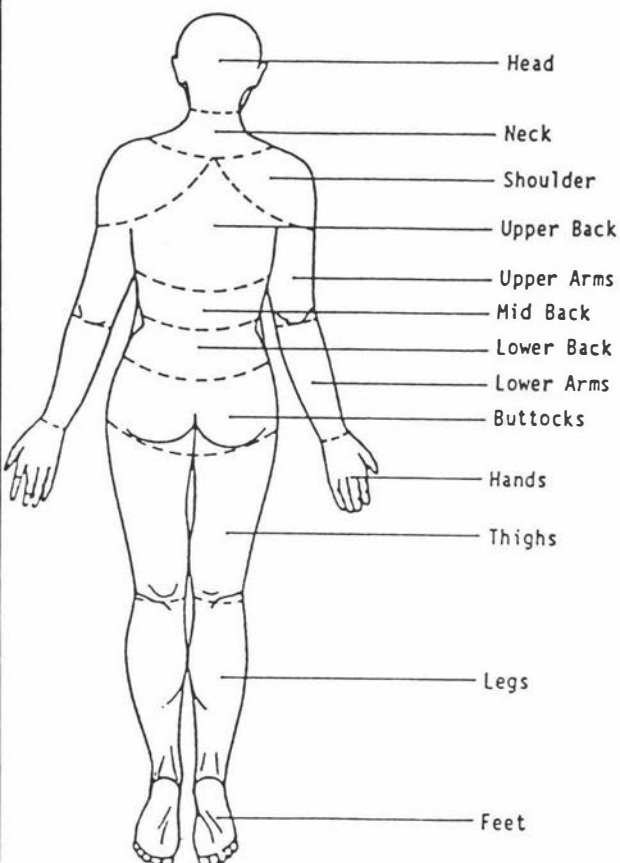
When using the Active Birth Chair, I felt:

(Tick (✓) one box only)

- Painful
- Sore and tender
- Numb
- Stiff
- Cramped
- Restless and fidgety
- Uncomfortable
- Barely comfortable
- Quite comfortable
- Perfectly comfortable
- Completely comfortable
- Other comments _____

PART D

Body Parts Comfort Assessment



The drawing on the left shows the body parts that are likely to be affected by the Active Birth Chair you have used to give birth to your baby.

The chart below is designed to find out how comfortable or uncomfortable you have felt in different parts of the body during your labour using the Active Birth Chair.

Please place a tick (✓) below the phrase or word that best describes your feeling for each body part shown on the drawing. Do not let labour pains influence your responses.

	Extremely Comfortable	Very Comfortable	Comfortable	Indifferent	Uncomfortable	Very Uncomfortable	Extremely Uncomfortable
Head							
Neck							
Shoulder							
Upper Back							
Upper Arms							
Mid Back							
Lower Back							
Lower Arms							
Buttocks							
Hands							
Thighs							
Legs							
Feet							

PART E**Chair Features Evaluation**

The following questions are designed for you to comment on the features of the Active Birth Chair you have used for the birth of your baby.

Please place a tick (✓) above the phrase or word that best describes your opinion about the chair feature.

1. Seat Height

Far Too High	Too High	High	Just Right	Low	Too Low	Far Too Low

2. Seat Length

Far Too Long	Too Long	Long	Just Right	Short	Too Short	Far Too Short

3. Seat Width

Far Too Wide	Too Wide	Wide	Just Right	Narrow	Too Narrow	Far Too Narrow

4. Seat Shape

Extremely Poor Fit	Very Poor Fit	Poor Fit	Just Right	Good Fit	Very Good Fit	Extremely Good Fit

5. Seat Slope (Angle)

Much Too Far Towards Back	Too Far Towards Back	Towards Back	Just Right	Towards Front	Too Far Towards Front	Much Too Far Towards Front

6. Hole in Seat

Extremely Good	Very Good	Good	Just Right	Poor	Very Poor	Extremely Poor

7. Size of Hole in Seat

Far Too Big	Too Big	Big	Just Right	Small	Too Small	Far Too Small

8. Shape of Backrest

Extremely Good Fit	Very Good Fit	Good Fit	Just Right	Poor Fit	Very Poor Fit	Extremely Poor Fit

9. Width Between Armrests

Far Too Wide	Too Wide	Wide	Just Right	Narrow	Too Narrow	Far Too Narrow

10. Upper Body Support

Extremely Good	Very Good	Good	Adequate	Poor	Very Poor	Extremely Poor

11. Foot Support

Extremely Good	Very Good	Good	Adequate	Poor	Very Poor	Extremely Poor

12. Appearance of Birth Chair

Extremely Attractive	Very Attractive	Attractive	Just Right	Unattractive	Very Unattractive	Extremely Unattractive

13. Please write in the space below any points you think would help us to improve the design of the Active Birth Chair and help other women in their labour.

PART F

To be answered by women with more than one birth experience.

The following questions are designed for women who have had more than one childbirth - to compare their labour experiences of using the Active Birth Chair for the birth of the present baby and other devices or furniture (beanbags, beds, delivery tables, other birth chairs, etc) for their previous baby.

Please put a tick (✓) in one of the boxes numbered 0-3 against the "Active Birth Chair" or the "Previous Device" - that you used for the birth of your previous baby. If you prefer the "Previous Device" you put a (✓) along the left hand scores. If you prefer the "Active Birth Chair" you put a (✓) on the right hand scores. If you prefer neither the "Previous Device" or the "Active Birth Chair" you place the (✓) above "0".

"3" is the highest score and depending on the question, it represents your like or dislike of either the "Previous Device" or the "Active Birth Chair" to a very high degree. A score of "1" means that you like or did not like the "Active Birth Chair" or the "Previous Device" only slightly. Again please do not (✓) "0" if you can help it.

Example: If you preferred the bed - the "Previous Device" you used for the birth of your last baby - only slightly better than the "Active Birth Chair", you (✓) above the "1" on the left hand scores.

		✓				
3	2	1	0	1	2	3
PREVIOUS DEVICE			ACTIVE BIRTH CHAIR			

1. Please indicate on the scale below whether you preferred the Previous Device or the Active Birth Chair.

3	2	1	0	1	2	3
PREVIOUS DEVICE			ACTIVE BIRTH CHAIR			

2. Which of the two devices do you consider to be more comfortable for childbirth.

3	2	1	0	1	2	3
PREVIOUS DEVICE			ACTIVE BIRTH CHAIR			

3. During "pushing", which of the two devices did you find easier.

3	2	1	0	1	2	3
PREVIOUS DEVICE			ACTIVE BIRTH CHAIR			

4. Which device allowed you to participate more actively during labour.

3	2	1	0	1	2	3
PREVIOUS DEVICE			ACTIVE BIRTH CHAIR			

5. I felt more satisfied about my labour using the:

3	2	1	0	1	2	3
PREVIOUS DEVICE			ACTIVE BIRTH CHAIR			

6. I found that I had more control of my labour using the:

3	2	1	0	1	2	3

PREVIOUS DEVICE

ACTIVE BIRTH CHAIR

7. I felt secure and safe using the:

3	2	1	0	1	2	3

PREVIOUS DEVICE

ACTIVE BIRTH CHAIR

8. I consider my labour to be less painful using the:

3	2	1	0	1	2	3

PREVIOUS DEVICE

ACTIVE BIRTH CHAIR

9. If you have the choice would you use the Active Birth Chair or the Previous Device for the birth of your next baby.

3	2	1	0	1	2	3

PREVIOUS DEVICE

ACTIVE BIRTH CHAIR

10. Please write in the space below any comment you would like to make.

FURTHER STUDY

As alluded in Chapter Eight, further research to examine associated clinical aspects of the maternal mother and the baby, and further extended postnatal evaluation of the System, are needed before conclusions can be drawn on the physiological advantage or otherwise of upright birth posture on the Obstetric Body-Support System.

The person assigned to undertake the study will ideally be a practicing midwife or obstetrician with a minimum of five years continuous midwifery or obstetric experience. S/he must have an inquiring mind, innovation and a strong desire for new knowledge to be acquired through research. It is important that s/he is currently working in a maternity unit and has "emic" support and participation from both management and colleagues. A friendly disposition, strong interpersonal and communication skills - both spoken and written - is also required. The candidate will have an undergraduate degree or equivalent in midwifery or obstetrics and have a passion to further their qualification by undertaking the research topic.

PROCEDURE

A well-structured "recruitment" plan aimed at educating and informing potential participants - both birth attendants and expectant mothers - will have to be put in place no less than two months before the first experiment commences. Childbearing women will be fully informed on the experiment, with demonstrations and trials on the Active Birth Chair. Volunteers will be recruited for the study from antenatal clinics and parents centres. With the help of their own midwife, obstetrician or birth educator, they will be advised to record their intention to use the Active Birth Chair in their Birth Plan and to sign the consent

form, shown on the next page, to participate in the experiment. As stated in the consent form, participation is voluntary. It must be made clear to them that they can discontinue to participate in the experiment, at any time or stage of their labour, or change their mind not to participate at all on labour day, even when they have signed the form.

METHOD

A reliable experimental design will have to be established and agreed upon by obstetricians and midwives at the participating hospital/s at a time nearer to the experiment.

However, the following tentative criteria which were adapted from Liu (1974); Hillan (1985); and Cottrell and Shannahan (1986) are proposed as a basic guide:

- A quasi-experimental design will be used to compare maternal outcome for 100 primiporous births. 50 primigravidae will be assigned to the experimental group - to give birth in the upright body-support system, and 50 to the control group to deliver in the traditional recumbent position.

Subjects will be paired if possible, in terms of their sequential arrival for delivery. After the 50 pairs of subjects have given birth, test of significance of the results will be computed. The experiment may be extended if statistical significance is not obtained.

ACKNOWLEDGEMENT OF INFORMATION - CONSENT FORM

1. I _____
 (name and address of person giving consent)
 of _____

Consent to use the "Active Birth Chair" for the birth of my baby.

2. I confirm that I have elected/chosen to use the Active Birth Chair voluntarily and I have discussed and obtained the consent of my obstetrician/midwife and partner for me to use the Active Birth Chair.
3. I also confirm that the function and working of the Active Birth Chair have been demonstrated to me to my satisfaction, and I understand that I could discontinue the use of the Active Birth Chair at any time during my labour or to withdraw completely from the Study.
4. After the birth of my baby I agree to answer a questionnaire regarding my birth experience and the functional aspects of the Active Birth Chair.
5. My identity will not be revealed or published.

Date: _____ Signature of person giving consent: _____

Date: _____ Signature of partner: _____

Date: _____ Witness: _____
 Midwife/Obstetrician

- Antepartal women must meet the following criteria:
 - › The study will be limited to primigravidae women between the ages of 20-25 who are married and living with husbands who have jobs and are able to provide financial support. Unwed women who bear a financial burden are considered to be more likely to approach labour with fear. As alluded before, fear could alter self-control and labour. However, Hillan (1985) included both multigravidae and primigravidae in her study.
 - › Any abnormality of bony pelvis or soft tissue structure of the pelvis in shape and size or any birth canal disorder will be excluded from the study because such anomalies may lead to dystocia (difficult birth).
 - › Women who have any indications of cephalo-pelvic disproportion or any biophysical pathology or psychiatric disorder will also be excluded because these conditions may alter the course of labour and the condition of the newborn infant.
 - › Drugs can inhibit or accelerate labour and to some extent may harm the foetus. Women who receive medication during labour will be excluded from the study. However, Liu (1974) maintains that this does not exclude women who have local anaesthesia (pudendal block) for an episiotomy during the conclusion of the second stage, which has no effect on uterine contraction or foetal condition. Hillan (1985) allowed her subjects to have analgesia, including epidural analgesia in her study. Her subjects were given 50mg Pethidine intra-muscularly if requested, and this could be repeated when necessary.

- › Only women with the foetus in a vertex presentation of the left or right occiput anterior can be included in the experiment.

MEASUREMENTS

Two major types of measurements will be collected in this experiment from both the experimental and control groups.

1. Clinical

- Umbilical artery and vein blood-gas analyses on pO₂, pH and pCO₂ to establish and compare oxygenation levels
- Time of first cry of babies - indicating establishment of active respiration.
- Apgar Scores to establish the condition of babies
- Post-partum haemorrhage
- Laceration frequency
- Episiotomy frequency
- Length of 2nd stage labour

2. Non Clinical

- All postnatal mothers are required to complete an Active Birth Evaluation questionnaire, similar to the one used in the beta test of this study. A different questionnaire of similar format and measurements will be designed for the control group participants.
- All midwives and obstetrician are required to complete an Obstetric Body-Support System Evaluation Questionnaire, similar to the one used in the beta test of this study. A different questionnaire of similar format and measurements will be designed for the birth attendants in the control group.

It is of utmost importance that both maternal mothers and birth attendants fully understand the function and use of the new obstetric system and are in no way apprehensive or afraid to use it. In order to ensure that all participants fully understand the function and use of the system a User Manual will be written.

Besides giving a summary of the advantages of upright childbirth, the function and use of the Active Birth Chair and the Delivery Seat-Kneeler, it is also important that the Manual contains guidelines to ensure that the management of labour is within the experimental guidelines.

CONFERENCES AND PUBLICATIONS

The main topics of this study have been presented at both national and international conferences. Papers have also been published in recognised journals. The reason for presenting research work and publication at various stages of the study is to solicit scrutiny, share and test new knowledge, approaches and methodologies in a learned multidisciplinary arena. It is also an excellent form of review from a diversity of national and international peer-groups.

"Ergonomics - Status, Method and Prospect of Application in Design" was presented at the Inaugural Conference of the New Zealand Ergonomics Society in 1987. Paper published in the conference proceedings by the New Zealand Ergonomics Society 1987. This paper initiated the development of the concept of Ergodesign that has been fully discussed throughout this thesis.

"Ergonomics in Childbirth: The Effect of Birth Postures on Maternal and Foetal Wellbeing" was presented at the Ergonomics for Health Conference, also organised by the New Zealand Ergonomics Society in 1990. Paper published in the conference proceedings by the New Zealand Ergonomics Society 1990.

"Ergonomics in Childbirth: The Investigation, Design and Evaluation of an Obstetric Body Support System for Physiologic Labour and Delivery" was presented at the 11th Congress of the International Ergonomics Association in Paris in 1991. Paper published in "Design for Everyone", Queinnec, Y. and Daniellou, F. (Ed), (1991), Taylor and Francis, London.