



UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

A TASK-SPECIFIC APPROACH TO JOB
ACCOMMODATION IN PHYSICALLY-DEMANDING
POSITIONS

by

GF BESTER

submitted in partial fulfillment of
the requirements for the degree

DOCTOR PHILOSOPHIAE

in the

FACULTY OF HUMANITIES
(Department of Biokinetics, Sport- and Leisure Science)

University of Pretoria

Promoter: Prof. PE Krüger

Pretoria

May 2008



DEDICATION

To Elana... I am truly blessed to have you in my life.



ACKNOWLEDGEMENTS

Praise the Heavenly Farther.

I also wish to acknowledge the following individuals:

Prof. PE Krüger : My promoter, for recognising the potential in the project, for sharing his knowledge and wisdom and for showing faith in me as a researcher and a student.

Japie Lubbe : For all the valuable advice and assistance as an expert in the field of physical work capacity.

Christine Smit : For assisting with the statistical analysis of the data.

SA ELEC employees : The supervisors, technicians and all other employees who assisted in the development of the task-specific job accommodation tool.

SA ELEC biokineticists : For assisting with the data collection process.

My parents : For all their encouragement and support during the course of this study.



SYNOPSIS

Title	: A task-specific approach to job accommodation in physically-demanding positions
Candidate	: George Francis Bester
Promoter	: Prof. P E Krüger
Department	: Biokinetics, Sport- and Leisure Science
Degree	: Doctor Philosophiae

Throughout the world, including South Africa, various approaches have been identified and implemented in an attempt to ensure that employees in physically-demanding positions are properly managed from a physical work capacity point of view, the primary goal always being to return the employee in need of assistance to full working capacity as soon as possible. The burning question has, however, always remained: “What happens to the employee in the meantime?”

This study focused on exactly that question, the aim being to develop a comprehensive tool to assist all parties concerned in managing the affected employee through the application of task-specific job accommodation.

The predetermined goal of the study was to develop a task-specific job accommodation tool for a physically-demanding position. This was achieved through a number of steps, which included an extensive literature review, a thorough job analysis, identification of a suitable test battery with related minimum physical requirements and cut scores, interviews, and the eventual development of the tool.

Once the task-specific job accommodation tool was completed, the next step was to make use of three case studies to assist in illustrating the way the tool is to be implemented, as well as to show the potential value of its implementation. The information from three actual incapacity cases in the company concerned was used for these case studies.



The results from this study are extremely positive and the three case studies have provided a glimpse of the potential value that could be added through the implementation of the job accommodation tool. The final product will greatly assist the company concerned in managing incapacitated employees in a manner that is beneficial to both the company and the individuals involved. Hopefully, this study will contribute to bring about a new era in the way South African companies and their occupational health departments approach the management of their incapacitated employees.

Keywords

critical physical demands

incapacity

inherent requirements of a job

job accommodation

job analysis

minimum physical requirements

physical ability testing

physical work capacity

physically-demanding job outputs

physically-demanding positions

physically-demanding tasks

task-specific



SAMEVATTING

Titel	: 'n Taak-spesifieke benadering tot werksaanpassing in poste wat fisiek van aard is
Kandidaat	: George Francis Bester
Promotor	: Prof. P E Krüger
Departement	: Biokinetika, Sport- en Vryetydswetenskappe
Graad	: Doctor Philosophiae

In Suid-Afrika, asook regoor die wêreld, word daar van 'n groot verskeidenheid benaderings gebruik gemaak in 'n poging om te verseker dat werknemers in poste wat fisiek van aard is doeltreffend bestuur word uit die oogpunt van fisieke werkskapasiteit. Die primêre doel met sulke benaderings hou gewoonlik verband met die vinnige herstel van fisiek-onbevoegde werknemers ten einde so gou as moontlik hul volle kapasiteit om werk te kan verrig terug te kry. So 'n benadering is goed en wel, maar die kwelvraag in so 'n geval bly steeds die volgende: “Wat gebeur in die tussentyd met die werknemer?”

Gedurende hierdie studie het die fokus juis op bogenoemde vraag geval. Die mikpunt was om 'n omvattende instrument te ontwikkel ten einde al die partye wat betrokke is by die bestuur van die geaffekteerde werknemer te help om doeltreffende, taak-spesifieke werksaanpassing toe te pas.

Die voorafbepaalde doel van die studie was om 'n taak-spesifieke instrument te ontwikkel vir 'n spesifieke, fisiek-veeleisende posisie. Hierdie doel is bereik deur 'n aantal stappe te volg wat onder andere die volgende ingesluit het: 'n omvattende literatuurstudie, 'n deeglike posontleding, die identifisering van 'n gepaste toetsbattery met gepaardgaande minimum fisieke vereistes en afsnytellings, gepaste onderhoude, asook die ontwikkeling van die instrument.

Na die voltooiing van die taak-spesifieke werksaanpassingsinstrument was die volgende stap om van drie gevallestudies gebruik te maak ten einde te illustreer hoe



die instrument geïmplementeer moet word, met die verdere doel om die potensiele waarde van implementering aan te dui. Drie ware gevalle in die maatskappy waarop daar tydens hierdie studie gefokus is, is gebruik vir die gevallestudies.

Die resultate wat uit die studie voortgespruit het is uiters positief, en die drie gevallestudies het 'n mate van insig verskaf betreffende die potensiele waarde wat toegevoeg kan word deur die implementering van die werkaanpassingsinstrument. Die finale produk sal ongetwyfeld 'n groot bydrae lewer om die betrokke maatskappy te help met die bestuur van geaffekteerde werknemers op 'n wyse wat voordele sal inhou vir die maatskappy en die betrokke individue. Daar word vertrou dat hierdie studie 'n nuwe era sal inlei in die benaderings wat gevolg sal word tydens die bestuur van fisiek onbevoegde werknemers. Dit geld vir alle soortgelyke Suid-Afrikaanse maatskappye, asook die gesondheidsdepartemente in hierdie maatskappye.

Sleutelsterme

fisiek veeleisende poste

fisiek veeleisende werkstake

fisiek veeleisende werksuitsette

fisieke-bekwaamheidstoetsing

fisieke onbevoegdheid

fisieke werkskapasiteit

inherente vereistes van die werk

kritieke fisieke vereistes

minimum fisieke vereistes

taak-spesifiek

werksaanpassing

werksanalise



CONTENTS

ACKNOWLEDGEMENTS	iii
SYNOPSIS	iv
SAMEVATTING	vi
TABLE OF CONTENTS	viii
LIST OF TABLES	xviii
LIST OF FIGURES	xix
LIST OF PHOTOS	xx
LIST OF ABBREVIATIONS	xxi

TABLE OF CONTENTS

CHAPTER 1: THE PROBLEM

1.1.	Introduction	1
1.2.	Motivation	2
1.3.	Research question	8
1.4.	Research hypothesis	8
1.5.	Goal of the study	8
1.6.	Objectives of the study	8
1.7.	Research approach	9
1.8.	Research design	10
1.9.	Research procedure and strategy	11
1.10.	Definitions of key concepts	11



CHAPTER 2: LITERATURE REVIEW

2.1.	Physical ability testing (PAT) for physically-demanding work	14
2.1.1.	What is PAT?	14
2.1.2.	Why implement PAT?	15
2.1.3.	Important considerations in developing PAT	18
2.1.3.1.	Job analysis	18
2.1.3.2.	Safety	19
2.1.3.3.	Validity	19
2.1.3.4.	Reliability	20
2.1.3.5.	Objectivity	20
2.1.3.6.	Performance credibility	21
2.1.3.7.	Standardisation	21
2.2.	Important physiological components involved in physical ability testing	22
2.2.1.	Muscular strength	22
2.2.1.1.	Isotonic contraction	23
2.2.1.1.1.	Muscle length–tension relationship	23
2.2.1.1.2.	Angle of pull of muscle	24
2.2.1.1.3.	The speed of shortening	24
2.2.1.2.	Isometric contraction	26
2.2.1.3.	Eccentric contraction	26
2.2.1.4.	Isokinetic contraction	27
2.2.2.	Muscular endurance	27
2.2.3.	Flexibility	28
2.2.4.	Cardiovascular fitness	29
2.2.5.	Muscle fatigue	34
2.2.5.1.	Fatigue at the neuromuscular junction	35
2.2.5.2.	Fatigue within the contractile mechanism	35
2.2.5.3.	The central nervous system and local muscular fatigue	37
2.3.	Job analysis	38



2.3.1.	Questionnaires	39
2.3.2.	Interviews	40
2.3.3.	Job descriptions	40
2.3.4.	Videotapes	40
2.3.5.	Job-site assessments	41
2.3.6.	Observation	41
2.4.	Identifying the test battery for physical ability testing	43
2.4.1.	Dynamic strength	44
2.4.2.	Trunk strength	45
2.4.3.	Static strength	45
2.4.4.	Explosive strength	45
2.4.5.	Extent flexibility	45
2.4.6.	Dynamic flexibility	46
2.4.7.	Gross body co-ordination	46
2.4.8.	Balance or equilibrium	46
2.4.9.	Stamina	46
2.4.10	Approaches to strength testing	48
2.4.10.1.	Dynamometry	51
2.4.10.2.	Cable tensiometry	51
2.4.10.3.	One-repetition maximum (1-RM)	51
2.4.10.4.	Electromechanical apparatus	52
2.5.	Calculating minimum physical requirements (MPR), or “cut-off scores”	55
2.6.	Women in physically-demanding positions	61
2.6.1.	The international trend	61
2.6.2.	Female workers and injuries	63
2.7.	Ageing workers in physically-demanding positions	66
2.7.1.	Physical work capacity and ageing	67
2.7.1.1.	Aerobic capacity	68
2.7.1.2.	Muscular capacity	69
2.7.2.	Physical workload, ageing and health effects	71
2.7.3.	Physical workloads and its training effect	72
2.8.	Occupational injuries in physically-demanding positions	73
2.9.	Job accommodation – what is job accommodation?	79



2.10.	Job accommodation – why implement job accommodation?	85
-------	--	----

CHAPTER 3: METHODS AND PROCEDURES: GATHERING INFORMATION

3.1.	Literature search	93
3.2.	The position identified for the purposes of this study	93
3.3.	Identifying the test battery	93
3.3.1.	Analysis of the job-description document	94
3.3.2.	Interviews	94
3.3.3.	Practical experience / observations and video recordings	94
3.3.4.	Video analysis	95
3.3.5.	The test battery	96
3.3.5.1.	Safety tests	96
3.3.5.2.	Physical ability tests	97
3.3.5.2.1.	Hamstring- and lower back flexibility	97
3.3.5.2.1.1.	Photo	97
3.3.5.2.1.2.	Equipment	97
3.3.5.2.1.3.	Test description	97
3.3.5.2.2.	Hand grip strength (right and left)	98
3.3.5.2.2.1.	Photo	98
3.3.5.2.2.2.	Equipment	99
3.3.5.2.2.3.	Test description	99
3.3.5.2.3.	3 minute step test	99
3.3.5.2.3.1.	Photo	99
3.3.5.2.3.2.	Equipment	100
3.3.5.2.3.3.	Test description	100
3.3.5.2.4.	Arm / shoulder muscle strength	100
3.3.5.2.4.1.	Photo	100
3.3.5.2.4.2.	Equipment	101
3.3.5.2.4.3.	Test description	101
3.3.5.2.5.	Back muscle strength	102



3.3.5.2.5.1.	Photo	102
3.3.5.2.5.2.	Equipment	103
3.3.5.2.5.3.	Test description	103
3.3.5.2.6.	Leg muscle strength	104
3.3.5.2.6.1.	Photo	104
3.3.5.2.6.2.	Equipment	105
3.3.5.2.6.3.	Test description	105
3.3.5.2.7.	Stomach muscle endurance	105
3.3.5.2.7.1.	Photo	105
3.3.5.2.7.2.	Equipment	106
3.3.5.2.7.3.	Test description	106
3.3.5.2.8.	Arm strength above the head	107
3.3.5.2.8.1.	Photo	107
3.3.5.2.8.2.	Equipment	108
3.3.5.2.8.3.	Test description	108
3.3.5.2.9.	Lifting strength from the floor (right and left)	109
3.3.5.2.9.1.	Photo	109
3.3.5.2.9.2.	Equipment	109
3.3.5.2.9.3.	Test description	110
3.3.5.2.10.	Arm adduction strength	111
3.3.5.2.10.1.	Photo	111
3.3.5.2.10.2.	Equipment	111
3.3.5.2.10.3.	Test description	112
3.3.5.2.11.	Shoulder endurance at eye-level (right and left)	113
3.3.5.2.11.1.	Photo	113
3.3.5.2.11.2.	Equipment	114
3.3.5.2.11.3.	Test description	114
3.3.5.2.12.	Balance test	115
3.3.5.2.12.1.	Photo	115
3.3.5.2.12.2.	Equipment	116
3.3.5.2.12.3.	Test description	116
3.3.5.3.	Pre-testing procedure	117
3.3.5.4.	Procedure during testing	118
3.3.5.5.	Post-testing procedure	118



3.4.	Calculating the minimum physical requirements (MPR)	119
3.4.1.	Statistical analysis	119
3.4.2.	The minimum physical requirements	120
3.5.	Job accommodation tool – breaking the job outputs down into critical tasks	122
3.5.1.	Job analysis	122
3.5.1.1.	Step 1: Analysis of the job-description document	122
3.5.1.1.1.	Maintenance	123
3.5.1.1.2.	Repair	125
3.5.1.1.3.	Building	126
3.5.1.1.4.	Health and safety	126
3.5.1.1.5.	Customer service	127
3.5.1.1.6.	House keeping (maintain an ergonomically sound and hygienic workplace)	127
3.5.1.2.	Step 2: Video analysis	127
3.5.1.3.	Step 3: Observations	128
3.5.1.4.	Step 4: Interviews (with the use of a questionnaire)	128

CHAPTER 4: METHODS AND PROCEDURES: DEVELOPING THE JOB ACCOMMODATION TOOL

4.1.	Determine which tests are applicable to which tasks	129
4.1.1.	Task observation	130
4.1.2.	Video analysis	130
4.1.3.	Task performance	131
4.1.4.	Professional opinion	131
4.1.5.	Practical experience	131
4.2.	Determine the weighting of each physically-demanding job output	132
4.2.1.	Calculation of actual weightings of work outputs for the technician position	134



4.3.	Finalising the task-specific job accommodation tool	136
------	---	-----

CHAPTER 5: RESULTS

5.1.	The final product	139
5.1.1.	The link between each critical physical demand and the job outputs	139
5.1.2.	The link between each critical physical demand and the tasks	141
5.2.	Implementation of the job accommodation tool	142

CHAPTER 6: IMPLEMENTATION OF THE FINALISED JOB ACCOMMODATION TOOL (THREE CASE STUDIES)

6.1.	Case study A	144
6.1.1.	Subject A	144
6.1.2.	Specific information on the disability	144
6.1.3.	Job accommodation for subject A	144
6.1.3.1.	Informed consent	145
6.1.3.2.	Physical ability test data	145
6.1.3.3.	Job accommodation mask	146
6.1.3.4.	Job accommodation report	146
6.1.4.	Outcome of case study A	146
6.1.5.	Return on investment for case study A	147
6.1.5.1.	Cost	147
6.1.5.2.	Financial benefits	148
6.1.5.2.1.	Cost saving due to sick leave reduction	148
6.1.5.2.2.	Productivity during job accommodation period	148
6.1.5.2.3.	Financial benefits to SA ELEC	149



6.1.5.3.	Financial return	149
6.2.	Case study B	149
6.2.1.	Subject B	149
6.2.2.	Job accommodation for subject B	150
6.2.2.1.	Informed consent	150
6.2.2.2.	Physical ability test data	150
6.2.2.3.	Job accommodation mask	150
6.2.2.4.	Job accommodation report	151
6.2.3.	Outcome of case study B	151
6.2.4.	Return on investment for case study B	152
6.2.4.1.	Cost	152
6.2.4.2.	Financial benefits	153
6.2.4.2.1.	Cost saving due to sick leave reduction	153
6.2.4.2.2.	Productivity during job accommodation period	154
6.2.4.2.3.	Financial benefits to SA ELEC	154
6.2.4.3.	Financial return	154
6.3.	Case study C	155
6.3.1.	Subject C	155
6.3.2.	Specific information on the disability	155
6.3.3.	Job accommodation for subject C	155
6.3.3.1.	Informed consent	155
6.3.3.2.	Physical ability test data	156
6.3.3.3.	Job accommodation mask	157
6.3.3.4.	Job accommodation report	157
6.3.4.	Outcome of case study C	157
6.3.5.	Return on investment for case study C	158
6.3.5.1.	Cost	158
6.3.5.2.	Financial benefits	158
6.3.5.2.1.	Cost saving due to sick leave reduction	158
6.3.5.2.2.	Productivity during job accommodation period	159
6.3.5.2.3.	Financial benefits to SA ELEC	159
6.3.5.3.	Financial return	160



CHAPTER 7: SUMMARY, CONCLUSION AND RECOMMENDATIONS

7.1.	Introduction	161
7.2.	Summary	161
7.2.1.	Summary of the literature review	161
7.2.1.1.	Physical ability testing (PAT) for physically-demanding work	162
7.2.1.2.	Important physiological components involved in physical ability testing	163
7.2.1.3.	Job analysis	163
7.2.1.4.	Identifying the test battery for physical ability testing	164
7.2.1.5.	Calculating minimum physical requirements (MPR) or “cut-off scores”	166
7.2.1.6.	Women in physically-demanding positions	167
7.2.1.7.	Ageing workers in physically-demanding positions	168
7.2.1.8.	Occupational injuries in physically demanding positions	169
7.2.1.9.	Job accommodation – what is job accommodation?	170
7.2.1.10.	Job accommodation – why implement job accommodation?	171
7.2.2.	Summary of the course of this study	172
7.3.	Conclusion	173
7.3.1.	The goal, the objectives and the hypothesis	173
7.3.2.	The task-specific job accommodation tool	174
7.4.	Recommendations	176
REFERENCES		179
ANNEXURE 1		202
ANNEXURE 2		206
ANNEXURE 3		207
ANNEXURE 4		208
ANNEXURE 5		216
ANNEXURE 6		223
ANNEXURE 7		227



ANNEXURE 8	228
ANNEXURE 9	229
ANNEXURE 10	236
ANNEXURE 11	240
ANNEXURE 12	241
ANNEXURE 13	242
ANNEXURE 14	249
ANNEXURE 15	253
ANNEXURE 16	254
ANNEXURE 17	255
ANNEXURE 18	262



LIST OF TABLES

Table	Page Number
2.1 Strength testing: Advantages, Disadvantages and Devices	49
2.2 Parts of the body most frequently injured during electric utility work (a comparison between males and females)	64
3.1 The minimum physical requirement (MPR) and the cut score for each test in the physical ability test battery for the “technician” position	121
4.1 Example of a grid with the tests and critical physical demands on the one axis and the work tasks on the other axis	129
4.2 The 3 scales used to determine the weighting of each job output	133
4.3 The actual scores, percentages and weightings for each work output in the technician position	137
5.1 The link between each critical physical demand and the job outputs	140
5.2 The link between each critical physical demand and the tasks	142
6.1 Test scores and ratings (M or D) for subject A	145
6.2 Test scores and ratings (M or D) for subject B	151
6.3 Test scores and ratings (M or D) for subject C	156



LIST OF FIGURES

Figure	Page Number
4.1 Graphic view of weight of each work output	136



LIST OF PHOTOS

Photo	Page Number
3.1 Lateral view of “hamstring- and lower back flexibility”	97
3.2 Anterior view of “grip strength test” (right hand)	98
3.3 Lateral view of “3 minute step test”	99
3.4 Anterior view of “arm / shoulder muscle strength test”	101
3.5 Anterior view of “back muscle strength test”	102
3.6 45° view of “leg muscle strength test”	104
3.7 Lateral view of “stomach muscle endurance test”	106
3.8 45° view of “arm strength above head”	107
3.9 Lateral view of “lifting strength from the floor” (right hand)	109
3.10 Lateral view of “arm adduction strength”	111
3.11 Adduction bars with grip strength dynamometer in place (ready for use)	112
3.12 Lateral view of “shoulder endurance at eye level” (left shoulder)	113
3.13 Anterior view of “balance test”	115



LIST OF ABBREVIATIONS

A	-	Output score
ADA	-	Americans with Disabilities Act
ADP	-	Adenosine diphosphate
ATP	-	Adenosine triphosphate
beats/min	-	beats per minute
C	-	Cut score
CA ⁺⁺	-	Calcium
cm	-	centimetre
CO ₂	-	Carbon dioxide
D	-	Does not meet minimum physical requirement
DND	-	Did not do
FCE	-	Functional capacity evaluation
FT fibre	-	Fast twitch muscle fibre
H ⁺	-	Hydrogen
kcal	-	kilocalories
kg	-	kilogram
kgf	-	kilogram force
l/min	-	liters per minute
M	-	Meets minimum physical requirement
ml/kg/min	-	millilitre per kilogram body mass per minute
mmHg	-	millimetre mercury
MPR	-	Minimum physical requirements
ms	-	millisecond
N	-	Number of subjects
PAT	-	Physical ability testing
PC	-	Phosphocreatine
pH	-	Level of acidity
Pi	-	Inorganic phosphate
R	-	Rand
reps/min	-	repetitions per minute



RPE	-	Rate of perceived exertion
SA ELEC	-	South African Electricity Supply Company
sec	-	seconds
ST fibre	-	Slow Twitch muscle fibre
USA	-	United States of America
VO ₂	-	Oxygen consumption
VO ₂ max	-	Maximal oxygen consumption / aerobic capacity
Σ	-	Sum
1-RM	-	One-repetition maximum
\$	-	United States dollar
%	-	Percentage
°	-	Degrees