



Shifting perspectives:

Why the single understanding of HFE is hurting its development

4 July 2018, St. Petersburg,
Russia

Andrew Todd, Chair, International
Development Committee



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Ngiyabonga Russia Kakhula

Baie Dankie

Enkhosi Kakhula

Ke a leboha

Ke itumetse

ndzi khense ngopfu

Ndi a livhuwa

Ke a leboga

Siyabonga kakulu



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What is ergonomics all about?

- Improving:
 - Work performance
 - Human health and well-being

What tremendous potential!





Historical approach

South African laboratory based research:



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Background – Finding a problem



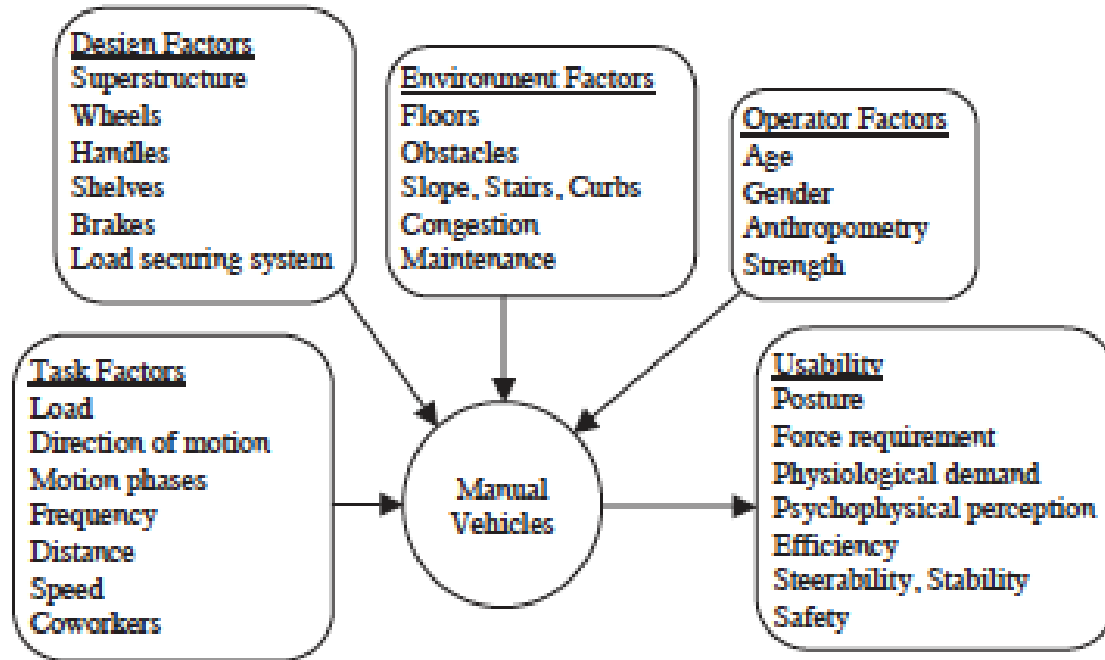
- Historical predominance of lifting, carrying and lowering
- Lifting associated with risk of injury (Dempsey and Hashemi, 1999; Marras, 2000)
- Resulted in introduction of manual handling devices (MHDs)
- Close to half MMH tasks now involve pushing and pulling (Jansen *et al.*, 2002)
- Obvious increase in pushing and pulling related research.





Background

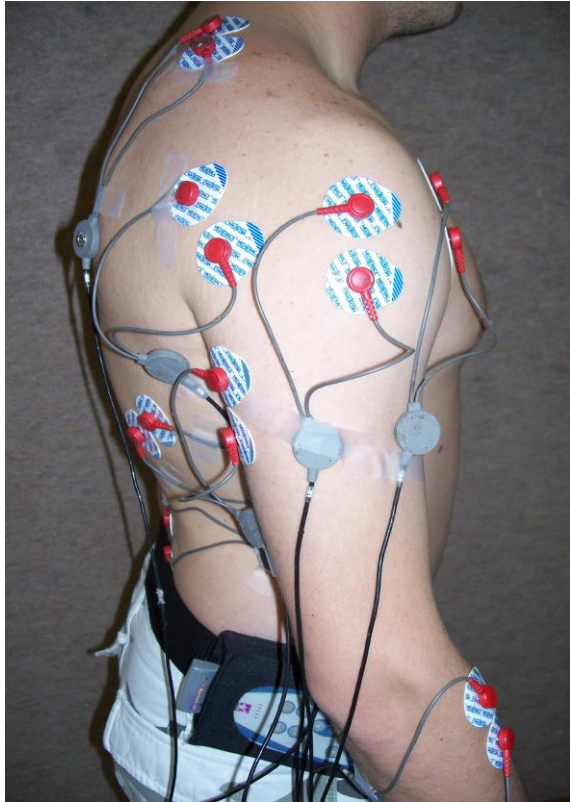
- Pushing and pulling factors for consideration (Jung et al., 2004):



Comprehensive laboratory studies



Comprehensive laboratory studies





Work 38 (2011) 291–299
DOI 10.3233/WOR-2011-1132
IOS Press

291

Pushing and pulling, technique and load effects: An electromyographical study

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Accepted 12 March 2010

Abstract. *Objective:* Increasing awareness of the high physical cost associated with lifting has led to the redesign of these incorporating manual handling devices and consequently pushing and pulling. Little research has focused on muscle a responses to pushing and pulling, the current study therefore investigated these responses to further the understanding of i injury, informing ergonomics intervention strategies.

Methods: A laboratory study was undertaken to determine the effect of three push/pull techniques and two loads (250 and 5 on muscle activation in nine muscles, distributed through the upper and lower body. Unloaded forward and backward w were used as control conditions for lower limb muscle activation.

Participants: Thirty-six healthy male volunteers participated in the study. Subjects were required to manoeuvre a loaded jack at a velocity of 0.45–0.55 statures.

Results: The muscles of the shoulders and upper extremity were affected to a greater degree by technique and load change those of the lower limbs. Further, high levels of erector spinae activation were recorded across all six experimental conditi

Conclusions: Each technique displayed a unique muscle activation profile, indicating that alternating between technique reduce early onset of fatigue. Further understanding of muscle activation during pushing and pulling is necessary.

Keywords: Manual handling devices, muscle activity, ergonomics

1588

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IOS Press

Impact of hand forces and start/stop frequency on physiological responses to three forms of pushing and pulling: A South African perspective

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Abstract. There has been limited attention given to the physiological demands of pushing and pulling, especially in industrially developing countries such as South Africa. Two key factors affecting the physiological demands of these tasks are the hand forces exerted and the start/stop frequency. The purpose of the current study was therefore to investigate the physiological responses to pushing and pulling at various loads and start/stop frequencies. 36 male subjects participated in the study and were required to complete a total of 18 conditions (three techniques: pushing, two- and one-handed pulling; three loads: 200, 350 and 500 kg; and two frequencies: 2 and 4 stops per minute). During each condition the heart rate, oxygen uptake and energy expenditure were measured. Pushing was found to elicit significantly lower responses for all three dependent variables than either form of pulling. The start/stop frequency was also found to have a significant impact on subject responses. The findings of this study indicate that the technique adopted to maneuver loads is critical in determining the physical demands placed on the human operator. Furthermore increasing the frequency of start/stops plays an important role, thus the forces exerted during these two phases are important from a physiological perspective.

Keywords: Pushing, pulling, physiology, frequency, South Africa



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Ergonomics SA, 2008, 20 (1)
ISSN Number : 1010-2728

The effects of load and gradient on hand force responses during dynamic pushing and pulling tasks

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ergonomics SA, 2005 (2)

Abstract

The limited attention afforded to push/pull activities and the motion phases (init sustained and ending) characteristic of these tasks has prompted a research focus in this area. The present study examined biomechanical responses in the form of hand force during dynamic submaximal trolley pushing and pulling. Participants pushed/pulled loads of 100, 200 and 300 kg on the level (determining impact of load) or pushed/pulled 100 kg along a 12° ramp (uphill and downhill- determining impact of gradient).

During level exertions significant differences ($p < 0.05$) in hand forces occur between loads of 100 and 200 kg, and 100 and 300 kg for initial and sustained but not ending forces. Values were similar for pushing and pulling at respective loads and motion phases. Strong correlations indicate that initial forces can be used to accurately estimate sustained and ending forces. Importantly, correct technique is essential in force reduction.

CURRENT TRENDS IN RESEARCH FOCUSED ON PUSHING AND PULLING

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ABSTRACT

The purpose of this review paper is to provide a synopsis of the findings of papers on pushing and pulling; and to identify areas of contention which require further in depth analysis. It is evident from reviewing the published papers on pushing and pulling that there is a lack of consensus as to which one of these two actions has the greatest force production. The main problem is probably the lack of standardized methodology in push-pull research. Furthermore, even when similar methodologies have been used the description of postures adopted during testing by the subjects varies greatly from paper to paper. The various studies have employed different postures and also imposed different restrictions on the postures adopted during experimentation, making comparisons between findings difficult. Much emphasis has been placed on the evaluation of static pushing and pulling tasks, and there is a clear need for further research into dynamic pushing and pulling. Additionally to date the focus of much of this research has been on the biomechanical stresses placed on the body with little attention being given to the physiological cost of pushing and pulling.



Conference presentations



Male and female pushing and pulling responses: slip, trip and fall implications

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© Christie, C.J. (2007) Proceedings of the 10th Conference of the Ergonomics Society of South Africa, Durban, SOUTH AFRICA, 21-22 June : ISBN 978-0-620-38797-2.

Abstract

Until recently the focus of research into manual materials handling (MMH) has primarily been on male workers. There is now substantial evidence illustrating both the financial cost and injury to the human asset. This has led to these tasks being replaced with the introduction of manual handling devices (MHD) and overhead hoists. Consequently new stresses and strains have been placed on the human operator performing pushing and pulling tasks. Furthermore the number of females being required to participate in MMH tasks increased over the last decade. In order to establish safe guidelines for pushing and pulling tasks, it is necessary to gain an understanding of male-female differences. Therefore the present study investigated the responses of male ($n=15$) and female ($n=12$) participants to laboratory-simulated maximal isometric pushing and pulling tasks.

Dynamometry was utilised to assess male and female strength potential under isometric conditions at wrist, elbow and acromiale heights. Testing was carried out under rigorously controlled laboratory conditions using a Chatillon™ Hand-Held Dynamometer (Model CSD-500). Each participant (male $mean\ age = 20.1$ years, $age=19.90$ years) was required to complete two sessions (after providing informed consent) in

Biomechanical, physiological and psychophysical responses to level and graded trolley pushing

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Abstract

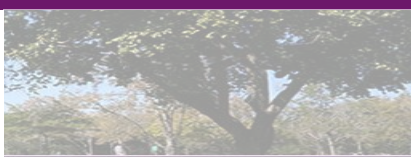
Owing to the lack of attention paid to dynamic graded pushing, the current investigation aimed at quantifying force output (during the initial, sustained and ending phases), lumbar compression, heart rate and psychophysical responses during pushing. Ten healthy male university students were required to push a trolley with a 100kg load up and down a 12° slope and along level ground to gauge which of horizontal, uphill and downhill exertions is more taxing on the worker.

Mean and peak forces were greatest during uphill and downhill sustained phases and the uphill initial phase. Considering mean and peak forces for initial and sustained phases, uphill pushing was higher ($p<.05$) (at least 31%) and level pushing was lower (at least 55%) respectively than the other conditions. Downhill pushing elicited higher forces (at least 52%) than the other conditions during the ending phase. Since forces elicited during the sustained phase of uphill and downhill efforts equaled or exceeded those of the initial phase, it may be appropriate to consider sustained forces when determining the inherent risk in graded pushing. L_5/S_1 compression was higher for uphill than level pushing but not for downhill pushing, implying that graded exertions may impose similar stresses on the lower back. Heart rates for uphill pushing were higher than the



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Conclusions



Is it a matter of perspective?



Perspective?

“a particular attitude toward or way of regarding something”

The problem?

The single story or single perspective.....



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Perspective #1

Don't reinvent the wheel perspective



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Perspective #1



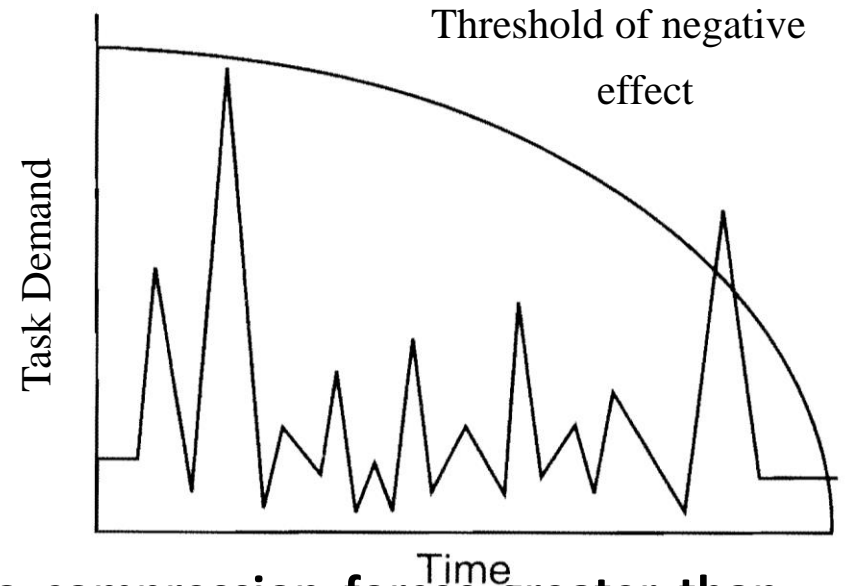
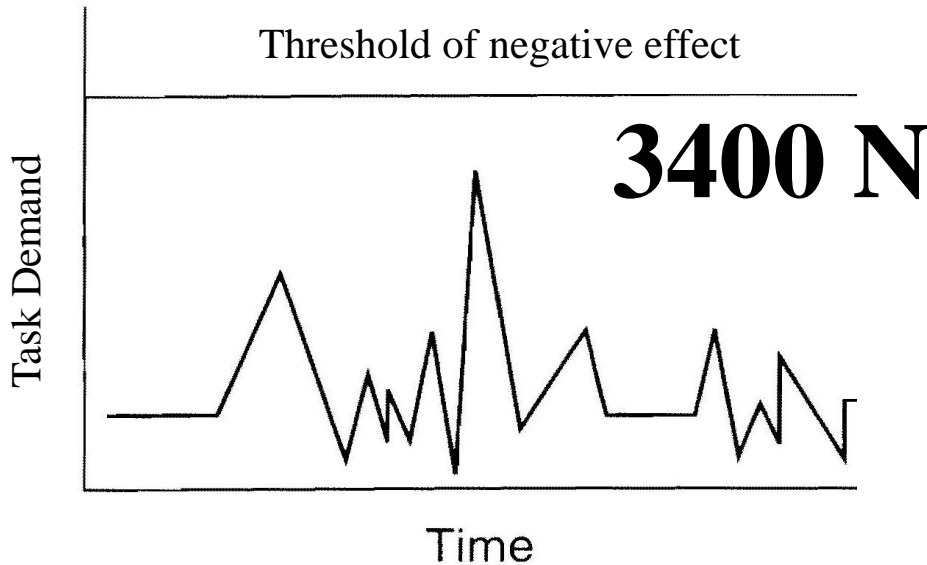
Task demands must be matched to human capabilities



Perspective #1



Therefore many guidelines exist:



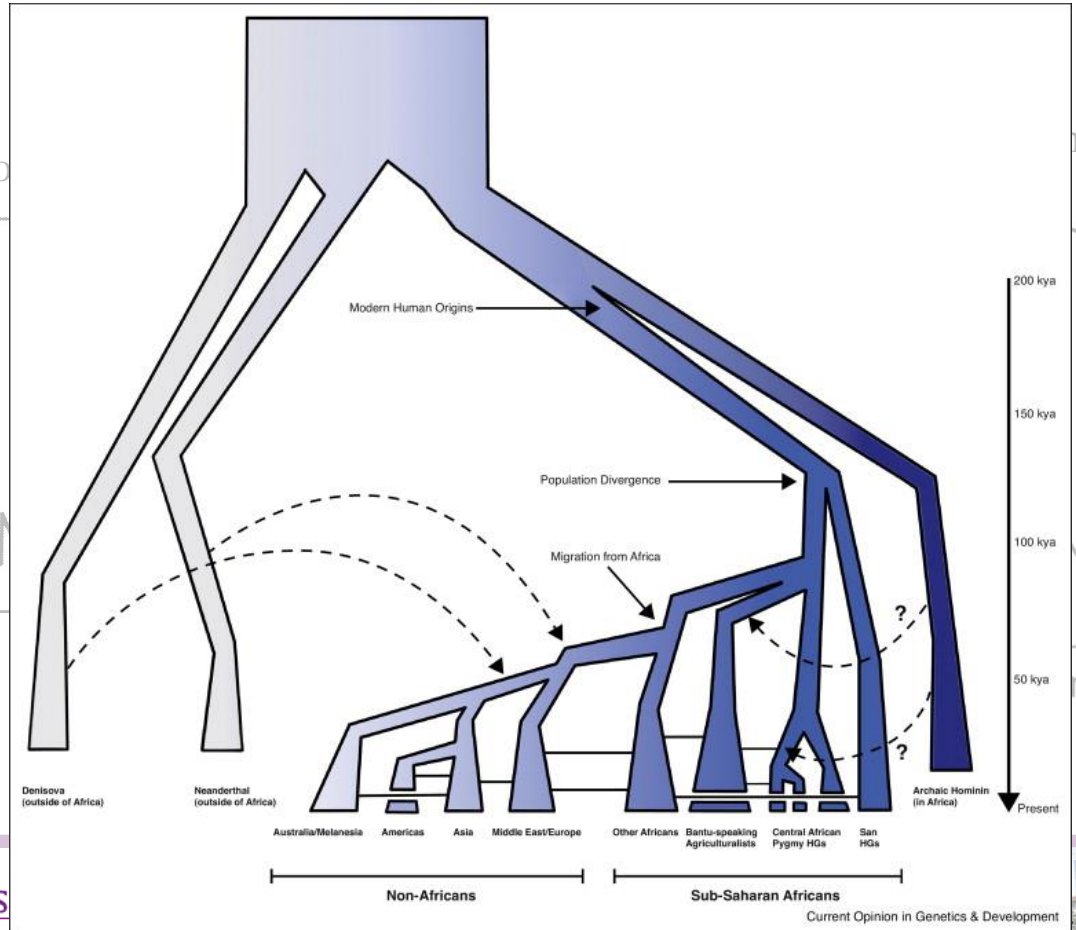
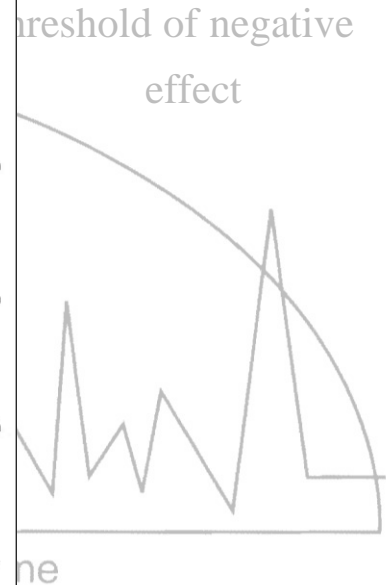
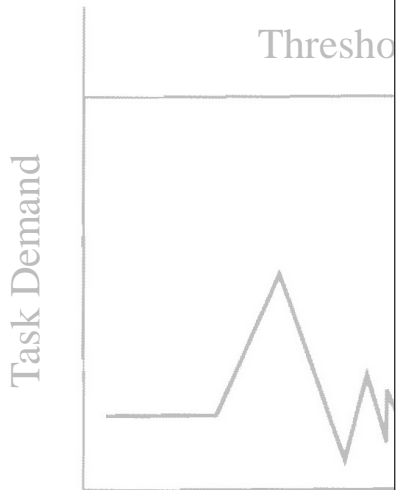
Conclusion: Don't expose your workers to compression forces greater than 3400 N



Perspective #1



The Problem: Therefore many guidelines exist:



Perspective #1

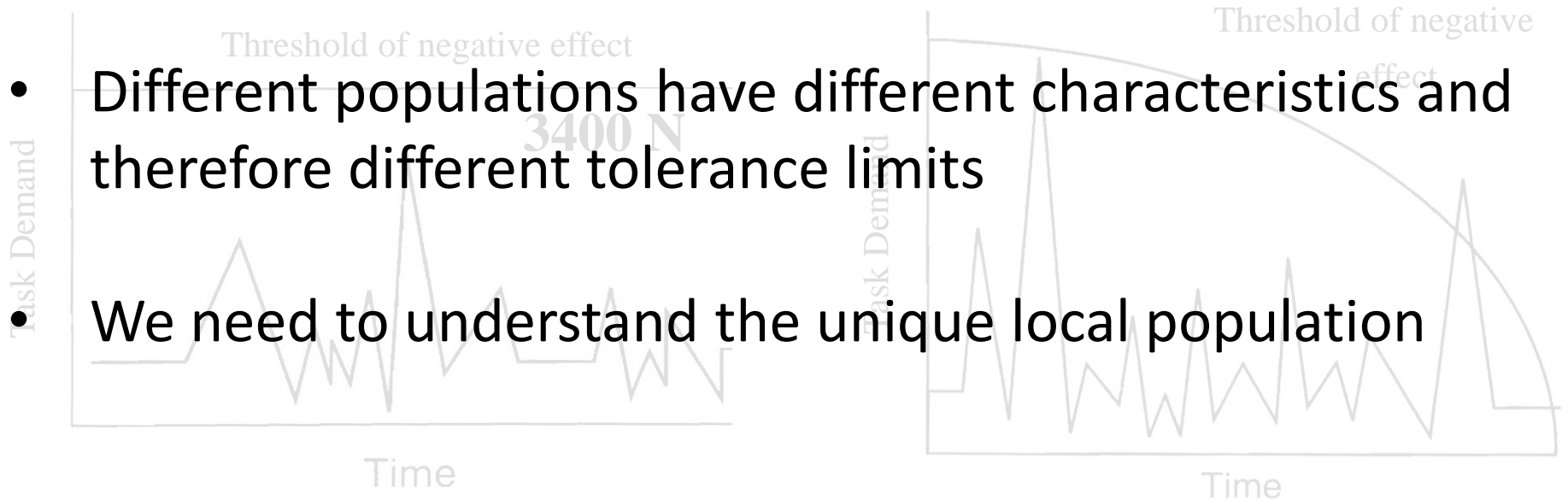


The Problem:

- One size does not fit all

- Different populations have different characteristics and therefore different tolerance limits

- We need to understand the unique local population





Perspective #2

Poor IDCs

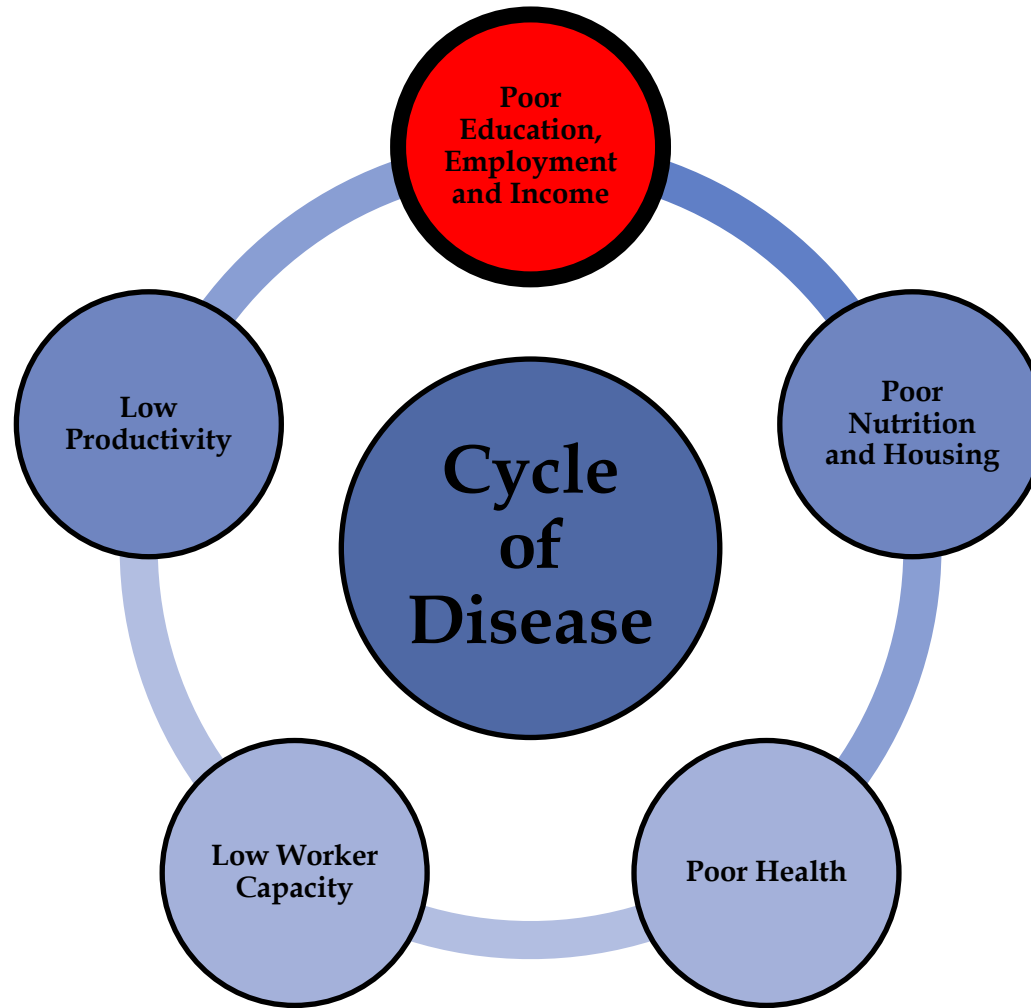




Typical perspective of IDCs?



The reality of South Africa



The reality of South Africa



The reality of South Africa

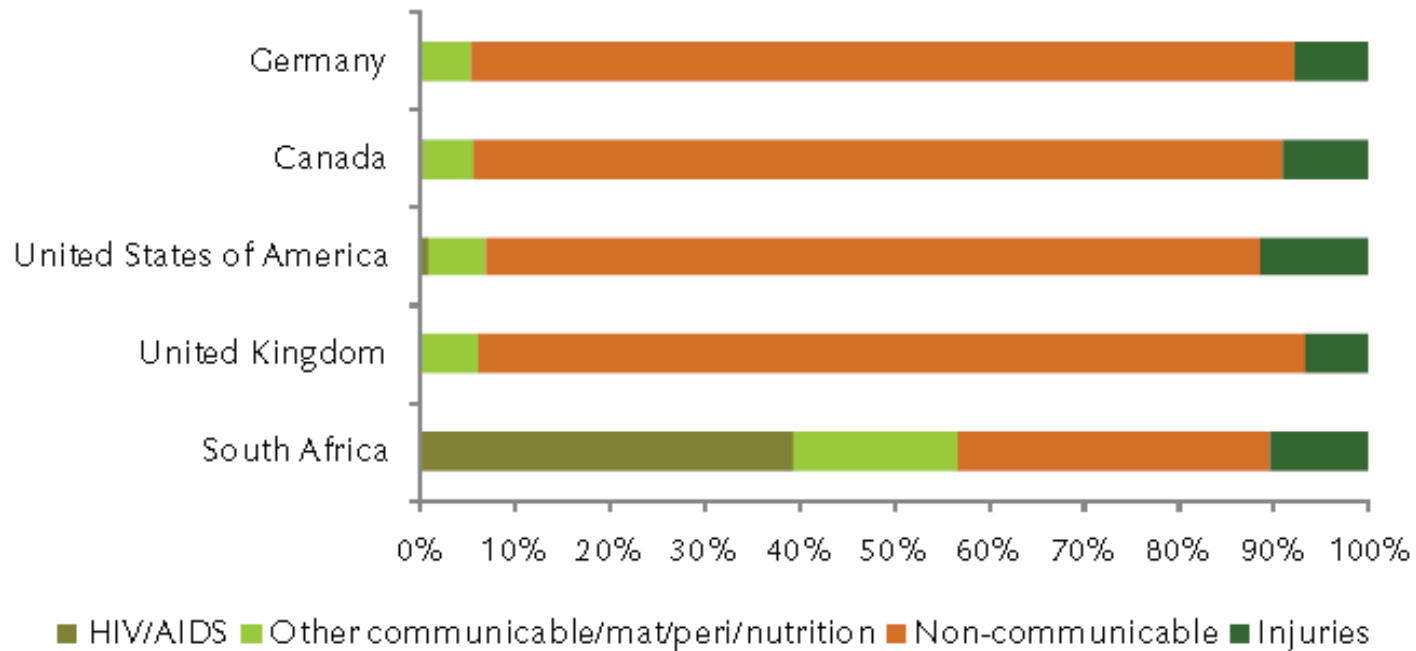




The reality of South Africa

Quadruple burden of disease:

- Disability adjusted life years for developed countries for 2004 (WHO, 2009)

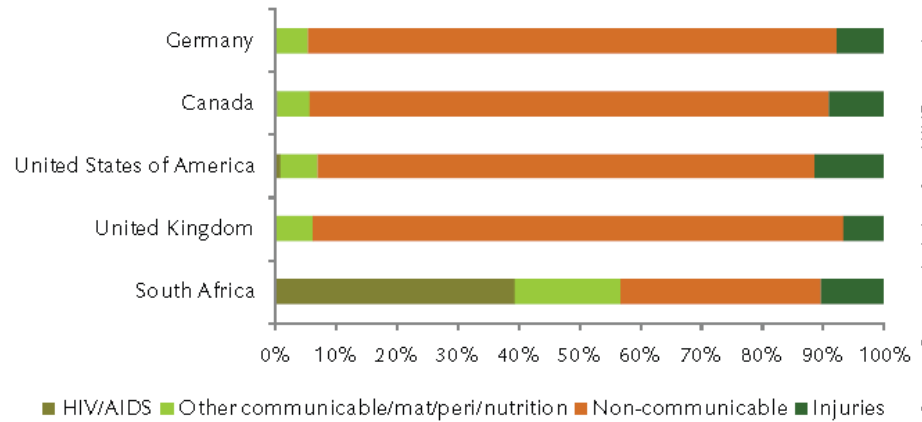
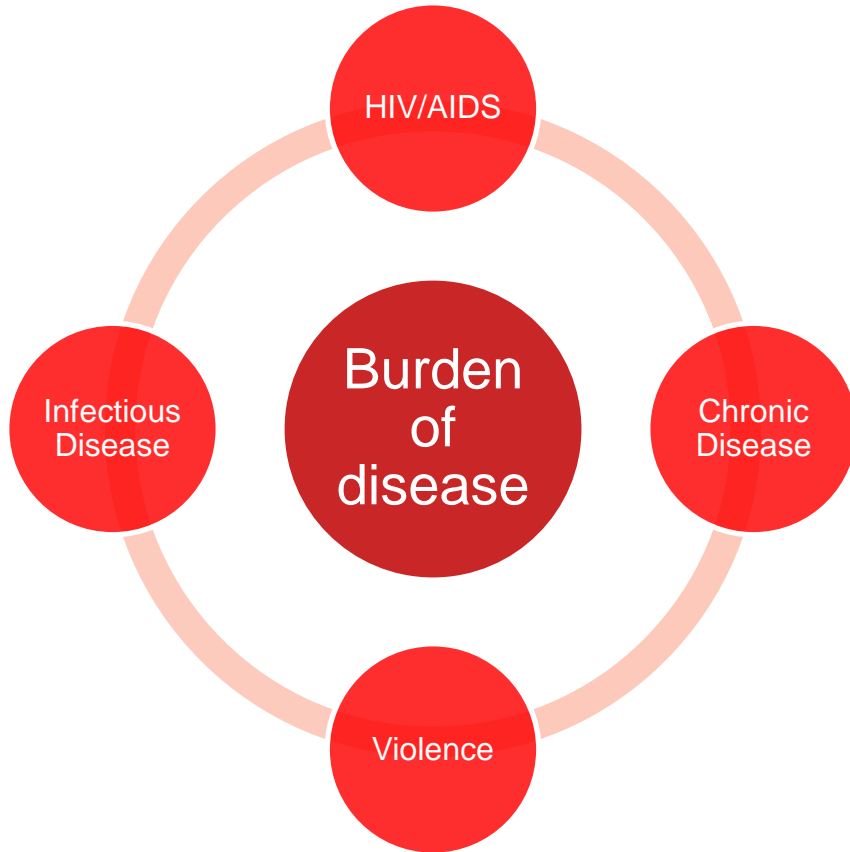




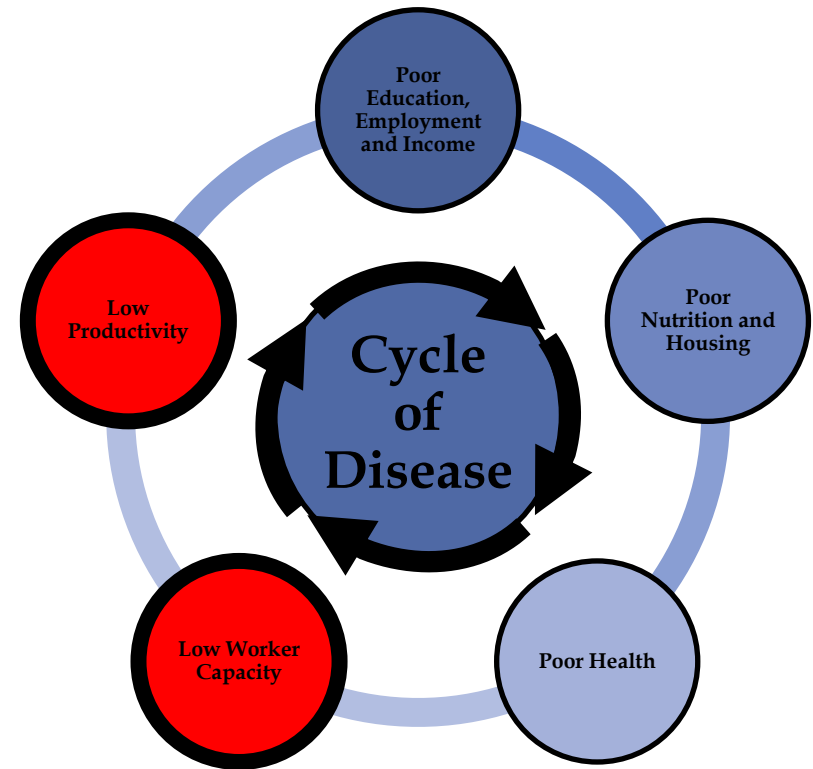
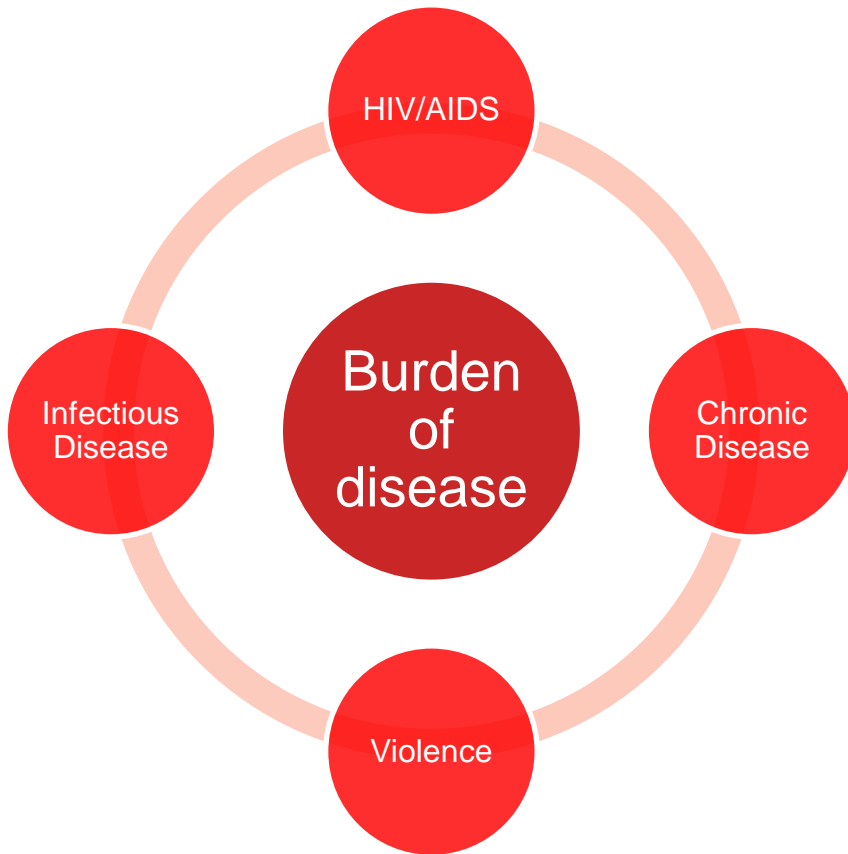
The reality of South Africa

Quadruple burden of disease:

- Disability adjusted life years for developed countries for 2004 (WHO, 2009)



Reality of IDCs?



Reality of IDCs?



HIV/AIDS

Poor
Education,
Employment
and Income

Conclusion:

Due to the cycle and burden of disease IDC workers have a lower work capacity and are therefore going to be less productive than their European counterparts!

Violence

Low Worker
Capacity

Poor Health



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The problem?

- These are all genuine IDC concerns that we need to be grappling with;
- Some workers may be compromised

However

- Does this really describe All people in All IDCs All of the time!





Is there another perspective?



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Perspective # 3

IDC Excellence perspective





Perspective # 3



Perspective #3



IDC Excellence:

- Is the physical capacity of IDCs really so poor?
- If so then how do we explain the following?



Perspective #3



IDC Excellence:

- African athletes dominate



Kimetto crosses the line in a world record time. Photo: DPA

Former farmer breaks marathon world record



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How does this relate to Ergonomics?



Interpret with caution:

- Key factor for physical performance?
 - Aerobic capacity
 - Lucia *et al.* (2006):

	$VO_{2\max}$ (ml.kg ⁻¹ .min ⁻¹)	VO_2 (ml.kg ⁻¹ .min ⁻¹) at 21 km.h ⁻¹
Spanish	77.8	74.8
East Africans	73.8	65.9

- What can we conclude from this?

Your perspective matters!



How does this relate to Ergonomics?



Conclusion:

IDC workers have greater endurance capabilities and are therefore capable of more within the worker environment and therefore should be more productive!



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Perspective #4?

The systems perspective



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How does this relate to Ergonomics?





How does this relate to Ergonomics?





How does this relate to Ergonomics?





How does this relate to Ergonomics?



The problem:

These two perspectives do not exist in isolation and we need to understand the interactions between them.





Into the wild research





A thought?

Wilson (2014):

“It is tempting to be hard-nosed and suggest that any study, investigation, analysis or development which **does not take a systems view is, in fact, not E/HF at all**. Rather such an initiative should be seen as a sub-set of E/HF, a biomechanical, cognitive psychology or physiology study, and **possibly of limited practical value.**”



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A systems view?

Wilson (2014) – Notions in HF&E systems:

- Systems focus
- Context
- Interactions
- Holism
- Emergence
- Embedding



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A systems view

An illustrative example of the HF&E notions





A systems view

An illustrative example of the HF&E notions





A contextual understanding

Context:

- Moray (1994) – Performance takes place in a context
- Increasingly characteristic of a complex socio-technical system
- A global reality check on “work as done” vs “work as imagined”





A contextual understanding

Context:

“My own view is that systems ergonomics should be carried out “in the wild”.... That is, laboratory research has its place but not a primary one.” (Wilson, 2014)



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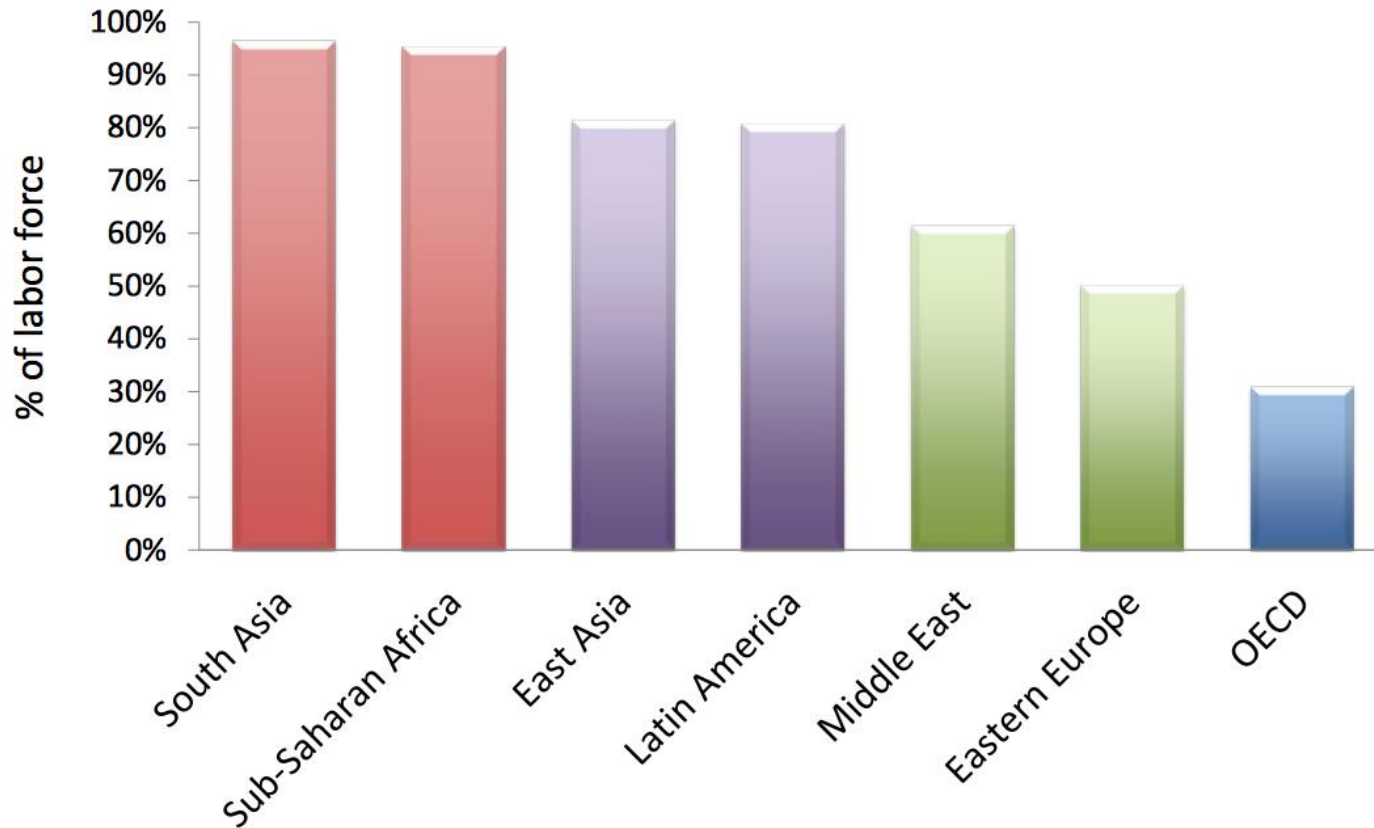




A contextual understanding

Context:

Informal employment:

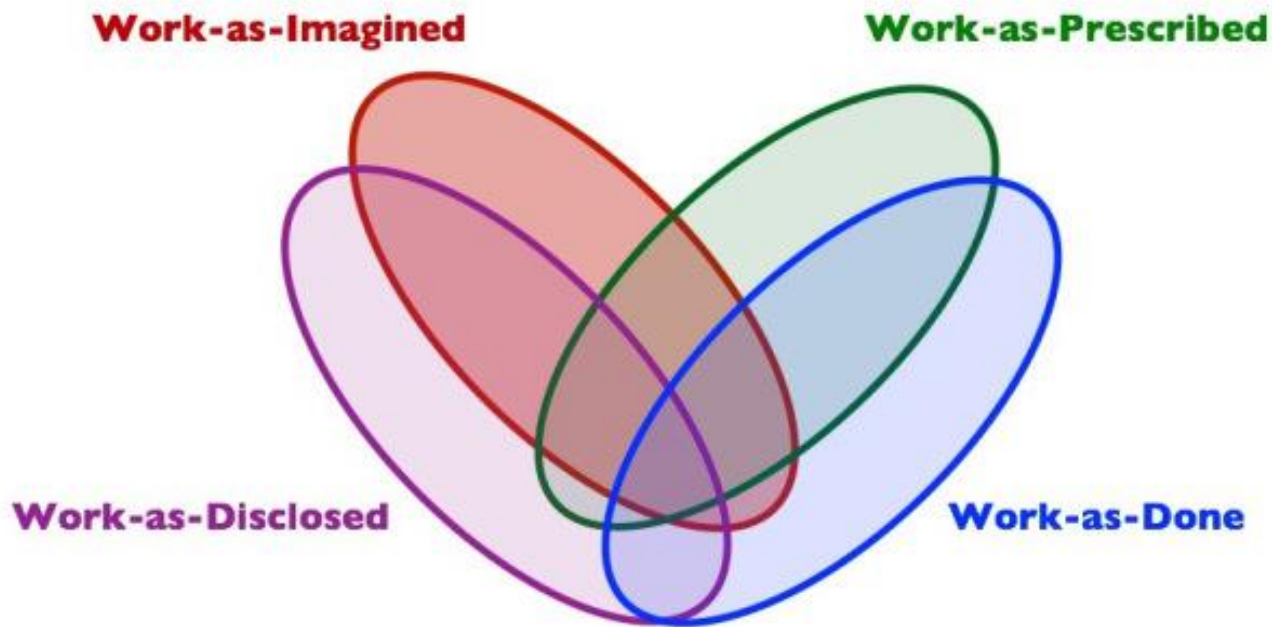




A contextual understanding

Context:

- Time to acknowledge how work is done?
- Time to acknowledge how pushing and pulling done?





A contextual understanding

Context:

- Do we need new (or forgotten) models?
 - Hollnagel\Shorrock – Work as done
 - Wisner (1985) – activity analysis and anthropotechnological approaches?





A contextual understanding

Context:

- Do we need new (or forgotten) models?



Understanding interactions



Interactions:

- Technology and informality?
- Technology:
 - Existing
 - Emerging -----> interact with people?
 - Fading



Understanding interactions



Interactions:



Holism is essential?



Holism:

- Inclusive city design for all?
- Design buildings not only for those that work in them but those that work around them?
- Street design?



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Systems are complex and dynamic

Emergence:

- Tools, spaces, etc will be used for things not designed for?





Systems are complex and dynamic

Emergence:

- Operators adapt poorly designed systems?





Systems are complex and dynamic

Emergence:

- Operators find new unintended uses?



From within?



Embedding:

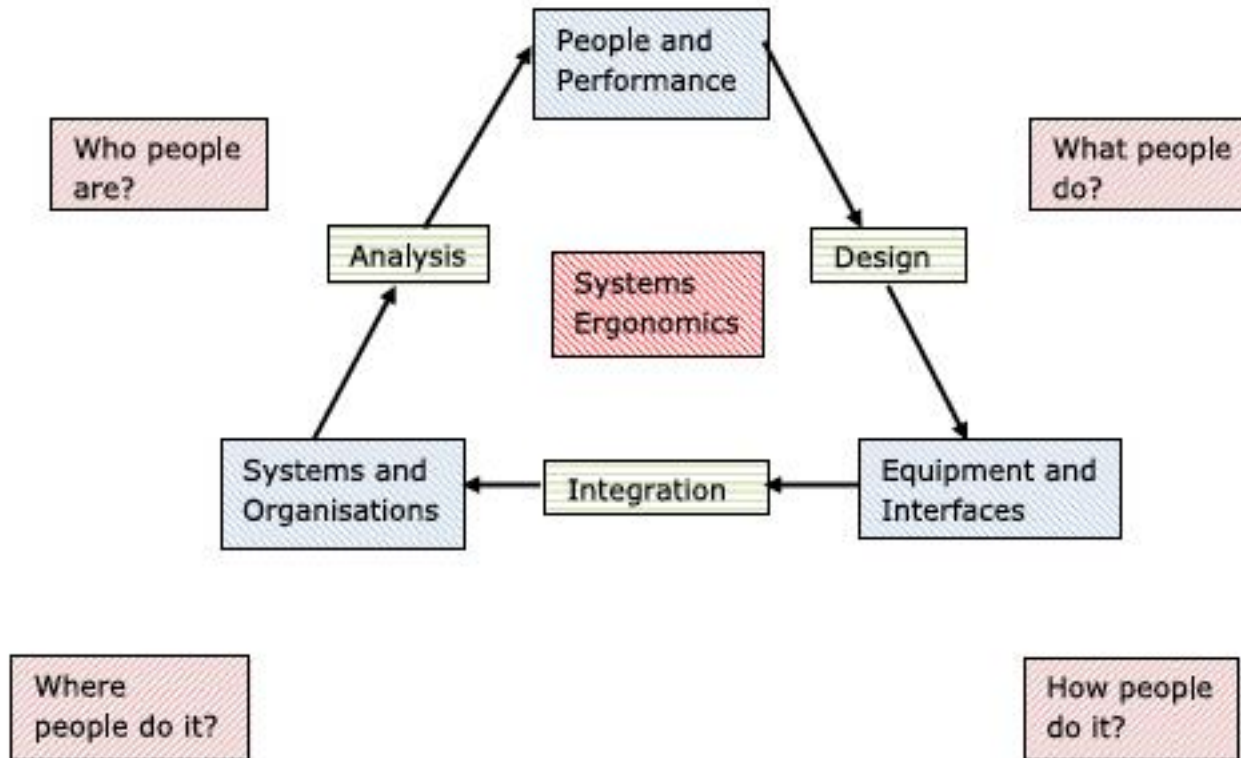
- Work with all key stakeholders and subject matter experts in a participatory manner?





How successful have we been?

Basics of systems ergonomics:



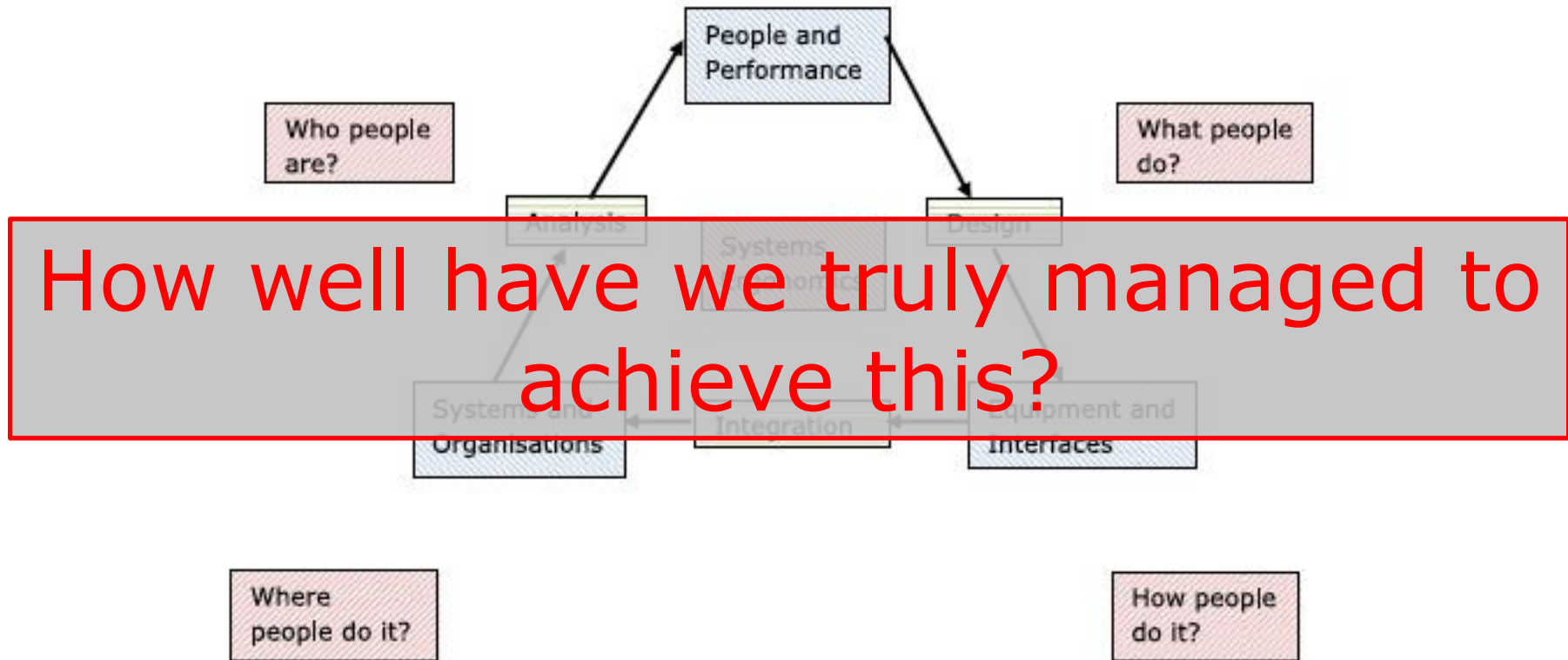
In many countries this is primarily done informally





How successful have we been?

Basics of systems ergonomics:



In many countries this is primarily done informally





Our new approach?

Our new approach: Technology and the future of work?

Embed in the system and understanding the needs in a collaborative team:

- Asiye etafuleni
- WIEGO
- Informal workers
- Local government
- Etc





SCENE SETTING



ORIGIN BY COUNTRY



CONTEXTUAL GENESIS



TYPES



TECHNOLOGIES

RF Technology and the Future of Work. Non-motorized transport



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Conclusion

Technology is a key driver of change:

- Ergonomists in unique position to understand the complex interaction between technology and people in a variety of contexts.
- Low cost high impact technology imperative
- The economic stratification in BRICS makes it the perfect context to show the world the way forward.



Unlocking potential?



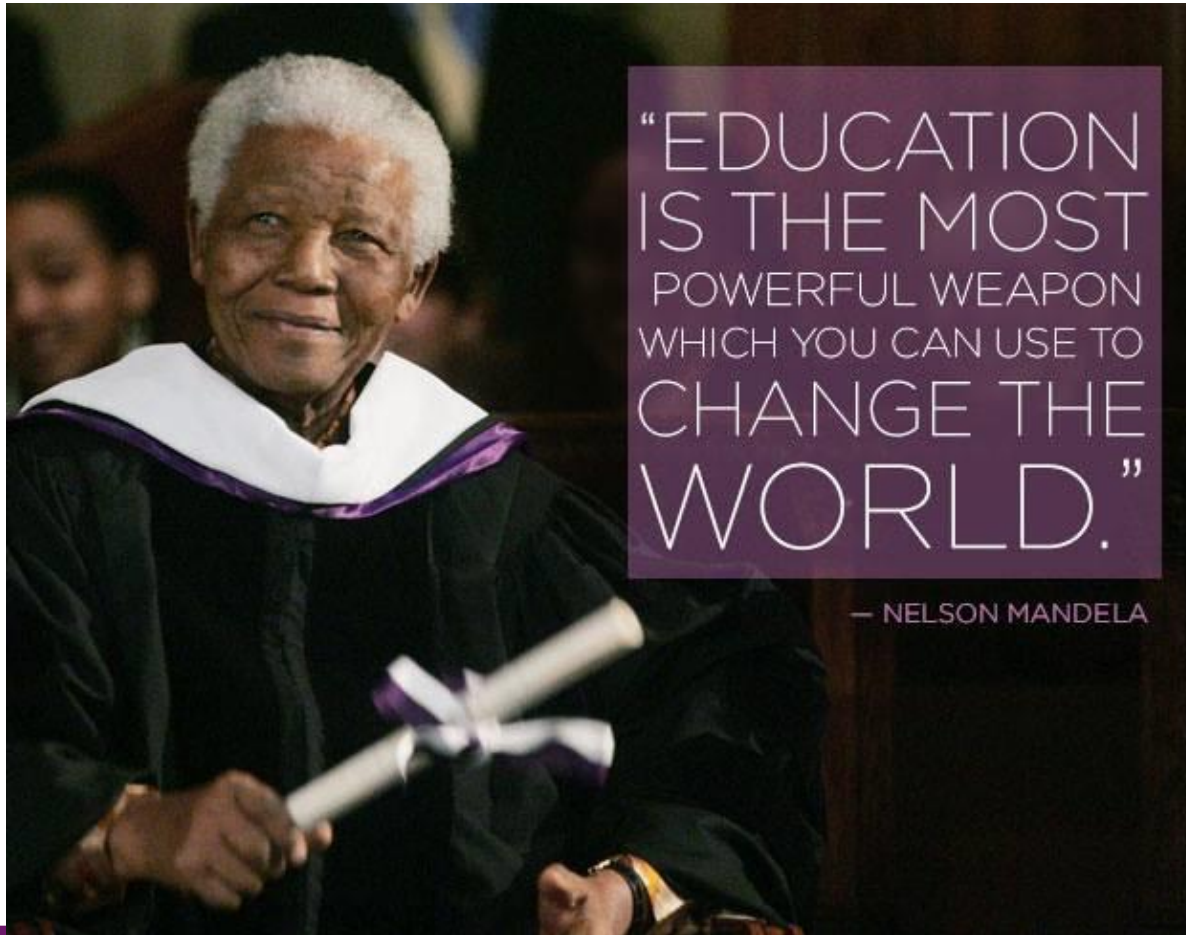
We need to understand diversity and acknowledge:

- No such thing as universal solutions
- Ergonomics intervention strategies need to be highly contextualized
- Adaptive and not prescriptive
- Sharing stories and connecting people





Unlocking potential?



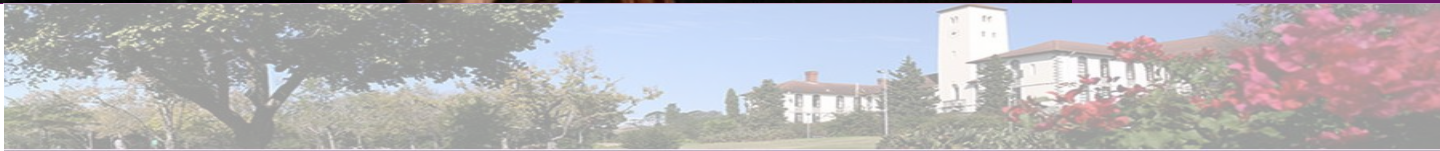
“EDUCATION
IS THE MOST
POWERFUL WEAPON
WHICH YOU CAN USE TO
CHANGE THE
WORLD.”

— NELSON MANDELA



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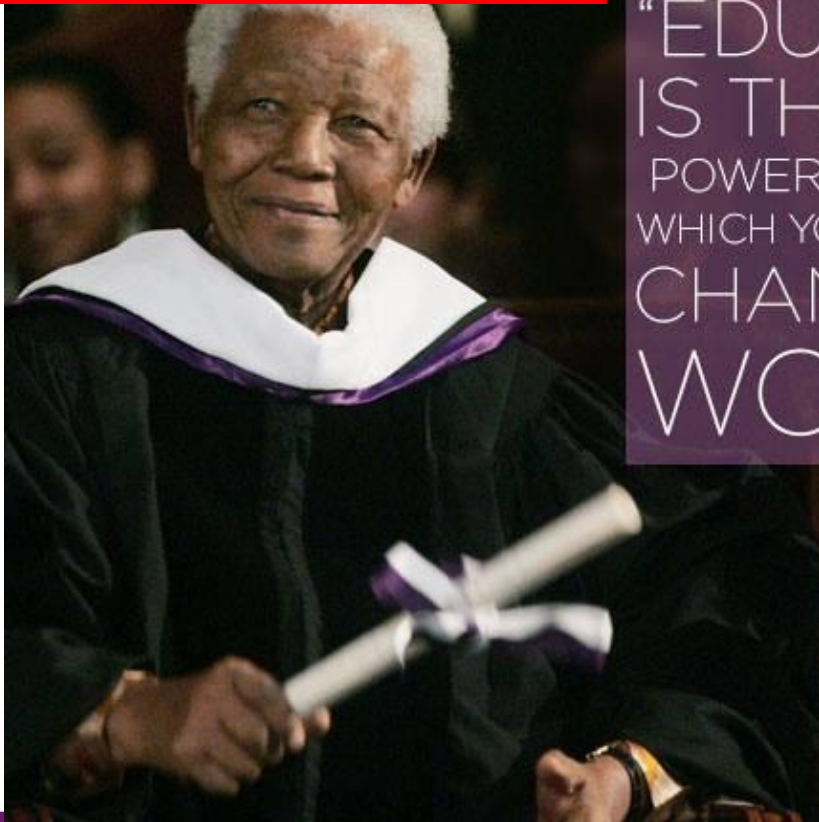
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Unlocking potential?



Ergonomics



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