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From Research to Practice in the Prevention of Musculoskeletal Disorders

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Acknowledgments

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Introduction

- Ergonomics has historically been a problem driven science and practice
- World War II prompted the emergence of a science to address human performance problems
- There is a natural link between research and practice
  - "From Research to Reality™" Liberty Mutual Research Institute for Safety
  - "From Research to Practice" NIOSH

Research vs. Practice

Researchers say…	Practitioners say…
I need more time.	I need the answer yesterday.
I need more money.	I need the answer yesterday.
You don't understand the implication of my findings?	"Give me something I can use." (Wayne Maynard, personal communication)
More research is needed.	Do your findings have any implications?
I published a journal article on that.	"Give me something I can use."

Research vs. Practice

- Fundamental differences exist between research and practice
  - Different objectives, constraints and stakeholders
  - Shared objective of enhancing human performance by enhancing health, safety and productivity
  - Not all research has an immediate application
  - Practitioners need to use best available tool or information
- Is Ergonomics at the core of some differences?
  - “Know thy user”

Psychophysical Tables

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Journal vs. 'Liberty Mutual Tables'

- Snook and Ciriello (1991) tables were designed to help loss prevention consultants analyze manual materials handling tasks
- Data were put in tables to facilitate determination of population percentile accommodated by a task
- Journal paper contains more traditional table with SI units
- Example of how research findings can be adapted to enhance performance (i.e. ergonomics!)

Snook, S.H., and Ciriello, V.M. (1991). The design of manual handling tasks: revised tables of maximum acceptable weights and forces. **Ergonomics**, 34(9), 1197-1213.

Width‡	Distance§	Percent¶	Floor level to knuckle height One lift every 5 s	9 s	14 s	1 min	2 min	5 min	30 min	8 h
		90	*5*	6	7	7	8	8	9	12
		75	*7*	8	9	9	10	10	11	14
	76	50	*8*	10	10	11	12	12	13	17
		25	*9*	*11*	12	13	14	14	15	21
		10	*11*	*13*	*14*	14	15	16	17	23
		90	*6*	7	8	8	9	9	10	14
		75	*7*	*9*	9	10	11	11	13	17
75	51	50	*9*	*10*	11	12	13	14	15	21
		25	*10*	*12*	*13*	15	16	16	18	24
		10	*11*	*14*	*15*	17	18	18	20	27
		90	*6*	8	8	9	9	9	11	14
		75	*8*	10	11	11	12	12	13	18
	25	50	*10*	*12*	13	13	14	14	16	21
		25	*11*	*14*	15	15	16	17	19	25
		10	*13*	*16*	*17*	17	19	19	21	29
		90	5	6	7	8	8	8	9	13
		75	*7*	8	9	10	10	10	12	16
	76	50	*8*	10	10	12	12	13	14	19
		25	*9*	11	12	14	15	15	17	22
		10	*11*	*13*	14	15	17	17	19	25
		90	*6*	7	8	9	10	10	11	15
		75	*7*	9	9	11	12	12	14	18
49	51	50	*9*	10	11	13	15	15	16	22
		25	*10*	*12*	13	16	17	17	19	26
		10	*11*	*14*	15	18	19	20	22	30
		90	6	8	8	9	10	10	11	15
		75	*8*	10	11	12	12	13	14	19
	25	50	*10*	12	13	14	15	15	17	23
		25	*11*	14	15	16	18	18	20	27
		10	*13*	*16*	17	19	20	21	23	31
		90	*7*	8	9	9	10	10	11	15
		75	*8*	10	11	12	13	13	14	19
	76	50	*10*	*12*	13	14	15	16	17	23
		25	*12*	*14*	15	17	18	18	20	27
		10	*13*	*16*	*18*	19	20	21	23	31
		90	*7*	9	9	11	12	12	13	18
		75	*9*	*11*	12	14	15	15	16	22
34	51	50	*11*	*13*	*14*	16	18	18	20	27
		25	*13*	*15*	*17*	19	21	21	24	32
		10	*14*	*18*	*19*	22	24	24	27	36
		90	*8*	10	11	11	12	12	14	19
		75	*10*	12	13	14	15	15	17	23
	25	50	*12*	*15*	16	17	18	19	21	28
		25	*14*	*17*	*19*	20	22	22	24	33
		10	*16*	*20*	*21*	23	25	25	28	38

‡ Box width (the dimension away from the body) (cm).
§ Vertical distance of lift (cm).
¶ Percentage of industrial population.
Italicized values exceed 8 h physiological criteria (see text).

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ANSI B11.TR1-2004 **Ergonomics Guidelines for the Design, Installation and Use of Machine Tools**

TABLE C.2-1 – FEMALE POPULATION PERCENTAGES FOR LIFTING TASKS ENDING BELOW KNUCKLE HEIGHT (< 28")

OBJECT WEIGHT (POUNDS)	LIFTING DISTANCE (INCHES)	HAND DISTANCE	7 INCHES					10 INCHES					15 INCHES				
		FREQUENCY ONE LIFT EVERY	15s	30 s	1m	5m	8h	15s	30 s	1m	5m	8h	15s	30 s	1m	5m	8h
65	28		-	-	-	-	13	-	-	-	-	-	-	-	-	-	-
	20		-	-	-	-	29	-	-	-	-	14	-	-	-	-	-
	10		-	-	-	-	34	-	-	-	-	20	-	-	-	-	-
62	28		-	-	-	-	17	-	-	-	-	-	-	-	-	-	-
	20		-	-	-	-	35	-	-	-	-	19	-	-	-	-	-
	10		-	-	-	-	40	-	-	-	-	26	-	-	-	-	-
59	28		-	-	-	-	22	-	-	-	-	-	-	-	-	-	-
	20		-	-	-	-	41	-	-	-	-	25	-	-	-	-	-
	10		-	-	-	-	46	-	-	-	-	32	-	-	-	-	-
56	28		-	-	-	-	29	-	-	-	-	14	-	-	-	-	-
	20		-	-	-	-	48	-	-	-	-	31	-	-	-	-	-
	10		-	-	-	-	53	-	-	-	-	38	-	-	-	-	13
53	28		-	-	-	-	35	-	-	-	-	20	-	-	-	-	-
	20		-	-	-	-	54	-	-	-	-	38	-	-	-	-	-
	10		-	-	-	12	59	-	-	-	-	45	-	-	-	-	18
50	28		-	-	-	-	43	-	-	-	-	26	-	-	-	-	-
	20		-	-	-	13	61	-	-	-	-	45	-	-	-	-	14
	10		-	-	-	17	65	-	-	-	-	53	-	-	-	-	25
47	28		-	-	-	-	51	-	-	-	-	34	-	-	-	-	-
	20		-	-	-	19	67	-	-	-	-	53	-	-	-	-	20
	10		-	-	14	24	71	-	-	-	11	60	-	-	-	-	32
44	28		-	-	-	11	58	-	-	-	-	42	-	-	-	-	12
	20		-	-	16	27	73	-	-	-	13	60	-	-	-	-	28
	10		14	16	20	32	76	-	-	-	17	67	-	-	-	-	41
41	28		-	-	-	18	66	-	-	-	-	51	-	-	-	-	18
	20		-	14	24	36	78	-	-	11	20	68	-	-	-	-	36
	10		21	23	29	41	81	-	-	14	24	73	-	-	-	-	50
38	28		-	12	16	26	73	-	-	-	13	60	-	-	-	-	27
	20		16	22	33	46	83	-	-	18	29	74	-	-	-	-	46
	10		30	33	38	50	85	14	16	22	34	78	-	-	-	-	58
35	28		17	19	25	37	79	-	-	11	21	68	-	-	-	-	37
	20		25	32	44	56	87	11	16	27	39	80	-	-	-	-	56
	10		40	43	49	60	88	22	25	32	44	83	-	-	-	13	67

Development and Evaluation of Ergonomics Audits for Mining Operations

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Project Objective

To develop and evaluate ergonomics audits for three types of mining operations

Small and Bulk Bagging Operations

Haul Truck Operation

Preparation/Minerals Processing Plant Maintenance and Repair

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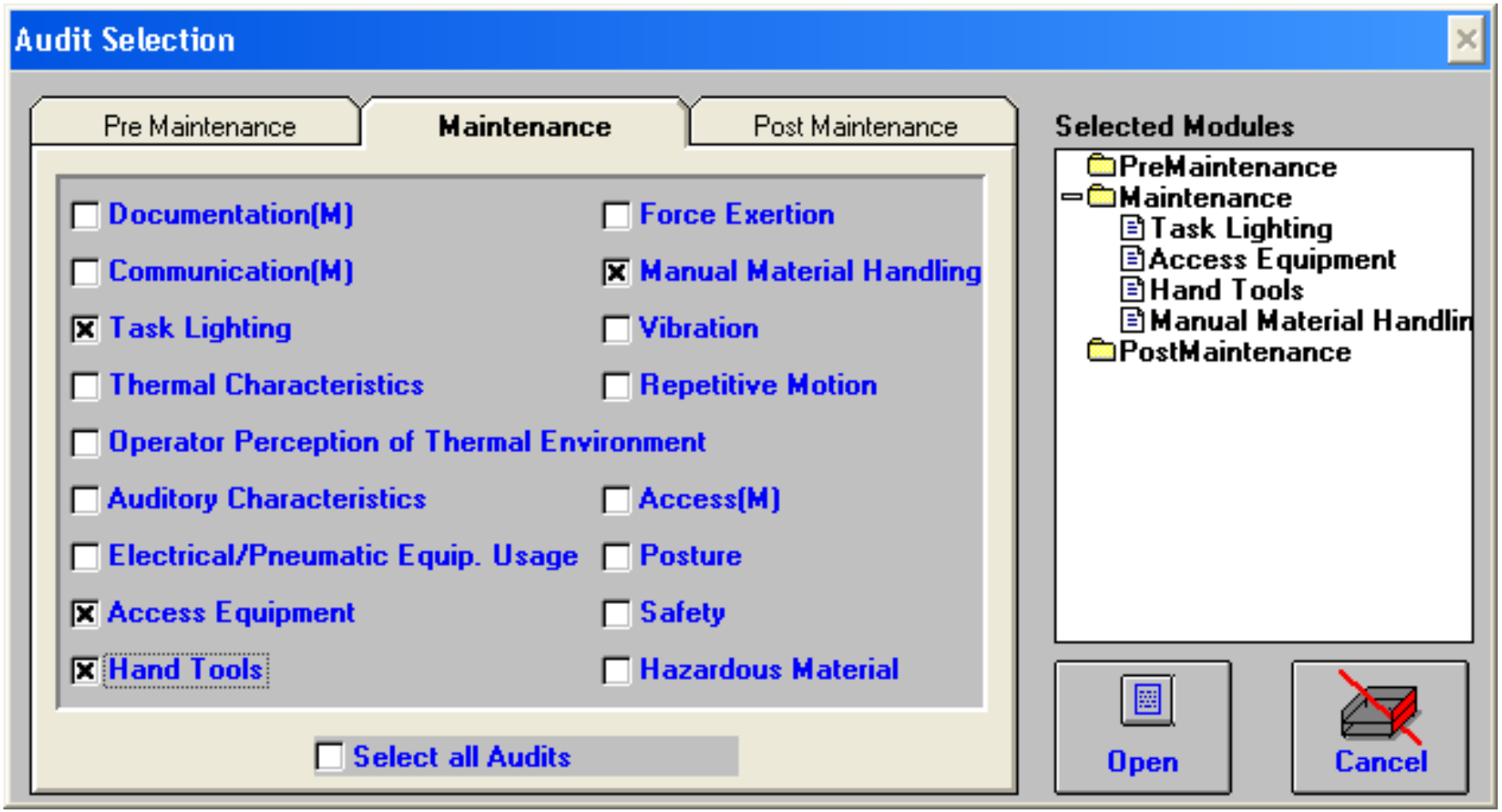
What is an Ergonomics Audit?

- An ergonomics audit provides a *comprehensive measurement* at a specific point in time of how well *jobs and workplaces* have been designed from an ergonomics standpoint (Koli et al., 1998)
- Concepts of checking, acceptable practices/ policies, and consistency (Drury and Dempsey, 2012)
- Only a few ergonomics audits have been developed and formally reported
  - Underground coal
  - Aircraft maintenance

Ergonomics Audit - ERNAP



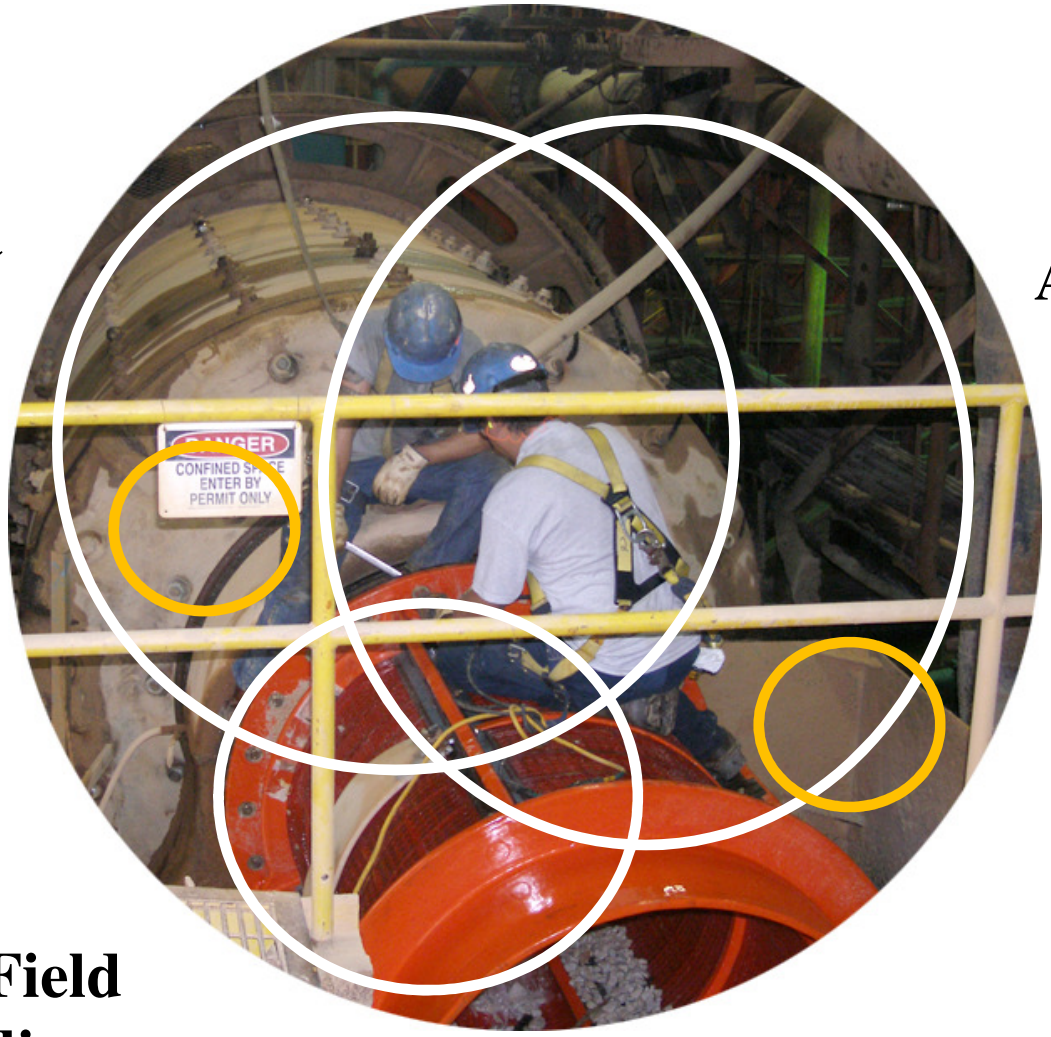
Desired Audit Characteristics

- Modular
- Reasonably self-explanatory
- Based on accepted principles
- Have analysts measure, not assess
- Encourage *reliable* and *valid* observations
- Impact: the audit should provide the user recommendations that have a reasonable chance of being implemented
- *Ergonomic!*

Content Validity

MSHA Data Analysis

Task Analysis



MSHA Fatality Reports

Mine Information

Lab/Field Studies

Audit Development

- Preliminary audit items were developed from the MSHA data, field observations and experimental studies
- Generally accepted ergonomics methods and MSHA standards were considered
- Items from previously developed and validated audits are included

Maintenance & Repair Structure

Organization	Facility	Pre-Maintenance	Maintenance	
				Task Specific
Management Practices	Machine Guarding	Tool Selection	Tool Use	Roller Changing
Administrative Practices	Spillage	Equipment Access	Posture	Greasing
	Environment	PPE		Screen Changing
	Slip, Trip, Fall	Lockout/tagout		Liner Changing
	Falls from Height	Area Preparation & Inspection		
	Housekeeping			
	Material Handling			

Bagging Structure

Facility Level	Small Bagging	Supersacks
PPE	Bag characteristics	Supersack characteristics
Housekeeping and tool storage	Filling	Bag handling
Environment	Quality control	Liners
Forklifts	Sealing	Closures
	Palletizing	Shrink wrapping
	Shrink wrapping	

Haul Truck Structure

Management/ Safety	Observation	Driver	Other Personnel
Training	Haul road/ Mine pit	Daily maintenance	
Policy		Fueling	
Information provided to drivers		Pre-shift	Maintenance
		Ingress/Egress	Dispatch
		Driving/Cab layout	
		GPS tracking and communication	
		Loading	
		Dumping	

Testing and Usability

- Content and structure of the audits will be discussed with end users for feedback
- Inter-rater reliability will be assessed with Certified Professional Ergonomists
- Validity check will test application of audit versus experienced professional ergonomists
  - Audit should capture at least as much as unaided ergonomists

Audit Conclusions

- Scientifically-derived audits are still not common in ergonomics
  - We should strive for valid and reliable tools
- The specific methods used to develop an audit can be adapted to the particular situation and intended users
  - Current approach had strong surveillance input
  - HTA is cornerstone
  - In spite of significant differences in the types of work performed, it was possible to derive audit structures to fit each domain

Conclusions

- Research to practice translation can be simple or complex
- The intended end use of an ergonomics product needs to be considered
- Researchers and practitioners have a lot to offer each other

Additional Information

Drury, C.G., and Dempsey, P.G. (2012). Human Factors and Ergonomics Audits. In G. Salvendy (ed.) *Handbook of Human Factors and Ergonomics*, 4th edition, pp. 1092-1121. New York: John Wiley & Sons

Dempsey, P.G., Porter, W.L., Pollard, J.P. and Drury, C.G. (2012). Using Multiple Complementary Methods to Develop Ergonomics Audits for Mining Operations. In *Proceedings of the Human Factors and Ergonomics Society 56th Annual Meeting* (pp. 1213-1217). Santa Monica, CA: Human Factors and Ergonomics Society

Disclaimer

The findings and conclusions in this presentation are those of the author and do not necessarily represent the views of the National Institute for Occupational Safety and Health

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