FREQUENCY, INTENSITY, SPEED AND DURATION OF TASKS PERFORMED BY AUSTRALIAN RURAL FIREFIGHTERS DURING BUSHFIRE SUPPRESSION

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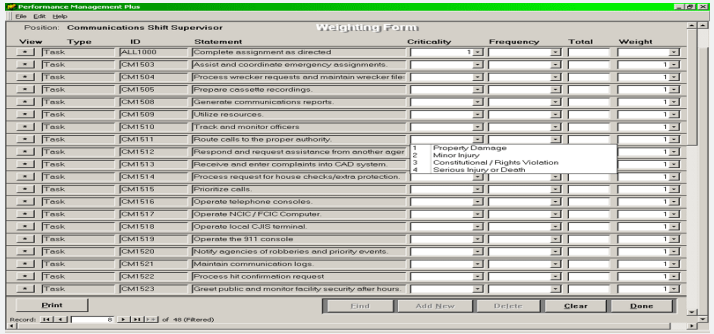
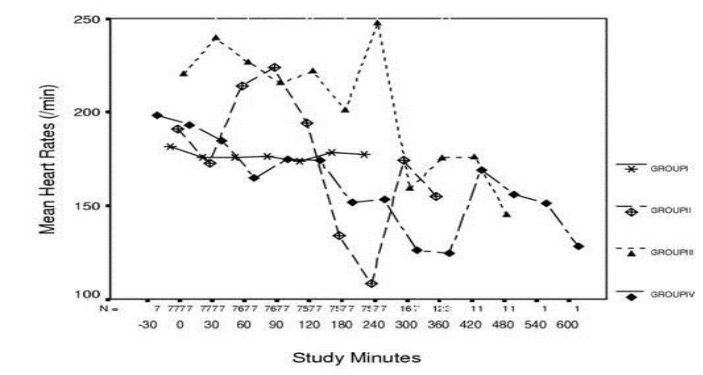
WORK DEMANDS IN FIREFIGHTING

Subjective Job Task Analyses



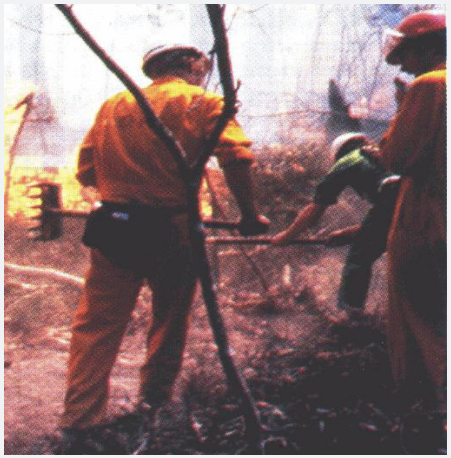
Physiology (or biomechanics) of isolated task simulations

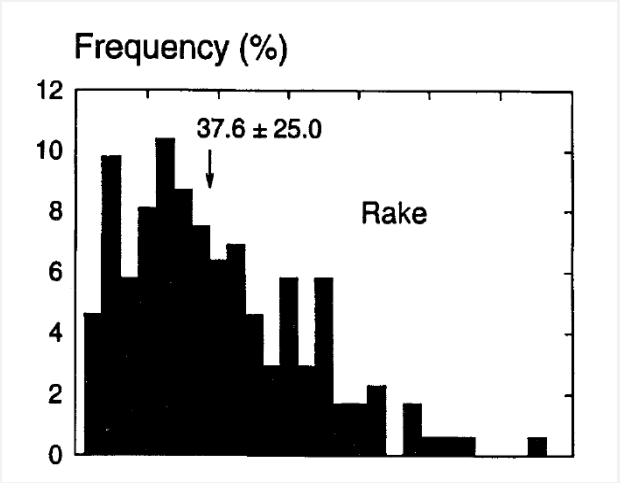
Remote Monitoring of Emergency Work



DETAILED TIME & MOTION ANALYSIS

Australian land management firefighters





Dutch Urban Firefighters

%HRR activities (within the 'working on the spot' working period)	M (SD), *Range*	*n*
Walking on stairs	43.9 (17.2), *14.1—86.1*	20
Climbing	43.7 (20.3), *42.0—91.7*	5
Lifting/carrying	38.4 (12.6), *3.1—58.7*	35
Other activities	38.0 (15.3), *5.6—61.8*	22
Running	37.9 (16.6), *4.6—66.0*	14
Stooping	36.8 (14.7), *6.6—72.1*	31
Pulling/dragging	35.6 (16.2), *12.3—77.4*	22
Pushing	30.9 (11.5), *25.0—61.5*	7
Kneeling/squatting	24.6 (16.0), *3.8—55.2*	5

AIMS

"Use video footage of individual firefighters wearing heart rate and GPS devices to quantify the frequency, intensity, speed and duration of bushfire suppression tasks"

METHODS

28 firefighters (TFS)

- NE & Southern Tasmania
- 4 × 6-h 'time windows'
- One researcher per firefighter
- Synchronize footage to GPS, HR to each fireground task repetition (Phillips et al., 2011b)

Table 1
Job Inventory for physical tasks performed during tanker-based suppression of multi-day bushfires.

Task no.	Task description
01	Preparation of individual equipment
02	Individually climb and dismount tanker
03	Advance 38-mm uncharged hose onto fire break
04	Advance 38-mm uncharged hose into terrain
05	Lateral repositioning of charged 38-mm hose
06	Full repositioning of charged 38-mm hose
07	Operating 25-mm rubber delivery hose
08	Hose work during blacking out activity
09	Advance charged 38-mm hose
10	Pump operation at tanker
11	Manual hose retraction
12	Solo handtool work
13	Rapid handtool work during spot fire containment
14	Handtool work during team line building
15	Chainsaw use in rakehoe crew
16	Chainsaw use for vehicle access
17	Using a fi axe for vehicle access
18	Handtool work during blacking out
19	Patrolling on foot whilst carrying handtool
20	Mobile patrolling as a member of a tanker crew
21	Mobile patrolling in a support vehicle
22	Knapsack hiking
23	Knapsack spraying
24	Quick fill pump carry
25	Generator carry
26	Trailer mounted quick fill pump set up
27	Draughting set up
28	Quick fill pump set up
29	Structure preparation for imminent ember attack
30	Water refuelling of truck
31	Adding class A foam
32	Hang hoses at station
33	Fire line driving in support of crew work
34	Transit driving between the staging area and fireground
35	Four wheel drive driving in terrain
36	Transit driving between home and staging area
37	Rapid construction of a sheltering ditch
38	Rapid preparation of refuge site with tanker
39	Preparation of tanker for burn over
40	Preparation of support vehicles for burn over
41	Administer minor first aid
42	Evacuate injured but assisting crew member
43	Evacuate seriously injured crew member
44	Integrated suppression effort on structure fire
45	Integrated suppression effort to contain spot fires
46	Integrated crew suppression effort on a back burn
47	Vehicle repair
58	Vehicle recovery
49	Vehicle tyre change
50	Burnout ignition
51	PLANT machinery supervision
52	Hose bowling
53	Hose making up on the bite

RESULTS

Type: 32 distinct tasks (of 53 identified by SME)
19 hose work, five handtool

Frequency: One to 103 repetitions on shift;

Intensity: 55% to 86% of maximal heart rate;

Speed: Movement speeds of 0.4 to 2.9 $km \cdot h^{-1}$;

Durations: 4 s to 7.6 min.

MOST FREQUENT

Task	Frequency	Mean HR (beats·min^{-1}) (%HR max)	Peak HR (beats·min^{-1}) (%HR max)	Speed (m·s^{-1})	Duration (s)	Type (Hose, Rake, Misc)
Lateral repositioning 38-mm hose	103	127 ± 23 (71.5 ± 12.6)	130 ± 23 (73.2 ± 15.5)	0.40 ± 0.29	17 ± 14	Hose
Targeted walk	95	117± 25 (64.8 ± 12.7)	121 ± 25 (66.9 ± 12.8)	0.76 ± 0.51	23 ± 29	Misc
Support 38-mm hose operator	66	123± 26 (68.9 ± 13.2)	128 ± 26 (72.1 ± 13.4)	0.28 ± 0.35	50 ± 58	Hose

- **Similar to SME job task analyses results (Phillips et al., 2011b)**
- **Parallel results for Dutch urban firefighters (Bos et al., 2004)**

MOST INTENSE

Task	Frequency	Mean HR (beats·min^{-1}) (%HR max)	Peak HR (beats·min^{-1}) (%HR max)	Speed (m·s^{-1})	Duration (s)	Type (Hose, Rake, Misc)
Team line building	1	157 ± 15 (86.2 ± 10.8)	168 ± 10 (92.2 ± 7.7)	0.14 ± 0.08	461 ± 387	Rake
Carry coiled 38-mm hose	6	156 ± 29 (83.4 ± 13.7)	161 ± 28 (86.0 ± 13.4)	0.79 ± 0.40	49 ± 60	Hose
Making up 38-mm hose on bite	5	155 ± 24 (82.1 ± 12.9)	164 ± 25 (86.8 ± 13.2)	0.40 ± 0.26	62 ± 47	Hose

- **Line building - only one repetition per six hours;**
- **'Vigorous' work, but lower heart rate than simulation research;**
- **Work pacing or simulation concerns?**

FASTEST

Task	Frequency	Mean HR (beats·min^{-1}) (%HR max)	Peak HR (beats·min^{-1}) (%HR max)	Speed (m·s^{-1})	Duration (s)	Type (Hose, Rake, Misc)
Carry coiled 38-mm hose	6	156 ± 29 (83.4 ± 13.7)	161 ± 28 (86.0 ± 13.4)	0.79 ± 0.40	49 ± 60	Hose
Support crew on fireline	5	101 ± 18 (55.0 ± 9.9)	112 ± 21 (60.8 ± 11.6)	0.78 ± 0.71	79 ± 51	Rake
Targeted walk	95	117± 25 (64.8 ± 12.7)	121 ± 25 (66.9 ± 12.8)	0.76 ± 0.51	23 ± 29	Misc

- **Slow walking speeds only;**
- **Slower speeds than simulation research;**
- **Work pacing or simulation concerns?**

LONGEST

Task	Frequency	Mean HR (beats·min^{-1}) (%HR max)	Peak HR (beats·min^{-1}) (%HR max)	Speed (m·s^{-1})	Duration (s)	Type (Hose, Rake, Misc)
Team line building	1	157 ± 15 (86.2 ± 10.8)	168 ± 10 (92.2 ± 7.7)	0.14 ± 0.08	461 ± 387	Rake
Blacking out work using 25-mm hose	20	107 ± 18 (59.0 ± 10.7)	116 ± 20 (64.2 ± 10.6)	0.18 ± 0.15	130 ± 138	Hose
Draughting	6	97 ± 16 (55.7 ± 8.5)	108 ± 20 (62.4 ± 10.0)	0.18 ± 0.13	119 ± 112	Misc

- **Large variation – supports SME job task analyses research;**
- **Shorter than simulation research.**

A COMPOSITE LIST…

Task	Frequency	Mean HR (beats·min^{-1}) (%HR max)	Peak HR (beats·min^{-1}) (%HR max)	Speed (m·s^{-1})	Duration (s)	Type (Hose, Rake, Misc)
Blacking out work using 38-mm hose	41	126 ± 24 (71.9 ± 15.3)	131 ± 24 (75.0 ± 15.0)	0.26 ± 0.19	76 ± 70	Hose
Lateral repositioning 38-mm hose	103	127 ± 23 (71.5 ± 12.6)	130 ± 23 (73.2 ± 15.5)	0.40 ± 0.29	17 ± 14	Hose
Operating 38-mm hose	41	124 ± 19 (69.8 ± 10.6)	129 ± 20 (72.4 ± 10.8)	0.34 ± 0.37	40 ± 58	Hose
Making up 38-mm hose on bite	5	155 ± 24 (82.1 ± 12.9)	164 ± 25 (86.8 ± 13.2)	0.40 ± 0.26	62 ± 47	Hose
Team line building	1	157 ± 15 (86.2 ± 10.8)	168 ± 10 (92.2 ± 7.7)	0.14 ± 0.08	461 ± 387	Rake

- **Novel approach to categorizing;**
- **Close match with SME job task analyses research**

  (Phillips et al. 2011b)

CONCLUSIONS & APPLICATIONS

bushfire CRC

Bushfire suppression:

- Intermittent, short-duration tasks;
- Composite of hose and handtool work;
  - Job-specific physical selection testing
- Moderate to vigorous work;
  - Cardiovascular health screening

Coupling video & personal monitoring advances job task analyses