Institute of Sound and Vibration Research

A Survey of Human Response to Vibration Research In Great Britain

M.J. Griffin

ISVR Technical Report 60

March 1973

University of Southampton

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UNIVERSITY OF SOUTHAMPTON
INSTITUTE OF SOUND AND VIBRATION RESEARCH
HUMAN FACTORS RESEARCH UNIT

A SURVEY OF HUMAN RESPONSE TO VIBRATION RESEARCH IN GREAT BRITIAN

M.J. Griffin

March 1973

ISVR Technical Report No. 60

Professor J.B. Large
(Joint Chairman, Operational
Acoustics & Audiology Group)

M.J. Griffin Ph.D.

ABSTRACT

This report presents information obtained from a questionnaire sent to fifty seven groups known to be interested in human response to vibration. The survey was conducted to aid communication and assist persons wishing to contact a research group with relevant research experience in human response to vibration.

The nature of the various vibration simulation facilities and portable vibration recording systems available is listed. Outline descriptions of laboratory and field experiments conducted since 1965 are presented in tabular form. References to a total of seventy-seven reports (including theses) published since 1965 are provided and there is an estimate of the number of persons employed in studying human response to vibration in Great Britain. There is also information on the various research programmes planned for the future.

ACKNOWLEDGEMENTS

We are grateful to the very many persons who have co-operated in this survey and hope that they will find it of some value.

Gratitude is also due to Mary Hawkins who prepared an interim report on the survey and Jacqueline Griffin who typed this final report.

CONTENTS

(1) INTRODUCTION

A questionnaire concerning human response to vibration research and facilities was sent to more than fifty organisations within Great Britain at the beginning of July 1972. The questionnaire was designed so that the information obtained could be published with the minimum of editing. This report presents almost all of the information returned within six months of the distribution of the questionnaire.

The survey was conducted to aid communication and assist persons wishing to contact a research group with some particular experience in human response to vibration. The replies do not contain any implication regarding either the quality of the research or the quantity of work conducted but not considered relevant to the question.

(2) DISTRIBUTION

In July 1972 approximately fifty questionnaires were sent to groups known to be involved or have some interest in human response to vibration research. The circulation list accompanied the questionnaire and the final question asked for names and addresses of persons who should be added to the distribution.

The final circulation ammounted to fifty seven groups. Fifteen of these replied that they were conducting no relevant research; Twenty seven completed the questionnaire and their replies are presented in this report. Fifteen groups did not reply. In all of the latter cases the questionnaire was followed by further unsuccessful attempts at communication. While it is likely that the majority of such groups are not conducting relevant research, it is known that the survey is not a complete statement of all the relevant research in the United Kingdom.

The circulation list and the nature of each reply will be found on pages 55 to 57 of this report.

(3) INFORMATION PRESENTED

This study was not designed to assess the quality of individual research projects or to determine the adequacy of the total research effort in Great Britain. Indeed, it is our opinion that the information should be presented without comment. However, to aid the reader in locating and understanding the replies to various questions a very brief summary of some of the more interesting points is presented in the following sections.

1a) Vibration Simulation Facilities (pages 1 to 8)

Apart from the mention of a few flight simulators, there appears to be only four facilities designed to produce more than one axis of vibration for research purposes. Two of these are 2 axis machines built specifically for investigating human response to vibration; one is a 2 axis ship motion simulator and the other a five axis aircraft-type simulator. There appears to be one rotational vibrator used for investigating human response.

1b) Portable Vibration Recording Facilities (pages 9 to 12)

Eighteen of the twenty-seven groups who are conducting relevant research gave details of some form of portable vibration recording system. However many of the recorders are extremely heavy and mains powered so that it would seem that only about six groups are equipped with self-powered three (or more) channel systems that weigh less than 20 lbs.

1c) Vibration Analysis Facilities (pages 13 to 16)

Twenty one groups answered this question and it is notable that the majority possess, or have access to, some form of computer analysis equipment.

2) Other Relevant Facilities (pages 17-18)

Studies of human response to vibration are usually conducted by a few workers who form only a small part of a larger group. The activities of the parent group may have led to the research and can often prove beneficial to the human response studies. Questions 2 and 7 provided the opportunity for reference to be made to other relevant research and facilities within the group.

3a) Relevant Laboratory Experiments Conducted between 1st January 1965 and 1st January 1970 (pages 19 to 21)

Seven groups provided details of fifteen experiments during this five year period. (The true amount of research is greater than this since it is known that some groups did not refer to experiments which have been published in the open literature). Approximately half of the fifteen experiments were conducted with fewer than six subjects and a similar number have not resulted in published papers. Nine of the experiments were concerned with the effects of vibration on performance, six with biodynamic response and six with subjective sensation.

3b) Relevant Laboratory Experiments Conducted since 1st January 1970

(pages 22 to 29)

Fourteen groups mentioned approximately fifty experiments - forty of which were conducted at a University or College. Almost all experiments employed more than six subjects and eleven involved more than twenty subjects. Eighteen of the experiments have not been published and a further six are still in progress. Consequently less than half of the experiments are to be found in the literature.

Twenty-one studies were concerned with human performance, sixteen with subjective sensation, eleven with biodynamic response, six with physiological response and three with the perception of vibration.

4a) Relevant Field Experiments Conducted prior to 1st January 1970

(pages 30 and 31)

Six groups provided information on twelve field experiments. However, only the work of three groups was designed to relate the physical characteristics of the vibration to its affects on subjects.

4b) Relevant Field Experiments Conducted since 1st January 1970

(pages 32 to 35)

Ten groups referred to twenty-two field experiments conducted since the beginning of 1970. Most of this research relates to helicopters and hovercraft.

5a) Publications Published/Presented between 1.1.65 and 1.1.70

(Excluding Review Papers) (pages 36 to 38)

Twenty research papers from seven groups were mentioned. Seven of the papers have been published in Scientific Journals and the remainder are Departmental Reports and Memoranda.

5b) Publications Published/Presented since 1.1.70 (Excluding Review Papers)

(pages 39 to 42)

Of the twenty-nine papers produced since 1970 only five have been published in Journals. The remainded are conference papers and departmental reports.

5c) Review(and Other)Papers Published since 1st January 1970 (pages 43 and 44)

Fifteen review papers are listed - four have been published in Journals.

5d) Theses Published since 1st January 1965 (pages 45 and 46)

Thirteen theses are listed. These include three Ph.D., two M.D. and five M.Sc theses.

6) Research Workers Employed on Body Vibration During Year Commencing October 1971 (pages 47 and 48)

During the year there were at least sixteen places in Great Britain where one or more persons were employed in some capacity to study human response to vibration. Five groups estimated that they spent more than one man-year on such research. The survey implies that a total effort of about 20 man-years was spent during the year ending October 1972 - approximately half of the effort comes from University Departments.

7) Other Relevant Research (page49)

See Section 2 for comments.

8a) Work to be Continued Year Beginning October 1972 (pages 50 and 51)

Thirteen groups have listed twenty-five different studies being continued during the year commencing October 1972.

8b) Work to be Commenced During Year Beginning October 1972 (pages 52 and 53)

Twelve groups mentioned twenty-three studies to be commenced in the year beginning October 1972. All except four of these new projects are to be conducted outside Universities.

9) Further Comments (page 54)

Four groups mentioned miscellaneous activities of general interest.

10) Distribution (pages 55 to 57)

The eventual circulation of the questionnaire is presented at the end of this report.

1a) VIBRATION SIMULATION FACILITIES: AVAILABLE FOR INVESTIGATING HUMAN RESPONSE:

		VIBRATOR TYPE	VIBRATION AXIS	DISPLACEMENT MAX. ± INS.	"USEFUL" FREQ. RANGE	MAXIMUM FORCE lbs.	MAXIMUM LOAD (AS NOW OPERATED) lbs.
BRITISH AIRCRAFT CORP. LTD., DYNAMICS & MATHS SERVICES, COMMERCIAL AIRCRAFT DIVISION, WEYBRIDGE, SURREY. (2)	1	5 axis rig	heave, sway, roll, pitch, yaw.	20 12 ± 35 degrees ± 15 degrees ± 8 degrees	0 - 0.6 Hz 0 - 0.6 Hz 0 - 0.5 Hz 0 - 0.3 Hz 0 - 0.4 Hz		2000 Cockpit Simulation Module
(and)	2	Servo-Consultants Type V5 5 off units	any	1.0	Constant Force Servo 0.5-150 Hz	± 680	
B.A.C. COMMERCIAL AIRCRAFT DIVISION FILTON (2)	1	Ling Altec	X, Z.	± $\frac{1}{2}$	5-2000 cps.	22,000	
	2	Savage 2 off	portable	± 1	5-2000 cps.	500	(Engaged on long term contract)
	3	3 Axis Redifon Simulator	Designed to give motion cues to pilot not designed to input vibration				

1a) VIBRATION SIMULATION FACILITIES: AVAILABLE FOR INVESTIGATING HUMAN RESPONSE: (continued)

		VIBRATOR TYPE	VIBRATION AXIS	DISPLACEMENT MAX. ± INS.	"USEFUL" FREQ. RANGE	MAXIMUM FORCE lbs.	MAXIMUM LOAD (AS NOW OPERATED) lbs.
UOP BOSTROM(UK) NORTHAMPTON (6)	1	Schenk electro-hydraulic	Vertical	± 2 ins.	DC - 50Hz	5,500	
BOURNEMOUTH COLLEGE OF TECHNOLOGY (7)	1	Motor Driven Mechanical	X and Y	0.5 ins.	0.5 - 25 Hz	0.4	0.4
CENTRAL LONDON POLYTECHNIC (8)	1	Fairy Hydraulic Vibrator	Vertical	± 2 ins.	DC to 20 Hz	1000	300
	2	Mayes Electro-hydraulic Servo controlled Universal testing machine	Vertical	± 2 ins	DC to 20 Hz	22400	500
CRANFIELD INSTITUTE OF TECHNOLOGY (9) (continued)	1	Electro-hydraulic	1 axis, can be mounted in any direction	± 3 ins.	0 - 60 Hz 10Hz-±1" ampl.	1000 (dynamic) 1500 (static)	

1a) VIBRATION SIMULATION FACILITIES: AVAILABLE FOR INVESTIGATING HUMAN RESPONSES: (continued)

		VIBRATOR TYPE	VIBRATION AXIS	DISPLACEMENT MAX. ± INS.	"USEFUL" FREQ. RANGE	MAXIMUM FORCE lbs.	MAXIMUM LOAD (AS NOW OPERATED) lbs.
CRANFIELD INSTITUTE OF TECHNOLOGY (9) (continued)	2	Electro-hydraulic	1 axis, can be mounted in any direction	± 3 ins.	0 - 60 Hz 10 Hz ± 1" ampl.	5000 (dynamic) 7500 (static)	
	3	Electro-magnetic	(as above)	± 0.35	5 Hz to 9 K Hz	55	
	4	Electro-magnetic	(as above)	± 0.40	5 Hz to 10 K hz	35	
	5	Electro-magnetic	(as above)	± 0.50	1.5 Hz to 3000 Hz	150	
HAWKER SIDDELY AVIATION LTD. HATFIELD (11)	1	Redifon 3 axis motion base for flight simulation, plus added sway axis.	vertical pitch roll sway(lat.)	± 12 ins. ± 15° - 10°	0 - 2 cps. 0 - 2 cps.	± 0.5 g 1 rad./sec² 2 rad./sec² ± 0.5 g	3000 lbs.

1a) VIBRATION SIMULATION FACILITIES: AVAILABLE FOR INVESTIGATING HUMAN RESPONSE: (continued)

		VIBRATOR TYPE	VIBRATION AXIS	DISPLACEMENT MAX. $\pm$ INS.	"USEFUL" FREQ. RANGE	MAXIMUM FORCE lbs.	MAXIMUM LOAD (AS NOW OPERATED) lbs.
I.A.M., R.A.F., FARNBOROUGH. (12)	1	Electro-mechanical	Vertical	$\pm$ 1 in.	1 - 15 Hz	?	250 lbs.
	2	Electro-hydraulic	Vertical	$\pm$ 36 ins.	0.01 - 15Hz	3000	500 lbs.
	3	Torque motor	Rotational	360°	0 - 20 Hz	200ft.lb	400 lbs
NATIONAL INSTITUTE OF AGRICULTURAL ENGINEERING, WREST PARK, SILSOE, BEDS. (14)	1	Mechanical	Vertical	$\pm$ 1 in.	0 - 10 Hz ($\pm$1/8") (distorted)		
	2	Electro-magnetic	Not used at present for human response studies	$\pm \frac{1}{2}$ in.	20 Hz - 3 K Hz	220	6 lbs. (nominal)
	3	Electro-hydraulic		$\pm 4\frac{1}{2}$ ins.	0 - 100 Hz or less	2430	
	4	Electro-hydraulic		$\pm$ 5 ins.	depending on static load.	2430	

1a) VIBRATION SIMULATION FACILITIES: AVAILABLE FOR INVESTIGATING HUMAN RESPONSE: (continued)

		VIBRATOR TYPE	VIBRATION AXIS	DISPLACEMENT MAX. ± INS.	"USEFUL" FREQ. RANGE	MAXIMUM FORCE lbs.	MAXIMUM LOAD (AS NOW OPERATED) lbs.
NATIONAL INSTITUTE FOR MEDICAL RESEARCH, (HAMPSTEAD LABS.) LONDON, N.W.3. (15)	1	Roll/pitch (ship motion) Angular sinusoidal (under construction)	2 Horizontal orthoganal axes	Angular Amp. 1 axis $\pm 10^{o}$ other axis $\pm 5^{o}$	(Planned) 0 - 0.3 Hz in each axis axes phase coupled.	Man and workplace cabin with response assessment facilities.	
R.A.E., E.P. DEPT. FARNBOROUGH. (16)	1	Servo Consultants Electro-hydraulic 2 axis	Heave and sway or shunt	10 ins. 10 ins.	0 - 40 Hz	1200 1200	600 lbs. (working) 600 lbs. (working)
	2	H.S.A. Electro-hydraulic 2 axis	Heave or sway	2.15 ins. 2.25 ins.	2 - 20 Hz	1200 1600	200 lbs. 200 lbs.
ROYAL MILITARY COLLEGE OF SCIENCE, SHRIVENHAM. (17)	1	Servo Consultants Electro-hydraulic	Vertical	± 11 ins.	Up to 100Hz but not yet fully tested.	1500 Kn	160 Kg
TRANSPORT & ROAD RESEARCH LAB., CROWTHORNE. (18)	1	Electro-hydraulic (used for indirect excitation)	Single	± 2 ins.	0 - 30 Hz	± 750	

1a) VIBRATION SIMULATION FACILITIES: AVAILABLE FOR INVESTIGATING HUMAN RESPONSE: (continued)

		VIBRATOR TYPE	VIBRATION AXIS	DISPLACEMENT MAX. ± INS.	"USEFUL" FREQ. RANGE	MAXIMUM FORCE lbs.	MAXIMUM LOAD (AS NOW OPERATED) lbs.
WESTLAND HELICOPTERS LTD., YEOVIL, SOMERSET. (19)	1	Goodmans VG 109 Electro	Vertical	± 3/8 in.	10 Hz - 2 K Hz	10,000	5 tons supported weight
	2	Goodmans V G 108	Vertical or horizontal	± 3/8 in.	10 Hz - 2 K Hz	3,500	2 tons supported weight
	3	Goodmans 8/600A	Vertical or horizontal	± ½ in.	5 Hz - 2 K Hz	250	
UNIVERSITY OF BIRMINGHAM, DEPT OF MECHANICAL ENGINEERING. (21)	1	University designed DRD- 5LB6 electro-hydraulic (4 off)	Vertical	± 3 ins.	0 - 40 Hz	5000	1000 lbs.
	2	Unidyne VTH 930	Vertical	± 4.5 ins	0 - 50 Hz	9000	1500 lbs.
UNIVERSITY OF EDINGBURGH, PHYSIOLOGY DEPT. (22)	1	Torque generators	Any	Not relevant	0 - 20 Hz	0 - 4 Newton metres Torque.	Not relevant

1a) VIBRATION SIMULATION FACILITIES: AVAILABLE FOR INVESTIGATING HUMAN RESPONSE: (continued)

		VIBRATOR TYPE	VIBRATION AXIS	DISPLACEMENT MAX. ± INS.	"USEFUL" FREQ. RANGE	MAXIMUM FORCE lbs.	MAXIMUM LOAD (AS NOW OPERATED) lbs.
UNIVERSITY OF LOUGHBOROUGH, DEPT. ERGONOMICS AND CYBERNETICS. (23)	1	Electro-hydraulic	Z	± 5 ins (plus 1" snubber) at 1 g	0.5 - 50 Hz 1 Hz - 20% 4 Hz - 10% 20 Hz - 2%	1500	300 lbs. (capable of 500 lbs.)
	2	Small mechanical vibrator	Z	± 0.25 ins.	2 - 10 Hz	200	200 lbs.
UNIVERSITY OF SHEFFIELD, DEPT. MECHANICAL ENGINEERING (24)	1	Ling 725 1 KVA amp. (to be installed autumn 1972)	Vertical	.75 up to 4 Hz	DC to 5000 Hz	840	250 lbs.
	2	Hydraulic (Government surplus actuator) (used for experiments to date but now out of use)	Vertical	2.0	0 - 30 Hz	2000	250 lbs. (chair and subject)
UNIVERSITY OF SOUTHAMPTON, ISVR. (25) (continued)	1	Derritron VP180LS Electrodynamic	Vertical	± 1 in.	1 Hz to 1 K hz	800	approx. 200 lbs

1a) VIBRATION SIMULATION FACILITIES: AVAILABLE FOR INVESTIGATING HUMAN RESPONSE: (continued)

		VIBRATOR TYPE	VIBRATION AXIS	DISPLACEMENT MAX. ± INS.	"USEFUL" FREQ. RANGE	MAXIMUM FORCE lbs.	MAXIMUM LOAD (AS NOW OPERATED) lbs.
UNIVERSITY OF SOUTHAMPTON, ISVR. (25) (continued)	2	Derritron VP85 (6 link arm) Electrodynamic	Vertical	± 0.5 in.	1.5 Hz to 1 K Hz	800	approx. 250 lbs.
	3	Derritron VP85 Electrodynamic	Vertical or Horizontal	± 0.5 in.	1.5 Hz to 10 K Hz	850	at least 500 lbs.
	4	Derritron VP4	Vertical or Horizontal	± 0.2 in.	1.5 Hz to 10 K Hz	24	approx. 5 lbs.
	5	Other Hydraulic vibrators not employed in human response studies.	-	-	-	-	-
UNIVERSITY COLLEGE OF SWANSEA, DEPT. OF MECHANICAL ENGINEERING. (26)	1	Fairey 1160.BIL	Vertical (shortly to be Horizont)	± 4.5 ins.	0-25 Hz	1160	600 lbs.
	2	Unidyne	Vertical	± 4.0ins.	0-50 Hz	10,500	600 lbs.

1b) PORTABLE VIBRATION RECORDING FACILITIES:

		ACCELEROMETER TYPE	RECORDER TYPE	NO. OF CHANNELS	"USEFUL" FREQ. RANGE	POWER SUPPLY	APPROX. WEIGHT OF SYSTEM
ACCIDENT AND AMBULANCE RESEARCH (1)	1	Miller Variable reluctance.	.S.E.Labs. 8-4	4 or 8	0 - 10 K Hz	Batt/mains	appr. 30 lbs. (with batteries)
	2	Ether UA 1	Home built	F.M. 1	0 - 100 K Hz	Batteries	10 lbs.
BRITISH AIRCRAFT CORPS. LTD.(2)		Electromechanisms Ltd ITI-22F-31	Honywell Cardioview Modified	10	0.5 - 40 Hz	Battery	10 lbs.
BRITISH LEYLAND TRUCK & BUS DIV. PRESTON.(3)		Strain gauge	FM/FM	4	DC to 125 Hz	Battery, various voltages	50 lbs. total
UOP BOSTROM (UK) NORTHAMPTON (6)		CEC-4-202 Strain guage ±10 g. + MIN. 2 channel power supply/ data amp.	Lockheed 417 FM $\frac{1}{4}$" $3\frac{3}{4}$ IPS	2 in, 1 out	DC - 625 Hz	Mains or internal battery	35 lbs.
CENTRAL LONDON POLYTECHNIC.(8)	1		B & K recorder Type 2305	1	0 - 5 Hz		
	2	B & K Types 4333 and 4324	S E lab. U V recorder	12	DC - 12 K Hz		
	3		Bryers X Y plotter				

1b) PORTABLE VIBRATION RECORDING FACILITIES: (continued)

		ACCELEROMETER TYPE	RECORDER TYPE	NO. OF CHANNELS	"USEFUL" FREQ. RANGE	POWER SUPPLY	APPROX. WEIGHT OF SYSTEM
CRANFIELD INSTITUTE OF TECHNOLOGY.(9)		Electro magnetic, Piezo, Servo,: (wide range of each type)	Lockheed	7	0 - 200 Hz	Mains or Battery	29 lbs.
			Elliot	14			100 lbs.
I.A.M., R.A.F., FARNBOROUGH,(12)			U.V.	6	0 - 100 Hz (depending galvo used)	A.C.	50 lbs.
MILITARY VEHICLES AND ENGINEERING EST., CHERTSEY,(13)		Ether U A 1 (other types under investigation)	Sangamo 3500	14	DC - 100 Hz	28 v.	
NATIONAL INSTITUTE OF AGRICULTURE ENGINEERING, SILSOE.(14)	1	Piezo-electric	Kudelski Nagra		30 Hz - 15 KHz	Self contained	30 lbs.
	2	Variable inductance or strain gauge	Phillips Analog 7 or Analog 14	up to 6 of each type of accelerometer	0 - 530 Hz 0 - 65 Hz	24v. D.C.	150 lbs.

1b) PORTABLE VIBRATION RECORDING FACILITIES: (continued)

		ACCELEROMETER TYPE	RECORDER TYPE	NO. OF CHANNELS	"USEFUL" FREQ. RANGE	POWER SUPPLY	APPROX. WEIGHT OF SYSTEM
R.A.E., E.P. DEPT. FARNBOROUGH. (16)	1	Smiths Inductive TD 413	McMichael IT-7-10-61	3	0 - 40	Portable 24v. D.C.	$25\frac{1}{2}$ lbs. total
	2	BLA 2 strain gauge	Tandberg	4	0 - 100	Portable	77 lbs.
ROYAL MILITARY COLLEGE OF SCIENCE, SHRIVENHAM. (17)		Piezo electric and LVDT	Phillips FM/AM/Direct	7	K Hz	Main/24v. battery	30 kg.
TRANSPORT & ROAD RESEARCH LAB., CROWTHORNE. (18)		Force feedback $\pm \frac{1}{4}g$, $\pm 1g$	U.V.	6 and 12	0 - 30	240v. 50 Hz	80 lbs. ?
WESTLAND HELICOPTERS LTD., YEOVIL, SOMERSET. (19)		Endevco 2265-20 Piezoresistive	Pemco 110A F.M. Airborne 14 channel recorder	9	0.5 Hz - 150Hz	Self contained	120 lbs.

1b) PORTABLE VIBRATION RECORDING FACILITIES: (continued)

		ACCELEROMETER TYPE	RECORDER TYPE	NO. OF CHANNELS	"USEFUL" FREQ. RANGE	POWER SUPPLY	APPROX. WEIGHT OF SYSTEM
UNIVERSITY OF BIRMINGHAM, DEPT. OF MECHANICAL ENGINEERING. (21)		Endevco. Piezo-resistive	Thermionic Racal.	4	0 - 200 Hz	220 v. A.C.	150 lbs
UNIVERSITY OF LOUGHBOROUGH, DEPT. ERGONOMICS AND CYBERNETICS. (23)		Endevco	U.H.E.R. with dept. made F.M. unit	2	0.5 - 20 Hz	Rechargable battery	10 kg.
UNIVERSITY OF SHEFFIELD, DEPT. ENGINEERING ENGINEERING. (24)			Bell & Howell T/R 3600	14	0 - 1 Meg.	250v.	200 lbs.
UNIVERSITY OF SOUTHAMPTON, ISVR. (25)		Endevco strain gauge 2265 - 20	F.M. Multiplex onto direct taperecorder	3 + 3	D.C. to 100Hz	Rechargable battery	5 lbs.
UNIVERSITY COLLEGE OF SWANSEA, MECHANICAL ENGINEERING. (26)		Endevco 2265 - 20	Dynatel Multiplex system. Also U.H.E.R. 4000 tape recorder.	6	0 - 150 Hz.	Cadmium	15 - 20 lbs.

1c) VIBRATION ANALYSIS FACILITIES:

	GENERAL DESCRIPTION OF SYSTEM	SYSTEMS CAPABILITIES
ACCIDENT AND AMBULANCE RESEARCH. (1)	(Use of Digital Computer at I.S.V.R. The University of Southampton)	
BRITISH AIRCRAFT CORP. LTD. (2)	'Ubiquitous' Spectrum Analyser (2 off) B & K Spectral Analyser. Prodera Transient 'Mazet' Typeanalyser. Prodela Harmonic Analyser. BAC Dynamic Digital Analysis Suite of Programs. Band Pass Filters. Tracking Filters. Level Counting. Transfer Function Analysers A to D Converters. General Purpose Analogue and Digital Computers.	Ranges 0 - 10 cps. to 0 - 5000 cps. (Transient, Harmonic and Random) Filtering, Amplitude measurements and sorting. Spectra, Correlation.)
BRITISH LEYLAND TRUCK AND BUS DIV. (3)	$\frac{1}{3}$ octave. 6% bandwidth. Narrow constant bandwidth	2Hz - 20 K Hz. 6.3 Hz - 20 K Hz. 5 Hz - 10 K Hz.
BRITISH RAILWAYS BOARD TECHNICAL CENTRE, DERBY. (4)	Vibration data is analysed by IBM 360 computer.	(Digitised for Fast Fourier Transform giving P.S.D.'s.
BOURNEMOUTH COLLEGE OF TECHNOLOGY. (7)	Pulse counter for frequency mechanical control of amplitude. (Paper trace accelerometer not yet operative).	

1c) VIBRATION ANALYSIS FACILITIES: (continued)

	GENERAL DESCRIPTION OF SYSTEM	SYSTEM CAPABILITIES
CENTRAL LONDON POLYTECHNIC. (8)	B & K measuring amplifier type 2606 and type 2204 sound level meter, B & K $\frac{1}{3}$ octave/octave filter type 1614 & B & K heterodyne slave filter type 2020. X Y plotter.	Measurement and frequency analysis if steady state vibration.
CRANFIELD INSTITUTE OF TECHNOLOGY (9)	ISAAC Vibration Analysis Equipment. Spectral Dynamics Complete Vibration Analysis System.	0 - 200 Hz (Amplitude Dispositions Power 2 - 10 K Hz (Spectral Densities Cross and (Auto Correlation
HAWKER SIDDELY AVIATION LTD. (11)	16 channel 15 bit A - D converter on line to digital computor. Narrow band B & K frequency analyser	General digital analysis programmes (FFT, etc.) 20 Hz - 20 K Hz
I.A.M., R.A.F., FARNBOROUGH. (12)	Access to Digital computers. Solatron T.F.A.	Frequency analysis etc. Distortion.
MILITARY VEHICLES AND ENGINEERING EST. CHERTSEY. (13)	PDP 9/L Computer installation with A/D converter. Ubiquitous Spectrum Analyser.	8 K core store. 256 K disc.
NATIONAL INSTITUTE OF AGRICULTURE ENGINEERING SILSOE. (14)	Fenlow low frequency spectrum analyser. Noise analysis equipment: spectral amplitude Frequency weighted ridemeter (1 channel)	0-1000 Hz - P.S.D. functions only Octave & $\frac{1}{3}$ octave Hz - K Hz (Frequency range can be extended by tape speed change) Level crossing counter. 0-80Hz. Fixed weighting networks, vertical & horizontal, as per ISO/DIS 2631.

1c) VIBRATION ANALYSIS FACILITIES: (continued)

	GENERAL DESCRIPTION OF SYSTEM	SYSTEMS CAPABILITIES
R.A.E., E.P., DEPT., FARNBOROUGH. (16)	MK 1 Eyeball (at present) Solartron digital TFA	Fantastic. DC - 16 K Hz 10 mV - 300 V
ROYAL MILITARY COLLEGE OF SCIENCE, SHRIVENHAM. (17)	B & K frequency analysis	
TRANSPORT AND ROAD RESEARCH LAB. CROWTHORNE. (18)	D'Mac analysis: table Digital computer facilities. also hand analysis.	
WESTLAND HELICOPTERS YEOVIL. (19)	Spectral dynamics 301 real time analyser: Digital speed up of data sample enables reconstructed analogue signal to be rapidly frequency analysed using stepped hetrodyne electrical filter system.	Frequency analysis in terms of r.m.s. or P.S.D. Frequency ranges: 0-100 Hz 0.3 Hz resolution 0-500 Hz 1.5 resolution. 0-1K 3 Hz resolution. etc. Confidence can be adjusted up to 9900 statistical degrees of freedom.
UNIVERSITY OF BIRMINGHAM, DEPT. OF MECHANICAL ENGINEERING (21)	Ubiquitous VA6 and 1015 Averager Quantec Analysis. SE Labs. 2001 TFA. Solartron 1860 Time Domain Analyser.	Real Time Analysis of Power Spectra 0-10 K Hz Averaging of successive spectra. Sine and Random Analysis. Accurate sine analysis. Accurate true r.m.s. measurement with variable range integrating time.

1c) VIBRATION ANALYSIS FACILITIES: (continued)

	GENERAL DESCRIPTION OF SYSTEM	SYSTEMS CAPABILITIES
UNIVERSITY OF EDINGBURGH, PHYSIOLOGY DEPT. (22)	Hybrid Analogue digital stimulus sequence and phase angle measurements.	
UNIVERSITY OF LOUGHBOROUGH, DEPT. ERGONOMICS & CYBERNETICS. (23)	B & K Noise analysis systems. Hewlett Packard Fourier Analyser	20 Hz and up. Based on small computer. Therefore extensive capabilities.
UNIVERSITY OF SHEFFIELD, DEPT OF MECHANICAL ENGINEERING. (24)	Hewlett Packard Correlater 3721A A selection of wave analysers by General Radio, Dawe, B & K.	Autocorrelation, cross correlation level distributions, signal averaging. 1, $\frac{1}{3}$, & 1/10 octave bandwidth analysis
UNIVERSITY OF SOUTHAMPTON. ISVR. (25)	Principally:- ISVR. Myriad Computer (Data Analysis Center)	Up to 24 Multiplexed channels. A to D conversion at up to 40,000 samples/sec. Max. of 10^6 samples. Standard Arithmetic, statistical and analysis programmes. Also other special programmes.
UNIVERSITY COLLEGE OF SWANSEA, DEPT. OF MECHANICAL ENGINEERING. (26)	Quantech 304 TDL P.A.R. Correlator & Fourier transform box. B & K Noise equipment (inc. 7001 tape recorder)	1 Hz analysis 0 - 5 K Hz. Correlation (auto & cross) 0 -50 K Hz Can be used with Quantech to give 1/40 Hz bandwidth 0 -100 Hz.

2. OTHER RELEVANT FACILITIES:

B.A.C. (2)	Acoustic facilities both at Weybridge and Filton
BRITISH RAIL DERBY. (4)	Railway coach fitted with Schaevitz servo-accelerometer type LSBE 16-2.
UOP BOSTROM. (6)	U.V. oscillograph.
BOURNEMOUTH C. OF TECH. (7)	Photographic target material, testing boothe and relevant lighting.
C. LONDON POLY. (8)	Derritron VCC1 vibrator control unit with six cross-over part control. Interdata model 70 mini-computer and multiplexer for recording and analysis of up to 12 transducers.
M.V.E.E. CHERTSEY (13)	Solartron Analogue Computer. Frequency Weighted 'Ridemeter'.
N.I.A.E. SILSOE. (14)	Portable frequency weighted ridemeter, 2 channels, weighting networks approx. to frequency weighting curves in ISO/DIS 2631, used with strain gauge type accelerometers.
R.A.E. FARNBOROUGH. (16)	Portable tracking task under construction. Hewlett Packard Fast Fourier Analyzer will be available later this year (DC - 2 K Hz 100 mV - 10 V)
R.M.C.S. SHRIVENHAM. (17)	Moderateanalogue computer equipment - suitable for probability distributions, r.m.s. monitoring etc.

2) OTHER RELEVANT FACILITIES: (Continued)

T.R.R.L. CROWTHORNE. (18)	Special device (Energy Input Device) using 4 Electro-hydraulic actuators driving 4 masses. Used for excitation of bridges.
WESTLAND HELICOPTERS. (19)	Incorporated in the recording system described in 1c) is a Endevco rack power supply 4910 which houses amplifier/integrators. A number of other analogue frequency analysers are available in addition to the IBM 370 computer facility.
U. BIRMINGHAM. (21)	A 'Broadbent' style vigilance task with timing equipment. Facilities for combined environments. Anechoic chamber for auditory measurements. Full facilities for generation of random vibration environments.
U. LOUGHBOROUGH. (23)	Vibration room 10 ft by 10 ft with controlled environmental conditions and all recording equipment, etc. remote. (in adjacent room) Tracking test etc. equipment load cell for seat interface studies.
U. SHEFFIELD. (24)	"Sound proof" chamber housing vibrating chair.
U. SOUTHAMPTON. (25)	Human Response to Vibration Literature Collection (approx. 1000 papers).

3a) RELEVANT LABORATORY EXPERIMENTS CONDUCTED PRIOR TO 1st JANUARY, 1970 (AND LATER THAN 1st JANUARY 1965)

		EXPERIMENTAL AIMS	CRITERIA (SEE BELOW)	FREQUENCY RANGE	AMPLITUDE RANGE	NUMBER OF SUBJECTS	PUBLISHED YES/NO
BRITISH RAIL MARYLEBONE, NW1(5)	1	To determine vibration isolation characteristics of bent knee and muscle group.	b,(and pf)	0-10 Hz (2, 4,6,8,10)	± 1/16"	3	NO(Cranfield Thesis)
HAWKER SIDDLEY. (11)	1	Randomly excited resonant mode. Vetical Vibration. Gust spectrum	ss	2-7 Hz	.05 - .30 r.m.s.g	10	YES
	2	Aircraft simulation. Random vertical ext^{n}. 16 cases.	pf, ss.	3.5-5.1 Hz	.13 - .21 r.m.s.g	2	NO
	3	Set up as 1. Effect on roll task and pitch task.	pf.	1.5-7.0 Hz	.05 -.3 r.m.s.g	6	YES (Summary)
	4	Randomly excited resonant mode. Lateral vibration. Effect on roll task and pitch task.	pf.	2-7 Hz	.025 - .2 r.m.s.g	3	YES (Summary)

Key to Criteria: b = biodynamics; ph = physiological reaction; pf = performance; ss = subjective sensation; p = perception threshold.

3a) RELEVANT LABORATORY EXPERIMENTS CONDUCTED PRIOR TO 1st JANUARY, 1970 (AND LATER THAN 1st JANUARY, 1965) (continued)

		EXPERIMENTAL AIMS	CRITERIA (SEE BELOW)	FREQUENCY RANGE	AMPLITUDE RANGE	NUMBER OF SUBJECTS	PUBLISHED YES/NO
N.I.A.E. SILSOE. (14)	1	To model mechanical impedance of body for testing suspension seats.	b.	0.5-5 Hz	$\pm\frac{1}{2}$" into seat suspension.	4	NO
R.A.E. FARNBOROUGH. (16)	1	4 jet transport vibration simulations: Dual Axis.	b,ph,pf,ss.	$1\frac{1}{2}$-4Hz Heave & Sway	$\pm$0.14-$\pm$0.35g	5,6,5,4,	YES
	2	Vibration, harness & other effects. Dual Axis.	pf, ss.	2-$3\frac{1}{2}$Hz Heave & Sway	$\pm$0.2-$\pm$0.35g	2,3.	YES
	3	Cine Film analysis. Dual Axis, with & without harness.	b.	1-4 Hz Heave & Sway	$\pm$0.14-$\pm$0.35g	3	NO
	4	Helmet weight under low frequency vibrations	pf, ss.	Random.	0.2g r.m.s. approx.	3	YES

Key to Criteria: b = biodynamics; ph =physiological reaction; pf = performance; ss = subjective sensation; p = perception threshold.

3a) RELEVANT LABORATORY EXPERIMENTS CONDUCTED PRIOR TO 1st JANUARY, 1970 (AND LATER THAN 1st JANUARY, 1965) (continued)

		EXPERIMENTAL AIMS	CRITERIA (SEE BELOW)	FREQUENCY RANGE	AMPLITUDE RANGE	NUMBER OF SUBJECTS	PUBLISHED YES/NO
T.R.R.L. CROWTHORNE. (18)	1	Human tolerance levels for bridge vibrations.	ss,p.	1-30 Hz	0.25"	40	YES
U. ASTON.(20)	1	Effects of Vibration on short term memory.	pf.	0-100 Hz Random	± 3"	12	YES
	2	Validation of vibrator to simulate passenger car vibration.	pf.	0-100 Hz Random	± 3"	12	YES
U. BIRMINGHAM.(21)	1	Impedance of seated human.	b.	2-20 Hz	0-0.15g	3 + Dummy	NO(student thesis)
	2	Development of mechanical dummy.	b.	0-20 Hz	0-0.15g	1 (Dummy)	NO(student thesis)

Key to Criteria; b = biodynamics; ph = physiological reaction; pf = performance; ss = subjective sensation; p = perception threshold.

3b) RELEVANT LABORATORY EXPERIMENTS CONDUCTED SINCE 1st JANUARY, 1970

		EXPERIMENTAL AIMS	CRITERIA (SEE BELOW)	FREQUENCY RANGE	AMPLITUDE RANGE	NUMBER OF SUBJECTS	PUBLISHED YES/NO
BOURNEMOUTH C. OF TECH. (7)		Preliminary trial only (object vibration).	ph.	4Hz & 10Hz	0.1	8	NO
C. LONDON POLY.(8)	1	To investigate the force mechanism that causes crack propogation in the neural arch.	b.	DC - 2 Hz	± 5 mm.	3 fresh cadaveric specimans of the spine from L4 to the sacrum.	NO
I.A.M. FARNBOROUGH (12)	1	Comparison of VO_2 with & without resraint	ph.	2-10 Hz		10	Thesis
	2	Comparison of tracking task with & without lens system.	pf.	2-10 Hz		10	In process
	3	Studies on vision under oscillation in Yaw.	ph, pf.				YES
R.A.E. FARNBOROUGH (16) (continued)	1	Tracking under dual axis vibrations.	pf.	2,5,7,Hz Heave & Sway	±0.2g Heave ±0.1g Sway	18	YES
	2	Subjective Assessment of rubber & bead cushions (single axis).	ss.	2,4,8 & 20Hz Heave or Sway	Up to ±1.0g	9	YES

Key to Criteria; b = biodynamics; ph = physiological reaction; pf = performance; ss = subjective sensation; p = perception threshold.

3b) RELEVANT LABORATORY EXPERIMENTS CONDUCTED SINCE 1st JANUARY, 1970 (continued)

		EXPERIMENTAL AIMS	CRITERIA (SEE BELOW)	FREQUENCY RANGE	AMPLITUDE RANGE	NUMBER OF SUBJECTS	PUBLISHED YES/NO
R.A.E. FARNBOROUGH. (16) (continued)	3	Weapons Aiming with binocular sight.	pf, ss.	0.3-4 Hz	± 0.2 g heave. ± 0.1 g Sway, Roll and Pitch.	9	YES
	4	Validation of ISO limits	ss.	1Hz-12Hz	±0.2g to ±1.2g	20	NO
	5	Measurement of non linearity of a body.	b.	1Hz-10Hz	±0.1g to ± .2g	4	NO
	6	Transmission of harmonically distorted low frequency vibration to the head of a seated man.	b.	1Hz-10Hz	0.4g	7	YES
U. ASTON (20) (continued)	1	To map effects of vibration on to task difficulty in an adaptive manual control task.	pf, effort, ph.	Random 0-50 Hz	± 3"	8	NO

Key to Criteria: b = biodynamics; ph = physiological reaction; pf = performance; ss = subjective sensation; p = perception threshold.

3b) RELEVANT LABORATORY EXPERIMENTS CONDUCTED SINCE 1st JANUARY, 1970 (Continued)

		EXPERIMENTAL AIMS	CRITERIA (SEE BELOW)	FREQUENCY RANGE	AMPLITUDE RANGE	NUMBER OF SUBJECTS	PUBLISHED YES/NO
U. ASTON.(20) (continued)	2	Study of vibration isolation strategies used during manual control.	b.	Random 0-50 Hz	$\pm$ 3"	8	NO
	3	Effect of vibration on development of manual control policies.	Learning	Random 0-50 Hz	$\pm$3"	2	NO
U. BIRMINGHAM.(21) (continued)	1	Equal sensation contours	ss.	0-40 Hz	0-0.2g	27 pt.1 7 pt.2	YES
	2	Effect of vibration on tracking task.	pf.	0-20 Hz Random	0-0.2g r.m.s approx.	10+	YES
	3	Effect of vibration on vigilance task.	pf.	0-30 Hz Random	0-0.3g r.m.s approx.	16	YES
	4	Comparison of Sine and Random Vibration.	ss.	Sine -6Hz only.Random 0-30Hz	0.05-0.2g r.m.s.	6	YES
	5	Effect of vibration on vigilance task.	pf.	0-30 Hz Random	0.25g r.m.s.	10	YES(to be published)

Key to Criteria: b = biodynamics; ph = physiological reaction; pf = performance; ss = subjective sensation; p = perception threshold.

3b) RELEVANT LABORATORY EXPERIMENTS CONDUCTED SINCE 1st JANUARY 1970 (continued)

		EXPERIMENTAL AIMS	CRITERIA (SEE BELOW)	FREQUENCY RANGE	AMPLITUDE RANGE	NUMBER OF SUBJECTS	PUBLISHED YES/NO
U. BIRMINGHAM (21) (continued)	6	Comparison of seat and feet vibration.	ss.	0-30 Hz	0-0.2g r.m.s	5	YES(to be published)
U. LOUGHBOROUGH (23) (continued)	1	Noise and vibration interactions.	p/ss.	25 Hz	0.37g r.m.s.	4	NO
	2	Anti-Vibration seating.	b.	1-40 Hz			NO
	3	Noise and vibration interactions.	pf/ss.	Random 3Hz 12 dB octave Roll off			YES
	4	Mechanical impedance.	b.	1-20 Hz	?	20	NO
	5	Self induced vibration.	b/ss.	1-6 Hz			NO
	6	Fixation of accelerometers	b.	1-50 Hz			NO
	7	Long duration exposure to vibration.	pf/ph.	Random0.3Hz 6dB/octave Roll off	2 hr FDP	12	No

Key to Criteria: b = biodynamics; ph = physiological reaction; pf = performance; ss = subjective sensation; p = perception threshold.

3b) RELEVANT LABORATORY EXPERIMENTS CONDUCTED SINCE 1st JANUARY 1970 (continued)

		EXPERIMENTAL AIMS	CRITERIA (SEE BELOW)	FREQUENCY RANGE	AMPLITUDE RANGE	NUMBER OF SUBJECTS	PUBLISHED YES/NO
U. LOUGHBOROUGH(23) (continued)	8	Effects of vibration on cognitive task performance	pf.	Random 0.3Hz 6dB/octave Roll off.	2 Hr FDP		NO
	9	Effects of vibration on reaction time and reading ability.	pf.	32Hz		20	NO
U. SHEFFIELD (24)	1	To find measurable physiological effects at FDP level.	b,ph.	2-30 Hz random(white noise velocity)	Effectively 0.1 g r.m.s.	20	NO
	2	Reaction time and vigilance used to assess effects of vibration.	pf.	(as above)	(as above)	20	Conference paper.
	3	Information processing and decision making task under vibration.	pf.	(as above)	(as above)	18	Conference paper.
	4	To assess effects of vibration on continuous attention task - 'tunnel vision phenomena'.	pf.	(as above)	(as above)	12	NO

Key to Criteria: b = biodynamics; ph = physiological reaction; pf = performance; ss = subjective sensation; p = perception threshold.

3b) RELEVANT LABORATORY EXPERIMENTS CONDUCTED SINCE 1st JANUARY, 1970 (continued)

		EXPERIMENTAL AIMS	CRITERIA (SEE BELOW)	FREQUENCY RANGE	AMPLITUDE RANGE	NUMBER OF SUBJECTS	PUBLISHED YES/NO
U. SOUTHAMPTON (25) (continued)	1	Effect of vibration frequency on reading performance (object vibration).	pf.	5-30 Hz	±0.05"	8	YES
	2	Effect of vibration level on reading performance (object vibration)	pf.	16 Hz	±0.025" to ±0.15"	8	YES
	3	Effect of single and dual frequency object vibration on reading performance.	pf	a)2-20Hz b)11+(3,4,5, 6,15 or 20Hz) c)(3+11) or (20+11) Hz	0-0.1"	a) 12 b) 12 c) 12	YES
	4	Determine threshold of perception of vertical whole body vibration (+ subsidiary experiments)	p	1.5-100 Hz	0.03g rms	48 (M&F)	YES
	5	Study of the startle effects of short duration vibration.	ph,ss.	20 Hz	± 1g and ± 0.1g	12	YES

Key to Criteria: b = biodynamics; ph = physiological reaction; pf = performance; ss = subjective sensation; p = perception threshold.

3b) RELEVANT LABORATORY EXPERIMENTS CONDUCTED SINCE 1st JANUARY, 1970 (continued)

		EXPERIMENTAL AIMS	CRITERIA (SEE BELOW)	FREQUENCY RANGE	AMPLITUDE RANGE	NUMBER OF SUBJECTS	PUBLISHED YES/NO
U. SOUTHAMPTON (25) (continued)	6	4 experiments to study factors affecting the results obtained by category selection and category production scaling methods.	ss.	4 & 8 Hz	0.03g rms	20,10,10,10	YES
	7	Studies of the reliablity of matching vibration stimuli against six different standards.	ss.	2.5-40 Hz (& random)	0.3 grms	12	NO
	8	To relate head vibration to visual acuity decrements and to relate vertical seat vibration to head motion.	b,pf.	7-75 Hz	up to 1 g	12	YES
	9	To investigate the effect of viewing distance on acuity decrements due to whole body vibration.	pf,b.	7,15,30,& 60 Hz	up to 1 g	6	YES

Key to Criteria: b = biodynamics; ph = physiological reaction; pf = performace; ss = subjective sensation; p = perception threshold.

3b) RELEVANT L/BORATORY EXPERIMENTS CONDUCTED SINCE 1st JANUARY, 1970 (continued)

		EXPERIMENTAL AIMS	CRITERIA (SEE BELOW)	FREQUENCY RANGE	AMPLITUDE RANGE	NUMBER OF SUBJECTS	PUBLISHED YES/NO
U.SWANSEA (26)	1	Determining exponents for finger vibration.	ss.	20-100 Hz	4 g	20	In progress
	2	Threshold for finger	p.	(as above)		20	In progress
	3	Equal sensation for finger	ss.	(as above)	4 g	10	In progress
	4	Exponants whole body standing.	ss.	3-100 Hz	0.3g @ 3 0.8g @100	50	In progress
	5	Equal sensation whole body standing.	ss.	5-50 Hz	0.5g @ 5 0.8g @ 50	18	In progress

Key to Criteria: b = biodynamics; ph = physiological reaction; pf = performance; ss = subjective sensation; p = perception threshold.

4a) RELEVANT FIELD EXPERIMENTS CONDUCTED PRIOR TO 1st JANUARY, 1970

		VEHICLE	EXPERIMENTAL AIMS	CRITERIA SEE BELOW	NUMBER OF SUBJECTS	VIBRATION ANALYSIS (TYPE, FREQ.RANGE)	NATURE OF SUBJECTIVE RESPONSE	PUBLISHED YES/NO
ACCIDENT AND AMBULANCE RESEARCH (1)	1	Ambulances	Assessment of patient response to vehicle ride and of performance of life support tasks.	ph, pf, and ss.	approx 15	0-60 Hz PSD $(SD)^2$ peak & r.m.s. values.	comfort and pain	YES
	2	Research ambulance			approx 15			
	3	Car			0			
N.I.A.E.SILSOE (14)		Tractors	Work is orientated towards the design of seats, measuring vibration on tractors NOT relating the vibration to human response.					
R.A.E. FARNBOROUGH(16) (continued)	1	SRN5	3 axis at floor	ss.	1	Eyeball	1-6 rating scale.	YES
	2	Electric train	(as above)	ss.	1	Eyeball	(as above)	YES
	3	Morris 1300	(as above)	ss.	1	Eyeball	(as above)	YES

Key to Criteria: b = biodynamics; ph = physiological reaction; pf = performance; ss = subjective sensation; p = perception threshold.

4a) RELEVANT FIELD EXPERIMENTS CONDUCTED PRIOR TO 1st JANUARY 1970 (continued)

		VEHICLE	EXPERIMENTAL AIMS	CRITERIA SEE BELOW	NUMBER OF SUBJECTS	VIBRATION ANALYSIS (TYPE, FREQ.RANGE)	NATURE OF SUBJECTIVE RESPONSE	PUBLISHED YES/NO
R.A.E. FARNBOROUGH(16) (continued)	4	Hillman Minx	3 axis at floor	ss.	1	Eyeball	1-6 rating scale	YES
	5	HM 2	(as above)	ss.	1	Eyeball	(as above)	YES
T.R.R.L. CROWTHORNE (18)	1		Tolerance to bridge vibration	ss.		Levels, frequency	People walking or standing on bridges	NO
WESTLANDS HELICOPTERS (19)	1	All Westland production helicopters	Vibration clearance			Manual analysis		NO
U.SWANSEA (26)	1	Southampton Hovercraft	Develop techniques of questionaire.	ss.	500	None	Vibration rating (various methods)	In progress

Key to Criteria: b = biodynamics; ph = physiological reaction; pf = performance; ss = subjective sensation; p = perception threshold.

4b) RELEVANT FIELD EXPERIMENTS CONDUCTED SINCE 1st JANUARY 1970

		VEHICLE	EXPERIMENTAL AIMS	CRITERIA SEE BELOW	NUMBER OF SUBJECTS	VIBRATION ANALYSIS (TYPE, FREQ.RANGE)	NATURE OF SUBJECTIVE RESPONSE	PUBLISHED YES/NO
ACCIDENT AND AMBULANCE RESEARCH (1)	1	Ambulances and cars	Assessment of human response (performance on life support task and patient response)	ph, pf, ss.	approx. 15	PSD 0-60 Hz	Comfort and pain	YES (commenced before 1970)
BRITISH LEYLAND (3)	1	Bus	Improved ride comfort.	pf		$\frac{1}{3}$ octave 2-50 Hz		NO
	2	Truck	Ride assessment	pf.		$\frac{1}{3}$ octave 2-50 Hz		NO
BRITISH RAIL DERBY (4)	1	Railway coach	To obtain design criteria.	pf.	12	PSD 0-50 Hz	Writing task	Internal only
BRITISH RAIL LONDON (5) (continued)	1	SR.N4 Hovercraft.	To compare transmissibilities of a net seat with conventional aircraft type (passenger)	b.	1	Counting No. of times triaxial acceleration exceeded certain values over 30 sec. time period	None	NO

Key to Criteria; b = biodynamics; ph = physiological reaction; pf = performance; ss = subjective sensation; p = perception threshold.

4b) RELEVANT FIELD EXPERIMENTS CONDUCTED SINCE 1st JANUARY, 1970 (continued)

		VEHICLE	EXPERIMENTAL AIMS	CRITERIA SEE BELOW	NUMBER OF SUBJECTS	VIBRATION ANALYSIS (TYPE, FREQ.RANGE)	NATURE OF SUBJECTIVE RESPONSE	PUBLISHED YES/NO
BRITISH RAIL LONDON (5) (continued)	1	SR.N4 Hovercraft	To compare transmissibilities of conventional crew seat cushion with suspension seat.	b.	2	F.F.T. giving P.S.D's transmissibilities calculated from P.S.D's.	None - only impressions	NO
I.A.M. FARNBOROUGH (12)	1	Hunter	Vibration profile of low level flight.	b.	1	Frequency analysis not yet done.	None	No
R.A.E. FARNBOROUGH (16)	1	SR.N4	3 axis at floor and pilots seat.	ss.	12	Eyeball	1-6 rating scale.	Commercial in confidence.
	2	Beverley, hydrofoil, launch, single and D. decker buses.	3 axis at floor.	ss.	1	Eyeball	1-6 rating scale.	YES
T.R.R.L. CROWTHORNE (18)	1		Tolerance to bridge vibrations	ss.		Levels, frequency.	People walking or standing on bridges.	NO

Key to Criteria: b = bidynamics; ph = physiological reaction, pf = performance; ss = subjective sensation; p = perception threshold.

4b) RELEVANT FIELD EXPERIMENTS CONDUCTED SINCE 1st JANUARY, 1970 (continued)

		VEHICLE	EXPERIMENTAL AIMS	CRITERIA SEE BELOW	NUMBER OF SUBJECTS	VIBRATION ANALYSIS (TYPE, FREQ.RANGE)	NATURE OF SUBJECTIVE RESPONSE	PUBLISHED YES/NO
U. SOUTHAMPTON (25) (continued)	1	8 Scout helicopters	Determine mean and range of floor vibration spectra(triaxial) in different flight conditions	ss.	1	Power Spectral Density 1-100 Hz	Ranking of flight conditions and aircraft.	YES
	2	1 Scout helicopter	As above BUT head vibration	ss.	8	As above	Ranking of flight conditions.	YES
	3	1 Scout helicopter	Determine ratio of vertical head to vertical seat vibration over 1-100Hz spectra.	b.	8	As above		YES
	4	Scout and Sioux helicopters	a) Eye movement b) reaction time c) Visual acuity performance during helicopter flight.	pf.	6 to 12 in each of trials a, b, & c.	Nil		YES

Key to Criteria; b = biodynamics; ph = physiological reaction; pf = performance; ss = subjective sensation; p = perception threshold.

4b) RELEVANT FIELD EXPERIMENTS CONDUCTED SINCE 1st JANUARY, 1970 (continued)

		VEHICLE	EXPERIMENTAL AIMS	CRITERIA SEE BELOW	NUMBER OF SUBJECTS	VIBRATION ANALYSIS (TYPE, FREQ.RANGE)	NATURE OF SUBJECTIVE RESPONSE	PUBLISHED YES/NO
U. SOUTHAMPTON (25) (continued)	5	Scout and Sioux helicopters	The measurement of pilot visual acuity during helicopter flight	pf.	9	Nil		YES
U. SWANSEA (26)	1	Seaspeed Cross channel	Develop techniques of questionaire design and analysis.	ss.	500	None	Vibration ratings (various methods)	In progress
	2	BEA helicopter			500			
	3	Seaspeed Cross channel			1200			
	4	B.R. Western			1600	In progress		

Key to Criteria: b = biodynamics; ph = physiological reaction; pf = performance; ss = subjective sensation; p = perception threshold.

5a) PUBLICATIONS PUBLISHED/PRESENTED BETWEEN 1.1.65 AND 1.1.70 (EXCLUDING REVIEW PAPERS)

	AUTHOR(S)	DATE	TITLE	REFERENCE
HAWKER SIDDELY. (11)	Woods, A.G.	1967	Human response to low frequency sinusoidal and random vibration.	Aircraft Engineering 39(6)
N.I.A.E. SILSOE. (14)	Matthew, J. Talamo, J.D.C.	1965	Ride comfort for tractor operators: III Investigation of tractor dynamics by analogue computer simulation.	J.Agric. Engng. Res.10(2) 93
	Matthews, J.	1966	Ride comfort for tractor operators: IV Assessment of the ride quality of seats.	J.Agric. Engng. Res.11(1) 44
	Matthews, J.	1967	An analogue computer investigation of the potential improvement in tractor ride afforeed by a flexible front axle.	J.Agric. Engng. Res.12(1)48
	Matthews, J.	1968	Some measurements of vibration encountered by operators on agriculture machinery.	Note 27, NIAE Silsoe (UNPUB)
R.A.E. FARNBOROUGH. (16) (continued)	Harwood, K.G. Lovesey, E.J.	1966	An attempt to assess the effects of helmet weight on navigator's efficiency in a simulated terrain-following sortie.	RAE Tech.Memo ME 361
	Harwood, K.G. Lovesey, E.J.	1966	Preliminary tests on the effects of low frequency whole-body vibration on aircrew performance.	RAE Tech. Memo ME 363
	Lovesey, E.J.	1969	A further investigation into the effects of multi-axis vibration on a simulated SST directed take-off and climb.	RAE TR 69103

5a) PUBLICATIONS PUBLISHED/PRESENTED BETWEEN 1.1.65 AND 1.1.70 (EXCLUDING REVIEW PAPERS) (continued)

	AUTHOR(S)	DATE	TITLE	REFERENCE
R.A.E. FARNBOROUGH. (16) (continued)	Harwood, K.G. Lovesey, E.J. Rowlands, G.F. Allen, G.R.	1968	The effect of low frequency vibration on pilot performance in a simulated supersonic transport aircraft take-off and flight.	RAE Tech Memo EP 392(UNPUB)
	Lovesey, E.J.	1968	The influence of a restraining harness upon human comfort and tracking performance under single and multi-axis heave and sway vibration.	RAE Tech Memo EP 397(UNPUB)
	Harwood, K.G. Lovesey, E.J. Rowlands, G.F.	1968	A comparison of the effects of vertical and lateral vibration on a simulated SST take off and climb when using three types of take off director.	RAE Tech Memo EP 409(UNPUB)
	Maslen, K.R.	1969	Tests on prototype miniature transducers for the measurement of body stress.	RAE Tech Memo EP 422(UNPUB)
	Rowlands, G.F.	1969	Some proposed tests to measure the effect of whole body vibration on the ability to see an aircraft flight director instrument.	RAE Tech Memo EP 426(UNPUB)
	Rowlands, G.F. Allen, G.R.	1969	The rotational eye movement needed to correct for vibration of the head,	RAE Tech Memo EP 427(UNPUB)
T.R.R.L. CROWTHORNE. (18)	Leonard, D.R.	1966	Human tolerance levels for bridge vibrations.	RRL Rpt. No.34

5a) PUBLICATIONS PUBLISHED/PRESENTED BETWEEN 1.1.65 AND 1.1.70 (EXCLUDING REVIEW PAPERS) (continued)

	AUTHOR(S)	DATE	TITLE	REFERENCE
U.ASTON.(20)	Whitehead,G.D.	1967	Human factor problems in the design of vibration isolation systems.	Rpt.No.20 Applied Psych. Dept.U.Aston
U. EDINGBURGH. (22)	Walsh,E.G.	1966	Head movements during rail travel.	Biomech. Engng. 1 402-407(1966)
	Walsh,E.G.	1968	Oscillations of the head, trunk and limbs induced by mechanical means.	J.Physiol. 198 69-72
	Walsh,E.G.	1969	Interference with the tremor of Parkinsonism by application of a rythmic force.	J.Physiol. 202 109-110
U.SOUTHAMPTON (25)	Guignard,J.C. Guignard,E.	1970	Human response to vibration a critical survey of published work.	ISVR.Memo No. 373

5b) PUBLICATIONS PUBLISHED/PRESENTED SINCE 1.1.70 (EXCLUDING REVIEW PAPERS)

	AUTHOR(S)	DATE	TITLE	REFERENCE
ACCIDENT AND AMBULANCE RESEARCH (1)	Snook, R.	1972	The accident flying squad.	Brit. Med. J.
	Snook, R.	1972	Medical aspects of ambulance design.	Brit. Med. J.
I.A.M. FARNBOROUGH (12)	Benson, A.J.	1970	Interaction between semicircular canals and graviceptors.	Recent Advances in Aerospace Med. 249-261
	Benson, A.J.	1971	Compensatory eyemovements produced by angular oscillation	Pro. Int. Union Physiol Sci. 25th Int Cong. Munich.
	Benson, A.J.	1972	Effects of angular oscillation in Yaw on vision	Proc. Aerospace Med. Assoc. 1972 43-44.
N.I.A.E. SILSOE (14)	Hilton, D.J.	1970	A frequency-weighted ride-meter.	J. Agric. Engng. Res. 15(4)379
R.A.E. FARNBOROUGH. (16) (continued)	Lovesey, E.J. Baines, D.C.	1970	Trials on a Mountbatten class hovercraft (SRN4 - 4) crew and passenger environment.	RAE TR 70233
	Lovesey, E.J.	1971	An investigation into the effects of dual axis vibration, restraining harness, visual feedback and control force on manual positioning task.	RAE TR 71213

5b) PUBLICATIONS PUBLISHED/PRESENTED SINCE 1.1.70 (EXCLUDING REVIEW PAPERS) (continued)

	AUTHOR(S)	DATE	TITLE	REFERENCE
R.A.E. FARNBOROUGH (16) (continued)	Lovesey, E.J.		Some effects of multi-axis vibration upon weapon aiming through a binocular sight.	RAE TR 71243
	Rowlands, G.F.	1972	The transmission of harmonically distorted low frequency vibration to the head of seated man.	RAE TR 72080
	Lovesey, E.J.	1971	3 axis vibration measurements in public service and other vehicles.	RAE Tech Memo EP 467(UNPUB)
	Lovesey, E.J.	1971	The alleviation of the effects of vibration on man by bead and sponge cushions.	RAE Tech Memo EP 479(UNPUB)
	Lovesey, E.J.	1971	Some effects of dual axis heave and sway vibration upon compensating tracking.	RAE Tech Memo EP 484(UNPUB)
	Trumper, M.G.	1971	A flight test programme to study the effects of environmental stresses on aircrew operating military strike aircraft.	RAE Tech Memo EP 499(UNPUB)
	Maslen, K.R.	1972	Efficiency under prolonged vibration and ISO "Guide"	RAE Tech Memo EP 512(UNPUB)
	Rowlands, G.F. Baines, D.C.	1972	A new method for the dynamics calibration of accelerometers for acceleration below $\pm$ 1 g.	RAE Tech Memo EP 515(UNPUB)
WESTLAND HELICOPTERS LTD. (19)	Jackson, C.E.P. Grimster, W.F.	1972	Human aspects of vibration and noise in helicopters.	J. of Sound & Vibration 20(3) 343-351, 1972

5b) PUBLICATIONS PUBLISHED/PRESENTED SINCE 1.1.70 (EXCLUDING REVIEW PAPERS) (continued)

	AUTHOR(S)	DATE	TITLE	REFERENCE
U. BIRMINGHAM (21)	Ashley, C.	1970	Equal annoyance contours for the effect of sinusoidal vibration on man.	Loughborough conf. 1970
	Ashley, C. Eames--Jones, A.	1971	A comparison between sinusoidal and random vibration.	Swansea conf. 1971
	Whitehead, G.D.	1970	Vibration manual control and adaptive tasks.	Loughborough conf. 1970
U. LOUGHBOROUGH (23)	Lawes, C.E.	1970	Vibrator safety.	Loughborough conf. 1970
	Lawes, C.E.	1970	A new approach to mechanical impedance.	(as above)
U. SHEFFIELD (24)	Simpson, A.J. Bulger, P.M.J.	1971	Effects of up to $2\frac{1}{2}$ hours exposure to random vibration	Swansea conf. 1971
	Watts, N.H. Betts, R.P.	1971	A pilot study of objective methods of measuring human response to vibration	(as above)
U. SOUTHAMPTON (25) (continued)	O'Hanlon, J.G. Griffin, M.J.	1971	Some effects of the vibration of reading material upon visual performance.	ISVR Tech Rpt. 49
	Griffin, M.J.	1971	Pilot visual acuity during helicopter flight.	ISVR Tech Rpt. 44

5b) PUBLICATIONS PUBLISHED/PRESENTED SINCE 1.1.70 (EXCLUDING REVIEW PAPERS) (continued)

	AUTHOR(S)	DATE	TITLE	REFERENCE
U. SOUTHAMPTCN (25)	McKay.J.R.	1971	Human perception of whole body vibration.	ISVR Memo 435
	McKay,J.R.	1972	A study of the startle effect of short duration vibration	ISVR Memo 460
	Griffin,M.J.	1972	The transmission of triaxial vibration to pilots in the Scout AH Mk 1 helicopter.	ISVR Tech Rept. 58.

5c) <u>REVIEW (AND OTHER) PAPERS PUBLISHED SINCE 1st JANUARY, 1970</u>

	AUTHOR(S)	DATE	TITLE	REFERENCE
HAWKER SIDDELY (11)	Woods, A.G.	1972	Design for acceptable aircraft vibration.	J. of Sound & Vibration 20 (3) 353-358.
T.R.R.L. CROWTHORNE. (18)	Whiffin, A.C. Leonard, D.R.	1971	A survey of traffic induced vibration	RRL. Rpt. No. 418
N.I.A.E. SILSOE (14)	Hilton, D.J.	1970	Design considerations relating to tractor cabin suspensions.	I.Mech E.Symp. London 1970
	Hilton, D.J. Stayner, R.M.	1972	Vibration isolation on agriculturel tractors.	Vib.isolation Symp; Soc.Env. Engrs.London.
	Stayner, R.M.	1972	Aspects of the development of a test code for tractor suspension seats.	J.of Sound & Vibration 20 (2) 247.
	Stayner, R.M. Bean, A.G.M.	1970 /71	Review of measurements of tractor suspension seats	N.I.A.E. DN/ 214/1445(UNPUB)

5c) REVIEWS(AND OTHER) PAPERS PUBLISHED SINCE 1st JANUARY, 1970 (continued)

	AUTHOR(S)	DATE	TITLE	REFERENCE
R.A.E. FARNBOROUGH (16)	Lovesey, E.J.	1970	The multi axis vibration environment and man.	Appl. Ergonomics
	Allen, G.R.	1971	Problems of transport organisations on vibration and ride comfort.	RAE Tech Memo EP 475(UNPUB)
	Allen, G.R.	1971	Techniques for body vibration experiments.	RAE Tech Memo EP 476(UNPUB)
	Allen, G.R.	1971	Human reaction to vibration.	J. of Environ. Sciences. 14(5)
U.BIRMINGHAM. (21)	Ashley, C.	1971	International recommendations on vibration exposure and man.	Swansea conf. 1971
U.LOUGHBOROUGH. (23)	Sandover, J.	1970	Interactions between noise and vibration.	Loughborough conf. 1970
	Floyd, W.F. Sandover, J.	1972	Problems associated with the application of the results of vibration in research to practical situations.	S.E.E.Symp. 1972
U.SOUTHAMPTON. (25)	Hawkins, N.M. Griffin, M.J.	1972	Helicopter pilot opinion questionaire.	ISVR.Memo 458
	Hawkins, N.M. Griffin, M.J.	1972	The U.K. Informal Group on the Human Response to Vibration(Meeting Southampton 1971 - Proceedings)	ISVR.Memo 414

5d) THESES PUBLISHED SINCE 1st JANUARY, 1965

	AUTHOR(S)	DATE	TITLE	REFERENCE
ACCIDENT AND AMBULANCE RESEARCH (1)	Snook, D.R.	1972	Accident and ambulance research	M.D. Thesis U.Bristol.
I.A.M. FARNBOROUGH (12)	Sharp, G.R.	1972	The respiratory effects of whole body vibration in man	M.D. Thesis U.Glasgow.
R.A.E. FARNBOROUGH (16)	Lovesey, E.J.	1971	An investigation into the effects of dual axis vibration on man.	Ph.D. Thesis U.Southampton.
U. ASTON (20)	Whitehead, G.D.	1972	A study of waveforms in ergonomics and neuropsychology research.	Ph.D. Thesis U.Aston.
U.BIRMINGHAM (21)	Oluyumi, M.A.	1968	The complex impedance characteristics of the seated human body.	B.Sc. Thesis U.Birmingham.
	Neville, M.A.	1968	Development of a biomechanical model of man	B.Sc. Thesis U. Birmingham.
	Hughes, J.	1971	A preliminary investigation into some aspects of human sensitivity to the combined effects of noise and vibration	B.Sc. Thesis U. Aston

5d) THESES PUBLISHED SINCE 1st JANUARY, 1965 (continued)

	AUTHOR(S)	DATE	TITLE	REFERENCE
U. LOUGHBOROUGH (23)	Innocent, P.R.	1971	An investigation into the effects of the combined environmental stresses of noise and vibration.	M.Sc. Thesis U.Loughborough
	Wills, T.M.	1970	An investigation into the effects of whole-body vibration on simple reaction time and tracking ability.	M.Sc. Thesis U. Loughborough
U. SOUTHAMPTON (25)	O'Hanlon, J.G.	1970	A study of the changes in visual performance when viewing an object vibrating at 5-30 Hz.	M.Sc Thesis U. Southampton
	Alexander, C.	1971	Performance changes due to the single and dual frequency vibration of reading material.	M.Sc. Thesis U. Southampton
	McKay, J.R.	1972	Human response to vibration: Some studies of perception and startle.	Ph.D. Thesis U. Southampton
	Fothergill, L.C.	1972	A study of the subjective response to whole-body vibration.	M.Sc.Thesis U.Southampton.

6) RESEARCH WORKERS EMPLOYED ON BODY VIBRATION DURING YEAR COMMENCING OCTOBER 1971

	APPROXIMATE RESEARCH EFFORT DURING YEAR COMMENCING OCTOBER 1971 (MAN YEARS)	NUMBER OF PERSONS ENGAGED ON RESEARCH
ACCIDENT AND AMBULANCE RESEARCH (1)	Not stated	one
BRITISH LEYLAND (3)	Less than $\frac{1}{2}$	Not stated
BRITISH RAIL, LONDON (4)	Half	Not stated
BRITISH RAIL, DERBY (5)	Less than $\frac{1}{2}$	one
CENTRAL LONDON POLY. (8)	Less than $1\frac{1}{2}$	four
I.A.M. FARNBOROUGH (12)	Not stated	five
N.I.A.E. SILSOE (14)	Less than $\frac{1}{2}$	one
N.I.M.R. LONDON (15)	Not stated	one
R.A.E. FARNBOROUGH (16)	four	five

6) RESEARCH WORKERS EMPLOYED ON BODY VIBRATION DURING YEAR COMMENCING OCTOBER 1971 (continued)

	APPROXIMATE RESEARCH EFFORT DURING YEAR COMMENCING OCTOBER 1971 (MAN YEARS)	NUMBER OF PERSONS ENGAGED ON RESEARCH
R.M.C.S. SHRIVENHAM (17)	one	two
T.R.R.L. CROWTHORNE (18)	Not stated	five
WESTLAND HELICOPTERS (19)	Half	three
U. BIRMINGHAM (21)	one	six
U. LOUGHBOROUGH (23)	one and a half	six
U. SHEFFIELD (24)	one and a half	two
U. SOUTHAMPTON (25)	three and a half	seven

7) OTHI ι RELEVANT RESEARCH

ACCIDENT AND AMBULANCE RESEARCH(1)	Reduction of vehicle deceleration by traffic light contol and vehicle identification for emergency vehicles.
BOURNEMOUTH C. OF TECH. (7)	The effect of vibrating ta gets material on the visual acuity of stationary subjects.
N.I.A.E. SILSOE (14)	a) Suspension of tractor cabs (Dr. D.J.Hilton) b) Survey of tractor ride vibrations.
R.A.E. FARNBOROUGH (16)	Theoretical and practical analysis of body response to transient loads.(In conjunction with U. Loughborough). Evaluation of a prototype miniature body stress transducer.
T.R.R.L. CROWTHORNE.. (18)	Commercial vehicle dynamic properties.
WESTLAND HELICOPTERS (19)	Proposed work to monitor the in flight pilot body vibration has been agreed by R.A.E. Mutial work has consisted of the preparation of the monitoring system and the formulation of a questionnaire for later correlation with analysed vibration levels.
U.BIRMINGHAM (21)	Vibration characteristics of complete vehicles.
U.LOUGHBOROUGH (23)	Effects of impact on people. Effects of other environmental stresses on performance, comfort, physiology etc.
U.SOUTI MPTON (25)	Studies of driver 'fatigue' and helicopter pilot performance.

8a) WORK TO BE CONTINUED DURING YEAR BEGINNING OCTOBER 1972

ACCIDENT AND AMBULANCE RESEARCH(1)		Continuing assessment of patient response to ambulance environment.
BRITISH LEYLAND (3)		Establish satisfactory ride comfort criteria for use by B.L. Truck & Bus Div. (possibly in conjuction with an academic establishment).
BRITISH RAIL (4)		Continuation of work to obtain design criteria for railway coaches.
BOURNEMOUTH C. OF TECH. (7)		Two-axis vibration of target material.
CENTRAL LONDON POLY. (8)		Work associated with crack propogation in the neural arch.
I.A.M. FARNBOROUGH (12)		Refurbishing of Electrohydraulic rig.
N.I.A.E. SILSOE (14)	1	Suspension of tractor cabs.
	2	Survey of tractor ride vibration.
R.A.E. FARNBOROUGH (16)	1	Improvement of vibrator performance.
	2	Measurement of sinusoidal body impedence.
	3	Investigation of limits for ultra low frequency (below 1 Hz).
	4	Dial reading under dual axis vibration
	5	In vehicle 3 axis measurements at seat of pants.

8a) WORK TO BE CONTINUED DURING YEAR BEGINNING OCTOBER 1972 (continued)

WESTLAND HELICOPTERS (19)		Monitoring of in flight pilot body vibration in helicopters
U.BIRMINGHAM (21)	1	Equivalent sensation contours.
	2	Relationship between sine and random.
U.LOUGHBOROUGH (23)	1	Body dynamics.
	2	Combined effects of noise and vibration.
	3	Physiological effects of vibration.
	4	Effects of long duration exposure.
U.SHEFFIELD (24)		Detailed investigation into the way vibration acts as a 'stressor' on human attention performance.
U. SOUTHAMPTON (25)	1	Studies of the effect of vibration on extended visual search.
	2	Investigation of the sources of variance associated with the techniques employed in the determination of subjective reaction to vibration.
	3	Maintenance, and updating and dissemmination of information from the Human Response to Vibration Literature Collection.
	4	Continuation of other studies dependent on contract extensions.

8b) WORK TO BE COMMENCED DURING YEAR BEGINNING OCTOBER 1972

ACCIDENT AND AMBULANCE RESEARCH(1)		Assessment of patient state by Data transmission from ambulance to hospital.
BRITISH RAIL, LONDON (5)		Transmissibility characteristics of inert-filled bead cushion in crew seat of SR.N4 Hovercraft.
I.A.M. FARNBOROUGH (12)		Cardiovascular effects of vibration.
	2	Head movements produced by vertical vibration.
M.V.E.E. CHERTSEY (13)	1	Field experiments of tracked vehicles on cross-country.
	2	M.V.E.E. are sponsoring R.M.C.S. Shrivenham to do work on measuring effect of vibration on human performance.
N.I.A.E. SILSOE (14)		Lab. vibrator study of responses to vibrations of type encountered on tractors (if present plans approved in detail).
N.I.M.R. LONDON (15)	1	Validation of planned characteristics of ship motion facilities.
	2	Development of methods of photographic and other assessment of human response to ship motion.
	3	Determination, for range of human subjects, of roll/pitch motion which is sub-threshold for motion sickness.
	4	Preliminary experiments on postural response to roll/pitch motion for seated subject

8b) WORK TO BE COMMENCED DURING YEAR BEGINNING OCTOBER 1972 (continued)

R.A.E. FARNBOROUGH (16)	1	Vibration transmissibility of a range of aircraft and other transport seats.
	2	Factors affecting body transmissibility including non-linearities.
	3	Measurement of time effects of vibration.
	4	Development of techniques to measure vibration input.
	5	Development of adaptive technique to give constant error by automatic adjustment of vibration level.
R.M.C.S. SHRIVINHAM (17)	1	Performance of military personnel in simulated cross country vibration conditions for durations of up to one hour.
	2	Assessment of suspension design using the results of 1 above.
WESTLANDS HELICOPTERS (19)		Further helicopter pilot body vibration monitoring and possible examination of required laboratory work.
U.BIRMINGHAM (21)		Effects of combined environments (noise and vibration) upon performance of a complex task (tracking and vigilence).
U.SHEFFIELD (24)		Investigation into the interaction between noise and vibration on human performance (particularly with reference to the 'tunnel vision' work).
U.SOUTHAMPTON (25)	1	Field and laboratory research necessary to specify the design of a 'complete' environmental simulator.
	2	Investigation of the sources of variance associated with the techniques employed in the determination of the effects of vibration on performance.

9) FURTHER COMMENTS

B.A.C. FILTON (2)	Certain classified work has been carried out on human response which is not available for general discussion and distribution. This work although not continuing, has stimulated interest in this activity. The performance of aircrew in a vibrating environment is of considerable interest and we are anxious to consider the application of any relevant research. BAC.(Com. A/C Div.) normally only enter this field themselves if a specific problem is forseen, the last time being low altitude high speed flight for TSR2. There is need of a means for using amplitude frequency curves of tolerance in a context of random excitation to assess tolerance. There is need of introducing time of exposure into this assessment. The experiments of the past all seem to have been on too small a scale. Human samples should measure hundreds not tens.
U.O.P. BOSTROM (6)	The facility is primarily intended to assist in the design/development of suspension seating for vehicles, and little basic research is carried out here at present.
FORESTRY COMMISSION (10)	Questions 1-8 not relevant. The research into hand arm vibration with which I am associated, is organised by Dr. W. Taylor (on circulation list). My interest is in the interpretation of the results of medical/engineering research in U.K. and abroad for guidance of management and the provision of a standard for hand arm vibration. The extent of my commitment is not more than $\frac{1}{4}$ of a year/annum. (G.D. Keighley)
N.I.M.R. LONDON (15)	A wide range of experiments is planned for this facility to determine postural response and working capacity under various roll/pitch motions, for standing and seated subjects, and with presence and absence of visual clues to motion.

DISTRIBUTION OF THE SURVEY AND THE NATURE OF REPLIES

NATURE OF REPLY	DISTRIBUTION
1	Accident and Ambulance Research, Crossways Farm House, Dunkerton, Bath Somerset.
+	Army Personnel Research Establishment,R.A.E., Farnborough,Hants.
*	Atkins Research and Development, Woodcote Grove,Ashley Road, Epsom,Surrey.
+	D Squadron, A.& A.E.E., Boscombe Down,Salisbury,Wilts.
6	U.O.P. Bostrom (U.K.) Ltd, Weedon Road Industrial Estate, Northampton.
7	Faculty of Technology, Bournemouth College of Technology, Lansdowne, Bournemouth,BH1 3VV.
2	British Aircraft Corporation Ltd, Commercial Aircraft Division, G.P.O. Box No. 77, Filton House, Bristol, BS99 7AR.
2	British Aircraft Corporation Ltd., Commercial Aircraft Division, Weybridge, Surrey.
+	British Hovercraft Corporation Ltd, East Cowes, Isle of Wight.
*	British Leyland (Austin-Morris) Ltd., Longbridge, P.O. Box 41, Birmingham, B31 2TB.
3	British Leyland Truck and Bus Division Ltd., Leyland, Preston, PR5 1SN.
4	British Railway Research Department, Railway Technical Centre, (Room 116K) London Road, Derby.
5	Ergomonics Unit, British Railways Board, 222 Marylebone Road, London N.W.1.
*	The British Ship Research Association, Wallsend Research Station, Wallsend, Northumberland.
*	Structural Engineering Division, Building Research Station, Bucknalls Lane, Garston, Watford, WD2 7JR.
8	Polytecnic of Central London,115 New Cavendish Street,London W.1.
*	Industrial Ergonomics, Dept. of Production Engineering, Cranfield Institue of Technology, Cranfield, Bedford.
9	Cranfield Institute of Technology, School of Automotive Studies, Cranfield, Bedford.

* No relevant research. + No reply received.
Numbers refer to positive replies listed in tables.

DISTRIBUTION OF THE SURVEY AND THE NATURE OF REPLIES (continued)

NATURE OF REPLY	DISTRIBUTION
*	Noise and Vibration Dept., Whitley Technical Centre, Chrysler U.K. Abbey Road, Coventry.
+	Dept. of Medical Physics, Weston Park Hospital, Sheffield.
*	EMI Electronics Ltd., Victoria Road, Feltham, Middlesex.
10	Forestry Commision, Alice Holt Lodge, Wrecclesham, Farnham, Surrey.
+	Ford Motor Company Ltd., Laingdon, Basildon, Essex.
11	Aerodynamics Dept., Hawker Siddely Aviation Ltd., Hatfield, Herts.
12	R.A.F., I.A.M., Farnborough, Hants.
+	Jaguar Cars Ltd., Allesley, Coventry, Warwickshire.
+	Leyland Gas Turbines Ltd., Meteor Works, Solihull, Warwickshire.
+	Dept. of Engineering, Massey Ferguson, Barton Dock Road, Manchester M32 OYH.
*	Medical Research Council Applied Psychology Unit, 15 Chaucer Road, Cambridge, CB2 2EF.
13	Military Vehicles and Engineering Establishment, Chobham Lane, Chertsey, Surrey.
+	Motor Industries Research Association, Lindley, Nuneaton, Warwickshire.
+	National Gas Turbine Establishment, Pystock, Hants.
14	National Institute of Agriculture Engineering, Wrest Park, Silsoe, Bedfordshire.
15	Human Biomechanics Laboratory, Natioanl Institute of Medical Research, (Hampstead Laboratories), Holly Hill, London N.W.3.
*	Dept. of Social Studies, Portsmouth Polytechnic, Hampshire Terrace, Portsmouth PO1 2EG.
*	Rolls-Royce Motors Ltd., Motor Car Division, Pym's Lane, Crewe, Cheshire, CW1 3PL.
*	The Rover Company Ltd., Solihull, Warwickshire,
16	Engineering Physics Dept., Royal Aircraft Establishment, Farnborough, Hants.
17	Royal Military College of Science, Shrivenham, Swindon, Wilts.

* No relevant Research. + No reply received.
Numbers refer to positive replies listed in tables.

DISTRIBUTION OF THE SURVEY AND THE NATURE OF REPLIES (continued)

NATURE OF REPLY	DISTRIBUTION
18	Transport and Road Research Laboratory, Dept. of The Environment, Crowthorne, Berkshire, RG11 6AU.
+	Triumph Motor Cars, Canley, Coventry, Warwickshire.
*	United Kingdom Atomic Energy Authority, Atomic Weapons Research Establishment, Building C21, Aldermaston, Reading, RG7 4PR.
*	Engineering Research Laboratory, Vauxhall Motors Ltd., Chaul End, Caddington, Luton, Bedfordshire.
19	Research Experimental Dept., Westland Helicopters Ltd., Yeovil, Somerset.
20	Dept. of Psychology, University of Aston, Gosta Green, Birmingham 4.
21	Dept. of Mechanical Engineering, The University of Birmingham, P.O.Box 363, Birmingham B15 2TT.
+	Dept. of Social and Occupational Medicine, University of Dundee, 9 Dudhope Terrace, Dundee DD3 6HG.
22	Physiology Dept., University New Buildings, The University of Edingburgh, Teviot Place, Edingburgh 8.
+	Dept. of Mechanical Engineering, Queen Mary College, University of London, London E.1.
23	Dept. of Ergonomics and Cybernetics, University of Technology, Loughborough, Leicstershire.
*	Dept. of Psychology, The University, Manchester, M13 9PL.
+	Acoustics Group, Dept. of Physics, The University, Salford, M5 4WT.
24	Dept. of Mechanical Engineering, Sheffield University, St. Georges Square, Sheffield, S1 3JD.
25	Human Factors Research Unit, Institute of Sound and Vibration Research, The University, Southampton, SO9 5NH.
+	BioEngineering Unit, University of Strathclyde, Glasgow C.1.
*	Dept. of Mechanical Engineering, University of Surrey, Guilford, Surrey.
26	Dept. of Mechanical Engineering, University College od Swansea, Swansea SA2 8PP.

* No relevant research. + No reply received.
Numbers refer to positive replies listed in tables.