

# Curriculum Vitae

## PERSONAL INFORMATION

Full name and title:	Dr Cheryl Diane Metcalf
Employee number:	1747711

## PRESENT APPOINTMENT

Present post & level:	Principal Enterprise Fellow – Level 6
Date of appointment to present post:	1 <sup>st</sup> March 2015
Academic Unit/Division:	Allied Health Professions/Health Sciences
Faculty:	Faculty of Environmental & Life Sciences

## PREVIOUS SUBSTANTIVE APPOINTMENTS

Appointment	From	To
<b>Lecturer in Biomechanics</b> Faculty of Health Sciences	01/11/11	28/02/15
<b>RCUK Roberts Fellow</b> (Life Sciences Interface) Faculty of Health Sciences	01/11/08	31/10/11
<b>Research Fellow</b> – Tog 0 Project School of Health Professions & Rehabilitation Sciences	01/11/07	31/10/08
<b>Senior Research Assistant</b> – Biomedical Sensors Project School of Electronics & Computer Sciences	01/09/07	31/10/07
<b>Senior Research Assistant</b> – Silver Ring Splints Project (Co-Applicant and Named Researcher) School of Health Professions & Rehabilitation Sciences	2006	2007
<b>Experimental Officer</b> for the Biomechanics Laboratory (temporary) School of Health Professions & Rehabilitation Sciences	2004	2005

## QUALIFICATIONS (Educational and Professional)

Date	Title of award	Subject	Awarding body
June 2008	PhD	Investigating the relationship between wrist movement and	University of Southampton (ECS)

		hand function: a clinically focused kinematic study	
June 2003	MSc	Evolutionary & Adaptive Systems	University of Sussex
June 2002	BA (Hons)	Computer Studies	University of Sunderland

### **MAJOR HONOURS & DISTINCTIONS**

Honour/distinction	Date awarded
I am an <b>inventor</b> on an <b>international patent</b> application “Haptic Stimulation Apparatus.” Application No: PCT/EP2016/069746. This patent is held by Morgan Innovation & Technology Ltd (Petersfield, UK) and is the basis of a technology (RealSim™) that is a direct development from my research in haptic devices for sensory rehabilitation. This <b>commercial product</b> culmination of an exciting and innovative <b>technology transfer partnership</b> .	<b>2018</b>
I <b>won first prize</b> at the Southampton SetSquared/Wessex AHSN Health Innovation Programme. This was a 3-day intensive programme to work up project ideas into prospective business ideas. We had to pitch our businesses to a real-life ‘ <b>Dragon’s Den</b> ’ panel comprised of investors, venture capitalists and entrepreneurs.	<b>2015</b>
My work was showcased as one of 16 University projects highlighted in the #weareconnected campaign. This also included appearing on the <b>University of Southampton TV advert</b> launched over the summer.	<b>2014</b>
I was <b>returned in the Research Excellence Framework 2014</b> for the Faculty of Health Sciences.	<b>2014</b>
Following the success of the PianoHAWK project and my collaboration with Music and the National Cheng Kung University (Tainan), I was asked to join the <b>Vice Chancellor’s delegation to Taiwan</b> . The PianoHAWK project was highlighted as a notable example of contributing to the UoS strategic agenda to enhance the UoS international reputation. The purpose of this delegation was to highlight and <b>support the collaboration between UoS and Taiwan</b> and to sign a Memorandum of Understanding to encourage further collaboration. Since returning, my team has produced two publications, an international grant application and I have hosted an intern to work with me and my students at UoS.	<b>2013</b>
Following a <b>Material Transfer Agreement</b> with <b>Shadow Robot Company Ltd</b> , data from HAWK and expertise were provided to ascertain limiting factors relating to the functional and anthropomorphic features of the Shadow Robot hand. I highlighted the importance of the curvature of the palm for providing true opposition of the thumb to the fifth finger, and further evidenced my theories with HAWK data. As a result, the company <b>redesigned subsequent commercial and development prototypes</b> to include a curved palm (Shadow Dexterous Hand E Series: <a href="http://www.shadowrobot.com">www.shadowrobot.com</a> ).	<b>2012</b>

<p>My work was showcased in two out of four installations awarded to the Faculty of Health Sciences for the University of <b>Southampton's 60@60</b> diamond jubilee.</p> <p><b>Success No. 16</b> 'Measuring Movement of the Human Hand' showcased the development of HAWK; a technology that I developed and patented, and is the most comprehensive method of measuring hand movement using motion capture technology. It has been successfully applied to the analysis of pianistic movement and was the focus of a launch at the Blüthner piano showroom at Berkeley Square, London.</p> <p><b>Success No. 43</b> 'Helping People Recover from Stroke' included work on Haptic Technology; developing pioneering devices for sensory re-education. This work has now been licenced to Morgan Innovation &amp; Technology Ltd under a commercial agreement.</p>	<b>2012</b>
<b>UK patent</b> (Reference case: 09793/GB, Application Number: 1201917.0). "Haptic Device" on 3 <sup>rd</sup> February 2012, co-invented by Dr Geoff Merrett, Dr Reuben Wilcock and Dr Sara Demain.	<b>2012</b>
<b>UK &amp; US PCT patent</b> (Reference case: 1003883.4). "HAWK – Hand and Wrist Kinematic Measurement: Apparatus and method for measurement of hand joint movement". Published as an international PCT patent application on the 15 <sup>th</sup> September 2011 (No: WO 2011/110845) and co-invented with Dr Scott V. Notley, previously with the Institute of Sound & Vibration Research.	<b>2010/2011</b>
<b>ARC silver medal award for research excellence</b> awarded to four members of the team for the silver ring splints project led by Dr Jo Adams. I was responsible for developing the kinematic measurement technique, planning and running biomechanical trials, processing the data from the motion analysis system, generating, interpreting and publishing the kinematic results.	<b>2008</b>

## **TEACHING ACTIVITY**

### **(a) Teaching responsibilities for this and the last academic year**

*Year 2017/18 on maternity leave*

Year:	2018/19	Sheet	1	of	2
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Programme/Module (and code)	Introduction to Professional Practice HPRS1030	Future Professional Practice PSIO3038 PSIO6038	Engineering Replacement Body Parts UOSM2031	Amputee Rehabilitation & Prosthetic Use HLTH6160	Contemporary Issues in Limb Loss HLTH6180
Degree title (and code)	All UG (excl. nursing)	All UG (excl. nursing)/Pre-reg MSc Physio	Curriculum innovation module	MSc Amputation & Prosthetic Rehabilitation	MSc Amputation & Prosthetic Rehabilitation
Students UG/PG:	UG	UG & PG	UG	PG	PG
Year of study:	1	3/1	2	1/CPD	1/CPD

Numbers:	35	120	40	11	9
Contact hours overall	5	30	1	32	32
My contribution:	Physiotherapy team lead. Delivering teaching and assessment.	Delivering teaching. Physiotherapy-specific student support.	Session lead Motion & Mechanics	Module co-lead, delivering teaching and assessment.	Module co-lead, delivering teaching and assessment.
Teaching & assessment responsibilities:	Delivering seminars & assessments	Supporting teaching, student support and assessment for module.	Planning & delivering teaching. Assessment.	Planning & delivering teaching. Student support. Assessment.	Planning & delivering teaching. Student support. Assessment.
Mean course rating:	Not available	Ongoing	Ongoing	4.325	Ongoing

(b) Summary of Teaching & Education Responsibilities in the two Academic years prior to a) above

Year:	<b>2016/17</b>
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Programme/Module	My contact hours	Contribution
Developing Research Skills (HLTH6116)	12	Module mentor supporting students and supervisors in delivery of project objectives.
Engineering Replacement Body parts (UOSM2031)	40	Taught lecture and assessments.
Amputee Rehabilitation & Prosthetic Use (HLTH6160)	17	Module co-lead, delivering teaching and assessment.
Contemporary Issues in Limb Loss (HLTH6180)	9	Module lead, delivering teaching and assessment.

Year:	<b>2015/16</b>
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Programme/Module	My contact hours	Contribution
Open Module (NURS6104)	6	Project student mentor
Evidence for Answers (HMPR1003)	35	Module lead and delivery teaching. Assessment lead.

Engineering Replacement Body Parts (UOSM2031)	1	Session on Motion and Mechanics. Assessments.
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### c) Summary of significant personal achievements in education and teaching

**I started teaching at the University in 2008** and was **Deputy Module Lead from 2008-2013** for Sensory Motor Interaction (HLTH6030), an interdisciplinary MSc Module. I represented this MSc module at the **internal scrutiny panel** for the revalidation of the MSc Health & Rehabilitation programme.

In 2015 I was **module lead** for a new **undergraduate module** Introduction to Qualitative Methods: Evidence for Answers (HMPR1003) and teaching on the **Curriculum Innovation module**: Engineering Replacement Body Parts (UOSM2031), which I continue to deliver teaching and assessment.

In 2016 **I developed and validated a new MSc** within Health Sciences despite being on an Enterprise Career Pathway. The **MSc in Amputation & Prosthetic Rehabilitation**, for which I was **co-programme lead** 2016-2018, was designed in response to stakeholder demand and endorsed by BACPAR (British Association of Chartered Physiotherapists in Amputee Rehabilitation). It has attracted new disciplines to the School, as well as raising our international profile in this area and notably increased our international student numbers. We also engage with industry to deliver the formative assessment for our students during an 'Industry Engagement Study Day' and I lead this through my experience in Enterprise. I continue to be **Deputy Programme Lead for this MSc, Module Lead** for Contemporary Issues in Limb Loss (HLTH6180) and **Deputy Module Lead** for Amputation & Prosthetic Use (HLTH6160).

In 2018/2019 I joined the **Physiotherapy programme teaching team** and became **Deputy Module Lead** for Introduction to Professional Practice (HRPS1030) and **Physiotherapy Team Lead** for Future Professional Practice (PSIO3038). In Future Professional Practice I was specifically responsible for **improving student satisfaction** following a change in module delivery. I support the Physiotherapy programme by **assessing admissions** and **interviewing potential students**.

From 2019/2020 I will be **module lead** for Future Professional Practice and **AHP Lead** for Introduction to Professional Practice. These two modules capitalise upon my experience and leadership in clinical innovation and the multidisciplinary teamwork required to implement new processes. Being involved in both modules also allows me to have oversight of the continuous learning with respect to cultivating innovative thinking from Years 1 to 3. These modules involve joint interdisciplinary learning where students from all professions in the School learn and are assessed in multidisciplinary groups. These modules **showcase our core values in Health Sciences of interdisciplinary learning** that reflects the importance of multidisciplinary team-working in clinical practice. In 2020/2021 I will continue as **AHP Lead** in the recently validated Implementing Innovation & Change cross-School module which replaces Future Professional Practice, and creates important legacy between the two modules. I will also be delivering a third of the teaching for the module, specifically on Innovation.

Through my experience and reputation in developing and delivering education, I have been an **internal assessor for PCAP** and I am currently working toward a Senior Fellowship of the Higher Education Academy application with mentorship from a Principal Fellow in Faculty of Medicine.

I also **support education in health sciences** through MSc Physiotherapy research project supervision, personal tutees (in both the MSc Amputation & Prosthetic Rehabilitation and UG & MSc Physiotherapy programmes), in-module assessments and interviewing new student applicants. I was also part of the **recent revalidation** representing Introduction to Professional Practice and Future Professional Practice for the Physiotherapy team.

**c) Summary of significant personal achievements in education and teaching**

To date I have examined two MPhil transfers and three final PhD vivas (two external) and in 2014 was **external examiner for the University of Auckland's Masters in Mechanical Engineering** final dissertation module.

**POSTGRADUATE SUPERVISION****a) Number of students**

Degree	Current	Completed	Total to date
PhD	2	4	6
MSc Pre-registration Physiotherapy	2	10	12
MSc Health & Rehabilitation	-	3	3
MRes Developing Research Skills	-	9	9
MEng Individual Research Project	-	6	6
MEng Group Design Project	-	13	13
MSc Strategic Entrepreneurship	-	1	1
MSc Mechanical Engineering	1	0	1
MSc Micro-systems Technology	-	1	1
BSc Physiotherapy	-	2	2

**b) Details of the three most recent higher degree students supervised to completion**

Student	Degree and title of thesis	Start date	Completion date
Lyndsey Goulston	The epidemiology and interaction of knee alignment and body mass on knee osteoarthritis	2008	2015
Benjamin Jenkins	PhD Locating The Self within the Aesthetic Experience of Sculpture.	2010	2015
Marlene Rosa	PhD Co-contraction in Hemiplegic Gait	2011	2015
Tara Sims	PhD A Participatory Design Approach to Developing	2010	2014

	Upper Limb Prostheses for Children and Young People		
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### c) Details of intern supervision from national and international institutions

Date	Duration	Institution	Description
February 2019	3 months	IFMK Physiotherapy College, Dijon, France	The world's first biomechanically faithful model of the PIP finger joint
June 2017	2 months	University of Southampton (EPSRC Vacation Bursary)	The world's first biomechanically faithful model of the PIP finger joint
June 2014	3 weeks	National Cheng Kung University, Tainan, Taiwan	Data collection during skill acquisition and musical performance.
June 2013	2 months	IFMK Physiotherapy College, Dijon, France	Process and analyse longitudinal kinematic data from an OA patient.
January 2010	8 months	University of Southampton (Adventures in Research funded)	Engineering components to supplement work on the Haptics Project.
February 2009	5 months	Università degli Studi di Bologna, Italy	Developing an inertial sensor system to detect and monitor activity, recognise gestures and provide feedback for DVT during long-haul flights.

## RESEARCH ACTIVITY

a) Summary of current research
<p><b>I am an innovator and pioneer in measuring and quantifying hand function.</b> My work in this area is applied to the development of health technologies for rehabilitation of hand function and for furthering our understanding of the basic mechanisms underpinning complex movements of the hand during skill acquisition. I am an applied researcher who thrives in multidisciplinary teams and projects where cultivating external relationships is paramount. I work at the interface of <b>engineering, computing and health sciences</b>, and apply my work to other areas, such as <b>musical performance</b> and <b>archaeology</b>. I use this application as an exemplar of identifying the highly skilled characteristics of performance that can be used to understand <b>skill acquisition</b> as a spectrum of learning and development. I am involved in international projects and research programmes that work across disciplines and <b>I enjoy finding ways to capitalise on opportunities; finding effective and novel engineering solutions to complex clinical problems.</b></p>

## a) Summary of current research

My research falls under three main themes; all contribute to furthering knowledge and innovation in hand biomechanics and health technology design and development. They are kinematic measurement, haptics and prosthetics.

Kinematic Measurement (Skill Acquisition): This is an evolving theme including projects that have been multinational and interdisciplinary, involving collaborators in **Institut des Sciences du Mouvement, Marseille, France** and **National Cheng Kung University, Tainan, Taiwan**. I coordinated a high-profile project, applying the HAWK technology to the analysis of skill acquisition in musicians. This theme is on-going and I have developed an empirically-evidenced theory on how skill is acquired, underpinned by a **neurophysiological map of highly skilled expertise**. This theme has included hosting data collection visits for doctoral students from NCKU, Taiwan in September 2013 and July 2014. This collaboration generated grant applications and publications. Recently, this theme involves collaborations with UoS Schools of Music (Capturing the Conductor) and Archaeology (Life at the Cutting Edge). Both projects aim to collect more experimental data to test my theory and provide additional evidence to support its basis.

Kinematic Measurement (Musculoskeletal Modelling): This is a long-standing collaboration between **bioengineering** and **clinical orthopaedic** staff at UHS. Over ten years we have provided an evidenced rationale for developing a data-driven **3D musculoskeletal model of the hand** using kinematic data (HAWK), fMRI and CT. This project has been historically funded through industry, UHS and, more recently, was funded by the Engineering and Physical Sciences Research Council (EPSRC), University of Southampton Doctoral Training Partnership, grant ref EP/L505067/1, and EP/N509747/1. Our aim is to produce the most comprehensive data-driven model available to the field of clinical biomechanics.

Haptics Devices: I lead a **multidisciplinary cross-faculty team** on a collaborative project with **industry** (Morgan Innovation & Technology Ltd, Petersfield) funded by the Innovate UK and directly by Morgan. I initially developed novel devices for providing a tactile sensation to a person's fingertip using a variety of different technologies and mechanisms (UK patent filed 2012). We took an innovative methodological approach to device development and adopted a **user-led design process**. Each device was evaluated by iterative testing with unimpaired participants and stroke patients, to identify which mechanism(s) provide a realistic sensation and satisfy aesthetic, comfort, reliability and calibration considerations. In 2015, I transferred the technology to Morgan who have developed it further with my expertise (UK/PCT/US/JAPAN patent filed 2016 – named inventor). This technology has now formed the basis of two products; RealSim™ and MiatTouch™, and Morgan are now seeking their own investment to commercialise these products into the health and gaming sectors.

Prosthetic Services and Devices: Over the past 15 years I have worked on various projects in the prosthetics field. The combination of this knowledge, with the skills I have developed in Enterprise, have allowed me to apply my research to exciting new international collaborations. This has culminated in our **successful EPSRC Global Challenges Research Fund** project, which aims to review existing technologies and their appropriateness to prosthetics service provision across Cambodia. Specifically, my contribution to this project is developing a model of sustainability that goes beyond the limits of the project, and translates any 'good practice'; improving access to the prosthetics service. My background in computing (UG/PGT) and health technologies (academic) allow me to facilitate communication between work packages and disciplines; capturing and developing useful ways of deploying technology to improve work flow and throughput of patients by providing previously unavailable services to communities.

### b) Summary of research in the previous three years

My work over the last three years has been focused around the development and validation of health technologies for biomechanical measurement and rehabilitation.

Smart Textiles: I lead a cross-faculty project sponsored by the **Centre for Defence Enterprise (Ministry of Defence)** investigating the use of conductive fibres or sensors in fabric substrates as an alternative to electrogoniometers or pressure distribution systems. We targeted this innovative technology to measure interface pressures between the stump and prosthetic socket in lower limb traumatic amputees.

Novel Motion Capture Technology: I was a co-applicant with colleagues in UoS Music, the **London Sinfonietta** and **Sound Media Ltd**, to investigate technologies that can capture movements and translate those movements to generate sound, and thus music. This project was funded by **AHRC** and has generated open access repositories of data, as well as an exciting public engagement exhibition.

### c) Summary of significant personal achievements in research

I was **returned in the REF 2014** for the Faculty of Health Sciences.

I have been an **invited speaker** to a number of national and international meetings and symposia to discuss innovations in health technologies.

Building on the notable success of the Kinect Project, in October 2013 I was invited to be an **expert panellist for HealthStartUp 5**, an international meeting of 100 invited entrepreneurs, investors and researchers to discuss 'Emerging Technologies in Physical Therapy and Rehabilitation'. This is a prestigious event, held in Warsaw and other notable panellists included Bill Crounse (Senior Director, Worldwide Health for Microsoft). This meeting provided the impetus for the Kinect Project as a potential spin-out for the University.

### d) Research grants and contracts

Dates	Award holder(s)	Funding body	Title	Value
2019	Dickinson, A., Eggbeer, D., Kopanoglu., Ostler, C., Donovan-Hall, M., Metcalf, C. & Ridell, J.	IfLS	People Powered Prosthetics: Prosthetic Innovation driven by user needs	£7 908
2018	Ostler, C., Donovan-Hall, Dickinson, A. & Metcalf, C.D.	BACPAR	Exploring meaningful outcomes of recovery following lower limb amputation and prosthetic rehabilitation	£3 000
2018	Dickinson, A., Worsley, P., Donovan-Hall, M.,	EPSRC GCRF	A Step Change in LMIC Prosthetics Provision through	£909 511

	Metcalf, CD., Granat, M., Batchelor, J., Wills, G., Oreffo, R., Kenney, L., Sann, R. & Heang, T.		Computer Aided Design, Actimetry and Database Technologies	
2018	Metcalf, CD., Dickinson, A., Littlefield, B. (Winchester Science Centre), Donovan-Hall, M., & Worsley, P.	Public Engagement with Research Unit Development Funding 2017/18	Developing an interactive exhibition for raising public awareness of innovations in applied healthcare: upper limb prosthetics	£4 000
2018	Bowen, C., Bannon, S., Packer, E., Brocklehurst, J., Dando, C., Cole, M., Metcalf, CD. & Littlefield, B.	Public Engagement with Research Unit Development Funding 2017/18	Feet for Life: Creation of a mobile lab-pod	£3 146
2018	Ostler C., Dickinson, A., Metcalf, CD., Donovan-Hall, M. Lambrick, D.	British Assoc. of Chartered Physiotherapists in Amputee Rehabilitation	What is a successful outcome following prosthetic rehabilitation? A patient's perspective	£3 000
2017	Dickinson, A., Metcalf, CD., Forrester, A., Warwick, D. & King, L.	EPSRC Vacation Bursaries 2017	The world's first biomechanically faithful model of the PIP finger joint	£2 500
2017	Donovan-Hall, M., Metcalf, CD., Dickinson, A., Worsley, P., Winchester Science Centre and Open Bionics Ltd	Wessex Academic Health Sciences Network (WAHSN) and Higher Education Innovation Fund (HEIF)	Widening public awareness of innovations in prosthetics	£2 000
2016-2017	Hoggard, C., Stade, C., Davies, W., Metcalf, CD., Brook, A., Bye- Jensen, P., Dilley,	Public Engagement Research Unit Development Funding 2016/2017	Life at the Cutting Edge: Testing Expertise, Dexterity and Skill Transmission in	£2 300

	J., Burgess, M. & Rowland, J.		the use of Ancient Technology	
2016	Dickinson, A., Worsley, P., Donovan-Hall, M, Batchelor, J & Metcalf CD.	EPSRC Institutional Sponsorship	Fitting Prosthetic Limbs in the Developing World: a Feasibility and Specification Study for CAD/CAM Technologies in Asia, South America and Africa	£48 023
2016 – 2018	Polfreman, R., Oliver, B. & Metcalf, CD.	British Academy	Capturing the Contemporary Conductor	£8 418
2015	Metcalf, CD & Wickes, S	University of Southampton Science Park	Catalyst Centre	£70 000 in kind (includes rent, overheads, £1000, mentorship and training programme)
2014 – 2016	Morgan I&T, Metcalf, CD, Demain, SH. & Merrett, GV.	Technology Strategy Board: SMART	Haptic Sensory System for the Hand	£178 600
2013 – 2017	Polfreman, R. & Metcalf, CD.	RCUK: Arts & Humanities Research Council	Hands-on Sound: tracking technologies in music for live electronics	£86 928
2011 – 2012	Metcalf, CD.	Southampton Enterprise Development Fund (UoS)	Exploitation of Kinematic Algorithms	£9 000
2011 – 2012	Morgan Automation, Merrett, GV., Metcalf, CD. & Demain, SH.	Technology Strategy Board SBRI (Stroke)	A low-cost home-based stroke rehabilitation system using haptic devices and virtual environments	£38 600
2011 – 2013	Metcalf, CD & Donovan-Hall, M.	Annual Adventures in Research Grant (UoS)	Iterative User-Centred Design of a Paediatric Upper	£19 993

			Limb Prosthetic Device	
2010 – 2013	Donovan-Hall, M. & Metcalf, CD	Faculty PhD Studentship	Exploring the views and needs of children with upper limb deficiency to inform the development of user-led prosthetics: a mixed methods design	£52 688
2010 – 2012	Merrett, GV, Demain, S. & Metcalf, CD	Annual Adventures in Research Grant (UoS)	Design and human evaluation of haptic devices for hand rehabilitation from sensory deficits due to neurological impairment	£37 070
2010	Hughes, AM & Metcalf, CD	British Limbless Ex Servicemen Association	European Travel Grant	£800
2009 – 2011	Metcalf, CD, Hughes, AM, Tudor, MJ	Centre for Defence Enterprise: Ministry of Defence	Instrumented stump sock for measuring temperature and pressure at the stump/sock interface	£102 891
2009 – 2011	Metcalf, CD & Burridge, JH	Wessex Medical Research	Hand opening to grasp ‘virtual’ objects during reaching tasks in a rehabilitation robot: a proof of concept study	£19 783
2009 – 2011	Warwick D, Adams J, Metcalf CD, Taylor M & Stokes M	Ascension Orthopaedics Corporation (USA)	Clinical and bioengineering investigation into the predictors and effectiveness of proximal interphalangeal joint surgery for	£15 000

			patients with hand arthritis	
2009	Metcalf, CD	Royal Academy of Engineering	International Travel Grant	£500
2008 – 2011	Metcalf, CD	RCUK Roberts Fellowship	Life Sciences Interface	£125,000
2008 – 2009	Morari, M, Micera, M, Schenk P, Lichtenberg J, Burridge JH & Metcalf CD	Swiss Government/KTI	SmartARMEO	£15 000
2007 – 2008	Adams J, Metcalf CD, Macleod C, Burridge JH & Cooper C	Wessex Medical Research	Silver Ring Splints Project	£10 000
2007 – 2010	Chappell PH & Metcalf CD	Southampton Enterprise Development Fund (UoS)	SHAP Business Enterprise	£15 000

## **PUBLICATIONS**

### Conference Contributions - Refereed

1. Ostler, C., Donovan-Hall, M., Dickinson, A.S. & Metcalf, C.D. The Me-Amputee Study: Exploring meaningful outcomes of recovery following lower limb amputation and prosthetic rehabilitation: The patient's perspective. *International Society for Prosthetics and Orthotics (ISPO) 17<sup>th</sup> World Congress 2019, Kobe, Japan*. 5-8 October.
2. Polfreman, R., Oliver, B., Metcalf, C.D. & Halford, D. Force and Motion: Conducting to the Click. *6<sup>th</sup> International Conference on Movement & Computing 2019, Tempe, Arizona*. 10-12 October.
3. Oliver, B., Polfreman, R., Halford, D. & Metcalf, C.D. Capturing the contemporary conductor: Using motion capture technology to study conducting gesture. *International Conducting Studies Conference 2018, Oxford, UK*. 21-23 June.
4. Dickinson, A S, Donovan-Hall, M K, Srors, S, Bou, K, Tech, A, Steer, J W, Metcalf, C D, Kheng, S, Worsley, P R,: Assessing and benchmarking low cost 3D scanners for transtibial prosthetic socket design. *Asian Prosthetics and Orthotics Scientific Meeting 2018*, Bangkok, Thailand.
5. Donovan-Hall, M K, Dickinson, A S, Srors, S, Tech, A, Metcalf, C D, Kheng, S, Worsley, P R, (forthcoming): The importance of a user-centred approach and scoping work when exploring the potential benefit of computer-based technology within P&O services in LMICs. *Asian Prosthetics and Orthotics Scientific Meeting 2018*, Bangkok, Thailand.
6. Ostler, C, Donovan-Hall, M, Dickinson, A S, Metcalf C D. The Me-Amputee Study: Exploring meaningful outcomes of recovery following lower limb amputation and prosthetic rehabilitation: The patient's perspective. *International Society for Prosthetics and Orthotics (ISPO) UK Annual Scientific Meeting 2018*, Southampton, UK
7. Metcalf, C, Phillips, C, Forrester, A, Glodowski, J, Simpson, K, Everitt, C, King, L, Warwick, D, Dickinson, A S, (07/2018): The accuracy of quantifying PIP finger joint flexion changes using skin mounted reflective markers. *World Congress of Biomechanics*, Dublin, Ireland.
8. Phillips, C, Forrester, A, Metcalf, C, Everitt, C, King, L, Warwick, D, Dickinson, A S, (07/2017): *Generating a musculoskeletal model of the index finger from MR, CT and optical motion capture data European Society for Biomechanics*, Seville, Spain.

9. Phillips, C, Forrester, A, Metcalf, C, King, L, Dickinson, A S, Warwick, D, (06/2017): A *computational musculoskeletal model of the PIP joint generated with anatomical data from MR, CT and optical motion capture*. EUROHAND 2017, Budapest, Hungary.
10. Hsu, L-C., Wang, Y-L., Lin, Y-J., Su, A.W.Y. & Metcalf, C.D. 2014. Detection of motor changes in violin playing by EMG signals. *15<sup>th</sup> International Society for Music Information Retrieval Conference*. Taipei: Taiwan. 27-31 October.
11. Metcalf, C.D. 2014. Improving sensory deficits in hand rehabilitation: Haptic devices. *Royal Society of Medicine Special Interest Group: Stroke*. London, UK. 16 June. [Invited talk].
12. Rosa, M.C., Marques, A.S., Rodrigues, J., Metcalf, C.D. and Demain, S.H. 2013. Relationship between the time spent in double support phase of gait and the knee strength in subjects with stroke. *XXII European Stroke Conference*. London: UK. 28-31 May. P. 263.
13. Rosa, M.C., Marques, A.S., Rodrigues, J., Metcalf, C.D. and Demain, S.H. 2013. Is the symmetry of double support phase a good predictor of gait speed recovery in subjects with stroke? *XXII European Stroke Conference*. London: UK. 28-31 May. P. 264.
14. \* Sims, T., Donovan-Hall, M. and Metcalf, C.D., 2012. Exploring the Views of Children, Parents and Clinicians to Inform the Design of Future Prosthetic Devices. *ISPO 2013 World Congress*. Hyderabad: India. 4 – 7 February.
15. \* Sims, T., Donovan-Hall, M. and Metcalf, C.D., 2012. Involving children and parents in the development of upper limb prostheses. *ISPO UK 40th Anniversary Meeting*. Sheffield: UK. 27 – 28 September.
16. Sims, T., Donovan-Hall, M. and Metcalf, C.D., 2012. Involving children and young people in the development of upper limb prostheses. *College of Occupational Therapists 36th Annual Conference and Exhibition*. Glasgow: UK. 12 – 14 June.
17. Sims, T., Donovan-Hall, M. & Metcalf, C.D., 2012. Exploring the Views of Children, Parents and Clinicians to Contribute towards the Development of Upper Limb Prostheses. *Trent International Prosthetics Symposium*. Loughborough: UK. 21-23 May.
18. \* Metcalf, C.D., 2012. Innovations in Bioengineering: Development of a Textile-Based Sensor for Pressure Measurement in Lower Limb Prosthetic Use. *Tissue Viability Society Annual Conference*. Kettering: UK. 18 – 19 April. p24. [Invited Talk].
19. Sims, T., Donovan-Hall, M. And Metcalf, C.D., 2011. Involving children and young people in the development of upper limb prostheses. *College of Occupational Therapists Specialist Section Children, Young People and Families National Conference*. Bristol: UK. 17 – 18 November.
20. Sims, T., Donovan-Hall, M. and Metcalf, C.D., 2011. Involving Children and Young People in the Development of Upper Limb Prostheses. *International Society of Prosthetics and Orthotics: Psychosocial Impact of Disability and Limb Loss*. Sydney: Australia. 3 -5 November. 48-49.
21. Redman, T., Sims, T., Chappell, P.H., Donovan-Hall, M., Cranny, A., Metcalf, C.D. and White, N.M., 2011. The Design of a Myoelectrically Controlled Hand with Multiple Actuators for Five-Year Old Children. *Myoelectric Controls Symposium (MEC): Raising the Standard*. New Brunswick: Canada. 14 -19 August. 83 - 86.
22. Goulston, L., Hooper, L., Gates, L., Metcalf, C.D., Bowen, C., Warner, M., Culliford, D., Maskell, J., Leyland, K., Burrridge, J.H., Stokes, M.J. & Arden, N. (2011). Static and Dynamic Knee Alignment in Osteoarthritis. *EULAR*. London: UK. 25-28 May.
23. Hill, K., Burrridge, J.H., Micera, S. & Metcalf, C.D. (2011). Kinematics of Reach-to-Grasp during Robotic Assisted Reaching. *XXIII Congress of the International Society of Biomechanics*. Brussels: Belgium. 3-7 July.
24. Merrett, G.V., Metcalf, C.D., Zheng, D., Cunningham, S., Barrow, S. & Demain, S.H. (2011). Design and Qualitative Evaluation of Tactile Devices for Stroke Rehabilitation. *IET Assisted Living Conference*. London: UK. 6 April.
25. Metcalf, C. D. (2009). Challenges in Measuring Small Joint Movements: Hand Biomechanics and Health Technology Assessment. *IMEchE Measurement and Sensing in Medicine and Health: Capturing Motion and Musculoskeletal Dynamics*. London: UK. 15 October. 25 - 28. [Invited Talk].
26. Adams, J., Hodges, K., Kujawa, J. & Metcalf, C. D. (2009). Test-retest Reliability of the Southampton Hand Assessment Procedure. *International Journal of Rehabilitation Research: Proc. of the 10th Congress of the European Federation for Research in Rehabilitation*. Riga: Latvia. 9-12 September. 32 (Supp 1), S18 - S19.
27. \* Metcalf, C. D., Spicka, C., Adams, J. & MacLeod, C. (2009) The Effectiveness of Silver Ring Splints to Correct Swan-Neck Deformity. *XXII Congress of the International Society of Biomechanics*. Cape Town, South Africa. 5-9 July. ISBN: 978-0-620-44037-0.
28. Gallos, Z., Adams, J. & Metcalf, C. D. (2009). Three Dimensional Motion Analysis of the Rheumatoid Proximal Interphalangeal Joint with a Silver Ring Splint in Situ: A Matched Case Study.

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*Rheumatology: British Society of Rheumatology Annual Meeting*. Glasgow, UK. 28 April – 01 May. 48 (Supp 1), ii54.

29. Metcalf, C. D., Collie, S. R., Cranny, A. W., Hallett, G., James, C., Chappell, P. H., White, N. M. & Burrridge J. H. (2009). Fabric-based Strain Sensors for Measuring Movement in Wearable Telemonitoring Applications. *IET Assisted Living Conference*. London, UK. 24-25 March. ISBN: 978-1-84919-121-0.
30. Adams, J., Metcalf, C. D., Macleod, C., Spicka, C., Burrridge, J. H., Cooper, C. & Cox, N. (2008). Three Dimensional Functional Motion Analysis of Silver Ring Splints in Rheumatoid Arthritis. *Rheumatology: British Society of Rheumatology Annual Meeting*. Liverpool, UK. 22-25 April. 47(Supp 2), ii154 – ii155.
31. Spicka, C., Adams, J., Macleod, C. & Metcalf, C. D. (2008). A Study Examining the Effectiveness of Silver Ring Splints for Hand Function in Adult Patients with Rheumatoid Arthritis. *Rheumatology: British Society of Rheumatology Annual Meeting*. Liverpool, UK. 22-25 April. 47(Supp 2), ii33 – ii34.
32. Metcalf, C. D., Yule, V. T., Chappell, P. H. & Burrridge, J. H. (2007). The Effects of Handedness on Movement Strategies of the Wrist. *Journal of Biomechanics: Proceedings of the XXI Congress of the International Society of Biomechanics*. Taipei, Taiwan. 1-5 July. 40(Supp 2), S526.
33. Metcalf, C. D. & Adams, J. (2007). The Development and Clinical Application of a New, Small Hand Joint, Functional 3D Motion Analysis Assessment System for Rheumatology and Musculoskeletal Rehabilitation Research. *International Journal of Rehabilitation Research: Proceedings of the 9<sup>th</sup> Congress of the European Federation for Research in Rehabilitation*. Budapest, Hungary. 26-29 August. 30(Supp 1), 24 – 25.
34. Metcalf, C. D., Chappell, P. H., Yule, V. T. & Burrridge, J. H. (2005). Differences in Wrist Movements during a Clinical Hand Function Test. *4<sup>th</sup> IEEE EMBS UK & RI Postgraduate Biomedical Engineering & Medical Physics Conference*. 18-20 July. Reading, UK. 41 – 42.
35. Metcalf, C. D., Yule, V. T., Burrridge, J. H. & Chappell, P. H. (2005). Enforcing Cyclic Movements of the Upper Limb for Movement Analysis Systems. *Bath Hand & Wrist Biomechanics Symposium*. 10 June. Bath, UK. p8.

Conference Contributions – Other
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1. In 2019 our team from the GCRF LMICs project will host a symposium on Global Challenges in Prosthetic Service delivery at 17<sup>th</sup> ISPO World Congress in Kobe, Japan.
  2. Huang, H., Merrett, G.V., Metcalf, C.D. & White, N.M., 2011. A Feasibility Study on Body-Worn Inertial Energy Harvesting during Walking and Running. *Energy Harvesting 2011*. 7 February. London: UK.
  3. Butler, K., Hughes, A.M., Torah, R.N., Alaya, I., Tudor, M.J. & Metcalf, C.D., 2010. Measuring pressures at the sock/stump interface in lower limb amputees: A Pilot Study. *Annual Conference of the British Association of Chartered Physiotherapists in Amputee Research*. 15 – 16 November. Wolverhampton: UK.
  4. \* Metcalf, C. D., 2009. Challenges in Measuring Small Joint Movements: Hand Biomechanics and Health Technology Assessment. *IMechE Measurement and Sensing in Medicine and Health: Capturing Motion and Musculoskeletal Dynamics*. 15 October. London: UK. 25 - 28. [Invited Talk].
  5. Adams, J., MacLeod, C., Metcalf, C.D. & Spicka, C., 2009. The Effectiveness of Silver Ring Splints. *4<sup>th</sup> Wessex Instructional Hand Course*. 9 May. Southampton General Hospital, UK.
  6. Metcalf, C. D., Chappell, P. H., Burrridge, J. H. & Yule, V. T. (2007). A Clinical Approach to Three-Dimensional Analysis of Wrist Movement and Hand Function. *Creating a Future: Postgraduate Research Showcase*. Faculty of Engineering, Science and Mathematics. 22 March. Southampton, UK. p21.
  7. Spicka, C., Adams, J., Macleod, C. & Metcalf, C. D. (2007). The Use of Clinical Assessment and Novel 3D Motion Analysis to Examine the Effectiveness of Silver Ring Splints in RA. *Proceedings of the 3<sup>rd</sup> LSI Conference*. 15 March. Southampton, UK. p17.
  8. Metcalf, C. D., Burrridge, J. H., Chappell, P. H. & Yule, V. T. (2007). Differences in Wrist Movements during Weighted Lifting Tasks II. *Proceedings of the 3<sup>rd</sup> LSI Conference*. 15 March. Southampton, UK. p13.
  9. Metcalf, C. D., Burrridge, J. H., Chappell, P. H. & Yule, V. T. (2005). Differences in Wrist Movements during Weighted Lifting Tasks I: A Kinematic Study. *Proceedings of the 2<sup>nd</sup> LSI Conference*. 1 December. Southampton, UK. 29 – 30.
  10. Metcalf, C. D. (2005). Movement Analysis of the Upper Limb during Cyclic Tasks. *Medical, Health & Life Sciences Faculty Conference*. 7 – 8 June. Southampton, UK. p67.
  11. Metcalf, C. D. (2005). Upper Limb Motion Analysis. *5<sup>th</sup> Academic Biomedical Engineering Research Group Workshop*. 10 February. Bournemouth, UK.
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12. Metcalf, C. D. (2004). Motion Analysis of the Upper Limb. *Life Sciences Interfaces Forum 2004*. 23 November. Southampton, UK.

#### Departmental/Research Working Papers

1. Centre for Defence Enterprise 3-, 6- and 9-month and final project reports.
2. AgResearch Collaboration Report following work placement in Christchurch, New Zealand. April 2008.
3. Knee Sensors Project Final Report. October 2007.

#### Edited Works: Contributions

1. van den Tillaar R and Aune TK (2019) Effect of Instructions Emphasizing Velocity or Accuracy Given in a Random or Blocked Order on Performance Testing and Kinematics in Dart Throwing. *Front. Psychol.* 10:1359. doi: 10.3389/fpsyg.2019.01359.
2. Editor: Proceedings of the 3<sup>rd</sup> Life Sciences Interfaces Conference. University of Southampton, UK. 15<sup>th</sup> March, 2007.
3. Editor: Proceedings of the 2<sup>nd</sup> Life Sciences Interfaces Conference. University of Southampton, UK. 1<sup>st</sup> December, 2005.

#### Impact Publications/Media/publicity

1. Understanding the Movements, Gestures and Skills involved in Conducting (2019). Vicon Standard Pushing Boundaries: Celebrating 35 years in the motion capture industry. (2019 Edition), 26-27.
  2. Insight: The Upper Hand (2016). Pianist Magazine December (No. 93), 76-78. Interviewed as expert in hand function, impairments and movements of pianists.
  3. \* Smurf searches for a cure for young academics' interdisciplinary blues (2013). Times Higher Education (THE). [SMuRF]. Following the publication and publicity surrounding the 'Incorporation of Early Career Researchers (ECRs) within multidisciplinary research at academic institutions', I was interviewed by the THE on the barriers facing early career academics working in multidisciplinary environments. The published article appeared in the 5<sup>th</sup> September 2013 edition of THE (p12).
  4. Ada Lovelace Tribute (2013). The Guardian. [Women in Engineering].
  5. Making the headlines (2013). The Voice. [Personal Profile]. I was one of three academics highlighted in an article that had enhanced the University profile through notable media coverage of their work. (p28).
  6. \* Researchers capture pianist hands in Hollywood 3D (2012). BBC Health Online. [HAWK].
  7. Using Hollywood technology to unlock the secret of pianist's sounds (2012). BBC Radio Solent, BBC South Today [HAWK].
  8. \* Researchers analyse piano playing using motion capture (2012). The Engineer. [HAWK].
  9. Using Hollywood Technology to Unlock the Secret of Pianists' Sounds (2012). The Voice. [HAWK]. The Voice highlighted the innovative application of HAWK to the musical performance domain. (p20).
  10. Musical Techniques Revealed (2012). New Boundaries. [HAWK]. This internal publication showcased the innovative application of HAWK to assessing skill acquisition in musical performance. This publication is sent externally to all the University's key stakeholders.
  11. Kinect for rehabilitation (2012). The Sun Newspaper. [Kinect Project]. This article highlighted the Kinect project as emerging technology for home-based rehabilitation. (p12).
  12. Researchers use Kinect gesture control in stroke rehab system (2012). The Engineer Online. [Kinect Project].
  13. \* Xbox Kinect Hacks Set Innovation in Motion (2012). CNN. [Kinect Project].
  14. Using Hollywood technology to unlock the secret of pianist's sounds (2012). The Vicon Standard. Front Page Article. P1-2. [HAWK]. This front page extended article is distributed internationally to all Vicon users to highlight pioneering research using the equipment.
  15. New options for stroke rehabilitation (2011). The Voice. [Haptics Project]. This article highlighted that innovation in health technology requires user-centred design and a multidisciplinary approach. (p20).
  16. Helping people recover from stroke (2011). New Boundaries. [Haptics Project]. My work was described within the context of the rehabilitation and health technologies research group, particularly focusing on Stroke Rehabilitation. (p17-19).
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17. Improving quality of life (2011). The Voice. [Personal Article]. I was the profile cover story for The Voice, talking about commercialisation my research and working in Healthcare Innovation. (p8-9).
18. The science of music – HAWK Demonstration. Multidisciplinary Research Week. [HAWK].

#### Journal Papers - Academic Journals

1. Wainwright, K., Sims, T. & Metcalf, C.D. (in review). A preliminary study toward establishing a paediatric prehension classification for health technology development and outcome measurement. *Journal of Occupational Science*.
2. Sims, T., Donovan-Hall, M. & Metcalf, C.D. (in review). The Occupational Impact of Upper Limb Prostheses: a barrier or facilitator to occupational participation? *British Journal of Occupational Therapy*.
3. Hull, K., Sims, T. & Metcalf, C.D. A Preliminary Study toward Establishing a Paediatric Prehension Classification for Health Technology Development and Outcome Measurement. *Prosthetics & Orthotics International*. ACCEPTED PENDING REVISIONS.
4. Sims, T., Cranny, A., Metcalf, C.D., Chappell, P.H. & Donovan-Hall, M. (2017). Participatory design of paediatric upper limb prostheses: qualitative methods and prototyping. *International Journal of Technology Assessment in Health Care*. 33(6), 629 – 637.
5. Rosa, M.C., Marques, A., Demain, S.H. & Metcalf, C.D. (2015). Fast gait speed and self-perceived balance as valid predictors and discriminators of independent community walking at 6 months post-stroke: a preliminary study. *Disability & Rehabilitation*. 37(2), 129-134.
6. Rosa, M.C., Marques, A., Demain, S.H. & Metcalf, C.D. (2015). Knee posture during gait and global functioning post-stroke: a theoretical ICF framework using current measures in stroke rehabilitation. *Disability & Rehabilitation*. 37(10), 904 – 913.
7. Rosa, M.C., Marques, A., Demain, S.H., Metcalf, C.D. & Rodrigues, J. (2014). Methodologies to assess muscle co-contraction during gait in people with neurological impairment – a systematic literature review. *Journal of Electromyography & Kinesiology*. 24(2), 179-191.
8. Rosa, M.C., Marques, A., Demain, S. & Metcalf, C.D. (2014). Lower limb co-contraction during walking in subjects with stroke: A systematic review. *Journal of Electromyography & Kinesiology*. 24(1), 1-10.
9. \* Metcalf, C.D., Irvine, T.A., Sims, J.L., Wang, Y.L., Su, A.W.Y. and Norris, D.O. (2014). Complex Hand Dexterity: A Review of Biomechanical Methods for Measuring Musical Performance. *Frontiers in Psychology: Cognitive Science. Research Topic on Performance Science*. 5:414. DOI: 10.3389/fpsyg.2014.00414.
10. Sobey, A.J., Townsend, N.C., Metcalf, C.D., Bruce, K.D. and Fazi, F.M. (2013). Incorporation of Early Career Researchers (ECRs) within multidisciplinary research at academic institutions. *Research Evaluation*. 22(3), 169-178.
11. \* Metcalf, C.D., Robinson, R., Malpass, A.J., Bogle, T.P., Dell, T.A., Harris, C. & Demain, S.H. (2013). Markerless Motion Capture and Measurement of Hand Kinematics: Validation and Application to Home-based Rehabilitation. *IEEE Transactions on Biomedical Engineering*. 60(8), 2184-2192.
12. Demain, S.H., Metcalf, C.D., Merrett, G.V., Zheng, D. & Cunningham, S. (2013). Haptic Devices: Review of the Physiology and Psychophysical Properties of the Hand and their Relation to Stroke Rehabilitation. *Disability & Rehabilitation: Assistive Technology*. 8(3), 181-189.
13. \* Metcalf, C.D. & Notley S.V. (2011). Modified Kinematic Technique for Measuring Pathological Hyperextension and Hypermobility of the Interphalangeal Joints. *IEEE Transactions on Biomedical Engineering*. 58(5), 1224-1231.
14. Chappell, P.H., Metcalf, C.D., Burrridge, J.H., Yule, V.T. & Pickering, R. (2010). Constant angular velocity of the wrist during the lifting of a sphere. *Journal of Medical Engineering & Technology*. 34(4), 274-284.
15. Spicka, C., Macleod, C., Adams, J. & Metcalf, C. D. (2009). The Effect of Silver Ring Splints on Hand Dexterity and Grip Strength in Patients with Rheumatoid Arthritis: An Observational Pilot Study. *Hand Therapy*. 14(2), 53-57.
16. Kyberd, P. J., Murgia, A., Gasson, M., Tjerks, T., Metcalf, C. D., Chappell, P. H., Warwick, K., Lawson, S. E. M. & Barnhill, T. (2009). Case Studies to Demonstrate the Range of Applications of the Southampton Hand Assessment Procedure. *British Journal of Occupational Therapy*. 72(5), 212-218.
17. Metcalf, C. D., Woodward, H., Wright, V., Chappell, P. H., Burrridge, J. H. & Yule, V. T. (2008). Changes in Hand Function with Age and Normative Unimpaired Scores when Measured with the Southampton Hand Assessment Procedure (SHAP). *British Journal of Hand Therapy*. 13(3), 79 – 83.

18. Adams, J., Macleod, C., Metcalf, C.D. & Spicka, C. (2008). ARC Silver Medal Award: A Research Report on the Effectiveness of Silver Ring Splints in Preventing Proximal Interphalangeal Joint Hyperextension during Functional Activity. *The Journal of Rheumatology: Occupational Therapy*. 23(1), 19-21.
19. \* Metcalf, C. D., Notley, S. V., Chappell, P. H., Burrridge, J. H. & Yule, V. T. (2008). Validation and Application of a Computational Model for Wrist and Hand Movements using Surface Markers. *IEEE Transactions on Biomedical Engineering*. 55(3), 1199 – 1210.

#### Official Reports: Part of Report

- \* Wessex Academic Health Science Network. *Virtual & Augmented Reality throughout Wessex*. (2017). Commissioned report – Consultancy.
- \* Department of Health. *Research & development work relating to assistive technology 2010-11. Presented to parliament pursuant to Section 22 of the Chronically Sick & Disabled Persons Act 1970*. Both the Haptics project (pages 51 & 79) and the Wessex Medical Research project on restoring reach-to-grasp following Stroke (page 90) were highlighted in this parliamentary report.

#### Review Articles in Academic Publications

1. Butler, K., Bowen, C.J., Hughes, A.M., Torah, R.N., Ayala, I., Tudor, M.J. & Metcalf, C.D. (2014). A systematic review of the key factors affecting tissue viability and rehabilitation outcomes of the residual limb in lower extremity traumatic amputees. *Journal of Tissue Viability*. 23(3), 81-93.
2. Rosa, M.C., Marques, A., Demain, S.H., Metcalf, C.D. & Rodrigues, J. (2014). Methodologies to assess muscle co-contraction during gait in people with neurological impairment - a systematic literature review. *Journal of Electromyography & Kinesiology*. 24(2), 179-191.
3. Rosa, M.C., Marques, A., Demain, S.H. & Metcalf, C.D. (2014). Lower limb co-contraction during walking in subjects with stroke: a systematic review. *Journal of Electromyography & Kinesiology*. 24(1), 1-10.
4. Adams, J.A., Ryall, C., Pandyan, A., Metcalf, C.D., Stokes, M., Bradley, S., & Warwick, D.J. (2012). Proximal Interphalangeal Joint Replacement in Patients with Arthritis of the Hand: A Meta-Analysis. *The Journal of Bone and Joint Surgery*. 94B(10), 1305-1312.
5. Metcalf, C. D., Adams, J., Burrridge, J. H., Yule, V. T. & Chappell, P. H. (2007). A Review of Clinical Upper Limb Assessments within the Framework of the WHO ICF. *Musculoskeletal Care*. 5(3), 160 – 173.

#### Exhibitions - Group

1. RHT Discovery Day 2014. Showcasing HAWK for Measuring Complex Hand Dexterity. September 2014. UK.
2. \* BIO International Convention on Biotechnology. Showcasing HAWK for Measuring Complex Hand Dexterity. June 2014. San Diego, USA.
3. \* MEDICA International Trade Fair. Showcasing Faculty Technology Transfer. September 2013.
4. \* UoS Stand at Farnborough Air Show. Showcasing HAWK for Measuring Complex Hand Dexterity for complex learning environments. July 2014 & July 2012. UK.

#### Public Appearances (research-related only)

1. \* Hands are Handy Things! *Winchester Science Festival*. Winchester Discovery Centre, UK. 2017.
2. #Handson: Prosthetics in the UK and Cambodia. *New Forest Show*. Brockenhurst Showground, UK. 2017/2018.
3. Hands are Handy Things! An overview of Complex Hand Dexterity and its importance. *Winchester Science Café*. Winchester: Discovery Centre, UK. 2014.
4. The Square-Peg Academic. *Faculty of Health Sciences PGR Conference*. 26<sup>th</sup> June. Southampton: UK. 2013.
5. How Do Researchers Research? *Association of Research Managers and Administrators*. 11 June. Southampton: UK. 2012.

6. \* Kinematic Measurement of Complex Hand Dexterity. *Computational Life and Medical Sciences Network Annual Symposium*. 28 June. London: UK. 2012.
7. \* We Are Only Limited by Our Imagination: HAWK. PianoHAWK Launch, *Blüthners Piano Showroom*. 16 May. London: UK. 2012.

#### Patents

1. Metcalf, C.D. & Notley, S.V. (2013). Apparatus and method for measurement of hand joint movement. US20130055830A1. UK/PCT
2. Wilcock, R., Metcalf, C.D., Demain, S.H. & Merrett, G.V. (2013). A pressure applying haptic device for a finger. GB2499019A. UK
3. Quest, J., Smith, S.P., Pawlak, A., Clarke, H.M. & Metcalf, C.D. (2017). Haptic stimulation apparatus. CA2993747A1. UK/PCT/US/JAPAN. Published US: 2018/0280227 (04/10/18).

#### Consultancy

Wessex Academic Health Science Network (2017). Commissioned to write a report on the prevalence of VR/AR in the health sector across the UK.

Southampton Hand Course for Surgeons & Therapists (2014). Guest Lecturer (HAWK) and ran a workshop on SHAP.

#### Citations

H-Index 13

678 (June 2019)

#### Web sites/Web site design/CD-ROM

Managed construction and deployment of the SHAP software and overlaying website interface [www.shap.ecs.soton.ac.uk](http://www.shap.ecs.soton.ac.uk). The copyright for this site resides with me.

#### Invited talks

1. European Neuro Convention (2017). Commercialising Products into the Health Sector. London: ExCel, UK.
2. International Society of Biomechanics Congress XXV (2015). Kinematic indicators of expertise: from neurological impairment to musical virtuoso. Glasgow, UK.
3. Winchester Science Café (2014). Hands are Handy Things!: An overview of Complex Hand Dexterity and its importance. Winchester: Discovery Centre, UK.
4. Music, Well-being & Emotions: Historical and Scientific Perspectives. (2014). London: UK. Royal College of Music.
5. Southampton Hand Course for Surgeons and Therapists. (2014). Southampton: UK.
6. Health Startup 5 (2013). Warsaw: Poland. Kinect for Rehabilitation;
7. Keynote lecture: PGR Annual Conference, Faculty of Health Sciences (2013). Doing things differently: The square peg academic. Southampton: UK;
8. Systems Engineering, University of Reading, (2013). Reading: UK. It's all about the hands!;
9. Computational Life and Medical Sciences Network Annual Symposium, (2012), London: UK. Kinematic Measurement of Complex Hand Dexterity;
10. Association of Research Managers and Administrators Annual General Meeting, (2012), Southampton: UK. How Do Researchers Research?
11. Annual Conference of the Tissue Viability Society (2012), Kettering: UK. Innovations in Bioengineering; the focus of which was the project funded by the Ministry of Defence on smart textile sensing technology;
12. Institute of Mechanical Engineers (2009), London: UK. Measurement and sensing in medicine and health: capturing motion and musculoskeletal dynamics. I presented a paper entitled 'challenges in measuring small joint movements: hand biomechanics and health technology assessment';
13. Centre for Rehabilitation, University Medical Centre, in Groningen: Netherlands, (2009) to give a talk to health professionals, medical physicists and prosthetists. The title of my talk was 'the

Southampton hand assessment procedure: measuring function following impairment and prosthetic use' and was related to the work I have been doing through the SHAP business enterprise and in collaboration with Professor Peter Kyberd, at the University of New Brunswick, Canada;

14. Soroptomists Southern Counties Annual Meeting (2007), Southampton: UK. I was invited to talk about my personal experiences of working in an engineering field, my educational background and the various areas of research in which I have been involved, and presenting science-based topics to the public audience.

## **CONTRIBUTIONS TO LEADERSHIP, MANAGEMENT & ENGAGEMENT**

### **a) The Academic Unit/Department**

Dates	Nature of contribution
2018 – Present	Health Sciences Research & Enterprise Committee Member
2018 – Present	Physiotherapy team lead for two cross-school modules (PSIO3038/PSIO6038)
2016 – present	Annual study day for MSc Amputation & Prosthetic Rehabilitation Inviting representatives from the prosthetics industry to talk to students about latest developments and horizon projects in the field.
2014	RHT discovery day hosted a stand showcasing HAWK
2009	Coordinated RHT robot therapy workshops X 2
2009	Assisted the ATRAS project team in running a 3-day interactive exhibition on rehabilitation robots. I was responsible for running practical demonstrations in the biomechanics laboratory

### **b) The Faculty or Budgetary Group**

Dates	Nature of contribution
2018 – present	FELS Associate Director of Enterprise
2018 – present	FELS KEF Champion
2018 – present	FELS Research & Enterprise Committee Member
2018 – present	FELS Lead for IP & Patents
2018 – present	FELS Internationalisation Committee Member
2013 – 2015	Managed Faculty budget allocation of the HIEF fund for engaging early career academics in work with industry
2016 – 2018	Concordat champion for Health Sciences
2013 - 2016	Deputy Concordat Champion
2012 – 2017	Athena SWAN Core Group
2009 – 2016	Faculty Ethics Committee

### c) The University

Dates	Nature of contribution
2019	I was one of three women highlighted as a superhero in the University's publicity campaign surrounding <b>International Women's Day 2019</b> . This campaign highlighted the variety within my academic role focusing equally on Education, Research and Enterprise.
2018 – present	<b>EPSRC IAA</b> Review Board Panel member
2018 – present	<b>Science &amp; Technology Facilities Council IAA</b> Board Panel Member
2018 – present	<b>GCRF UoS Steering Group</b> member
2017 – present	<b>I am a PERu Associate</b> . My role is to highlight opportunities to contribute to public engagement within Health Sciences (staff and students) and to promote the value of engaging the public in our research and making the University more accessible to the community.
2017	Reviewer for the University awarded <b>MRC Confidence in Concept (CiC)</b>
2014	I was interviewed for a <b>series of videos supporting 'Women in Academia'</b> for the University. Following their launch, the videos were tweeted and received <b>national attention through social media</b> outlets. I received a letter from the Vice-Chancellor thanking me for my participation in the videos and the initiative.
2014 – 2018	<b>ESRC Impact Acceleration Award</b>
2014 – 2017	University DSTL Strategic Lead for Rehabilitation
2014 – 2017	WiSET Executive Committee member
2014 – 2015	Chair of 'Successful Business Engagement' seminar series for UoS ECRs coordinated by RIS
2013	Part of the University delegation to Taiwan with the Vice-Chancellor
2013 – present	Concordat Working Group member
2012 – 2017	University Industry Sector Team: Health & Pharma member
2012 – 2016	Institute of Complex Systems & Simulation Doctoral Training Centre Board member for Biomedical Systems
2012 – 2013	Founding member of the Southampton Multidisciplinary Research Forum (SMuRF). The objective of SMuRF was to provide information and training to Early Career Researchers working within across multidisciplinary areas. In order to facilitate this, a two-day conference was held with approximately 100 delegates. I was responsible the finances for the conference (budget = £12 000) and organising the conference.
2011 – 2017	Elected senate member

2009 – 2010	Enterprise Executive Group member for Medicine, Health & Life Sciences Faculty
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#### CONTRIBUTIONS TO ENTERPRISE

Dates	Nature of contribution
2018	<b>FELS Associate Director of Enterprise</b>
2017	Interviewed by the <b>Department of Business, Energy &amp; Industrial Strategy</b> on the challenges facing UK academia when commercialising IP.
2016	<b>Founded a start-up company</b> based on my research.
2016	Completed the <b>USSP Catalyst Programme</b> .
2015	Participated in the <b>SetSquared/Wessex AHSN Health Innovation Programme</b> developing a business case and pitched to a ‘ <b>Dragon’s Den</b> ’ of real investors. I was awarded <b>first place</b> in this programme and I was invited to apply for the University of Southampton Science Park Catalyst Programme, as well as representing the region at the national Health Innovation Dragon’s Den, where I came second.
2014	<b>Deputised for Professor Sue Colley</b> (Associate Dean for Strategy Delivery, Business & Enterprise) during an extended period of leave (6 weeks). I regularly deputised for Prof. Colley at University level enterprise meetings, such as the ESRC IAA steering group and the UIST board.
2013 – 2015	<b>Managed the Faculty allocation of the HIEF fund</b> for engaging early career academics in work with industry. I also mentored the academics during their projects to help negotiate the different requirements of a commercial agenda with respect to a research agenda. I monitored each project, ensuring deliverables were met, and I reported regularly to Faculty and University committees on progress.
2013 – 2018	<b>Managed Faculty relationships</b> with strategic industrial partners.
2012 - present	I was one of 200 delegates, invited as lead of the SHAP Business Enterprise, by the <b>British Business Embassy</b> to Lancaster House in London, to a <b>Global Business Summit on Advances in Assistive Medical Technologies</b> . I started the SHAP business while I was a PhD student in ECS, and continue to manage the business and international trade. This has raised the international profile of SHAP, as well as Health Sciences’ enterprise portfolio.
2012	Completed a <b>Material Transfer Agreement</b> with <b>Shadow Robot Company Ltd</b> that resulted in data from HAWK and expertise being provided to determine limiting factors relating to the anthropomorphic features of the Shadow Robot hand in order to optimise functional capacity. Specifically, I highlighted the importance of curvature of the palm for providing true opposition of the thumb to the fifth finger, and further evidenced my theories with HAWK data. As a result, the company <b>redesigned subsequent commercial and development prototypes</b> to

	include a curved palm (Shadow Dexterous Hand E Series: <a href="http://www.shadowrobot.com">www.shadowrobot.com</a> ).
2012 – 2017	University Industry Sector Team: Health & Pharma member
2010 – 2018	I have <b>filed three patent applications</b> , all of which are published (UK and US publications). I have developed IP that has been licenced by industry and is leading to commercial innovations for the health and computer gaming sectors.
2009 – 2018	As a senior member of the Health Science's Enterprise team, I have worked on a number of <b>strategic programmes</b> to further the enterprise agenda within FHS and highlight the work being undertaken in knowledge and technology transfer. I have implemented processes to facilitate knowledge and technology transfer, protection of intellectual property and commercial exploitation of research and innovation. I have completed an <b>intensive and prestigious training programme</b> with the London Technology Network (LTN). I am responsible for maintaining the Faculty database of enterprise/innovation-related activity and facilitate meetings between academics and industry. In 2011, I led a workshop on 'Working with External Employers: Research Staff Perspective' at the 'Broaden Your Horizons Researcher Career Fair' and am regularly asked to speak to staff and external stakeholders about engaging with industry and academics.
2007 – present	I lead an internationally recognised and <b>innovative business enterprise</b> . I launched the SHAP business enterprise in 2007, which developed SHAP as a sustainable business selling a clinical outcome measure for assessment of upper limb prostheses. This initiative has <b>generated international recognition and SHAP is now the leading upper limb prosthetic outcome measure globally</b> . I am directly responsible for the day-to-day management of the SHAP business. I communicate directly with potential and existing customers, negotiating hire/sale prices, arranging contracts and provide after-sales support. To date, we have <b>sold 100+ SHAP kits</b> to an international customer base across the UK & Europe, Northern America, Australia, New Zealand, South Korea and Japan, and it has <b>generated over £200,000 revenue</b> . I am proud to say that our customers include <b>all major international manufacturers</b> of upper limb prosthetics, the <b>US Military</b> , global research institutes, hospitals and industry.

## **STAFF DEVELOPMENT AND TRAINING**

### **a) Staff development and training activities undertaken**

Over the last three years (including current year) plus any significant activities in previous years.

Dates	Activity	Hours
2019	The NHS Explained: How the health system in England really works (The King's Fund) ONLINE	8
2019	Innovation Strategy (Université libre de Bruxelles) ONLINE	12

2019	Transforming Digital Learning: Learning Design Meets Service Design (Deakin University, Australia) ONLINE	6
2019	Open Innovation (Durham University, UK) ONLINE	12
2019	Sustainable Futures (University of Bristol, UK) ONLINE	16
2019	Entrepreneurship in Non-Profits (University of Basel, Switzerland) ONLINE	16
2019	Global Health & Disability (London School of Hygiene & Tropical Medicine, UK) ONLINE	12
2019	Innovation: The World's Greatest (University of Leeds, UK) ONLINE	4
2019	Innovation & Enterprise (University of Bristol, UK) ONLINE	16
2019	Teaching Entrepreneurial Thinking (Queensland University of Technology, Australia) ONLINE	2
2019	PREP Framework Writing Workshop for Fellowship Applications	2
2015 – 2016	UoS Science Park – Catalyst Programme	50+
2015	Southampton SetSquared/Wessex AHSN Health Innovation Programme	25
2014	Essential Mentoring Skills (Health Sciences)	6
2011	NIHR i4i Life Sciences Accelerator Programme	32
2011	Researcher Talent Development Programme	16
2009	London Technology Network Business Fellow Training	30

**b) Staff development and training activities coordinated, tutored, led or initiated**

Over the last three years (including current year) plus any significant activities in previous years.

Dates	Activity	Hours
2014 – 2017	Chaired seminar series for 'Successful Business Engagement' targeted at ECRs	12
2014 – present	Coordinated the Faculty Fixed-Term Forum for all fixed-term staff to support career development	10

**c) Conference attendance**

Major conferences attended over the last three years (including current year) plus any significant participation in previous years.

Dates	Title	Nature of involvement
06/17	European Neuro Convention (London, UK)	Invited Speaker
07/15	International Society of Biomechanics Congress XXV (Glasgow, UK)	Invited Speaker
08/13	Health Startup 5: Microsoft stakeholders in Kinect for Health (Amsterdam, Netherlands)	Invited expert panellist
07/09	XXII Congress of the International Society of Biomechanics (Cape Town, South Africa)	Executive Council member
07/07	XXI Congress of the International Society of Biomechanics (Taipei, Taiwan)	Executive Council member

#### **ACADEMIC AND PROFESSIONAL ACTIVITIES OUTSIDE THE UNIVERSITY**

Details for the last three years (including current year) together with a summary of significant activities in previous years.
<p>I have actively contributed to learned national and international societies as an elected member of executive boards. I have used these positions to highlight my research and cultivate opportunities for collaboration. I am an <b>Associate Editor</b> of the Gold Open Access journal <i>Frontiers in Psychology: Performance Science</i>, which is the second highest top-cited Psychology journal globally.</p> <p><b>International</b></p> <p>My emerging international reputation in health innovation is evidenced as an <b>invited member</b> of <b>World Health Organisation's Global Cooperation on Assistive Technology (GATE)</b> initiative, to improve access to high-quality, affordable assistive technology worldwide, and as <b>invited member</b> of the <b>Exceed Research Network</b>, an international network of researchers working together to improve access to prosthetic services and devices in South East Asia.</p> <p>In July 2005 I was the first student to be <b>elected to the Executive Council of the International Society of Biomechanics</b> by the membership. During my two-year term I was responsible for coordinating all student activities at two international conferences (Ohio, USA and Taipei, Taiwan). In addition I regularly contributed to the society newsletter and negotiated significant increases in financial support for student members attending conferences and for future student representatives to attend the Executive Council meetings. I now act as an international mentor for students and early career researchers in the field.</p> <p>In 2008 I was invited to join an <b>international steering committee for Upper Limb Prosthetic Outcome Measures (ULPOM)</b>, whose aim is to identify valid and appropriate clinical and research outcome measures for assessing upper limb prostheses, and to establish standards of quality for future outcome measures. I am on steering committees for both general and paediatric assessment selection.</p> <p>My emerging reputation as an innovative enterprise-led researcher prompted an invitation as an <b>expert panellist at HealthStartUp 5</b> in Amsterdam, Netherlands, in October 2013. As one of the 100 international delegates invited from investors and experts, I was asked to present our work on the Kinect for Rehabilitation project, as well as speak on the panel topic 'Emerging Technologies in Physical Therapy and Rehabilitation'. In addition, I was also a Conference Programme Committee Member for <b>BIODEVICES 2014</b>, Loire Valley, France.</p>

Details for the last three years (including current year) together with a summary of significant activities in previous years.

In December 2013, I was part of the **University delegation to Taiwan**, which included a period of work at NCKU, Tainan with colleagues collaborating on the PianoHAWK project.

I am a member of the **Times Higher Education (THE) Reader Panel** and a **regular reviewer** for numerous international, interdisciplinary journals, including the:

- British Medical Journal
- IEEE Transactions on Biomedical Engineering
- IEEE Transactions on Systems, Man, and Cybernetics-Part C: Applications & Reviews, Sensors,
- Journal of NeuroEngineering and Rehabilitation
- International Journal of Rehabilitation Research
- British Journal of Occupational Therapy
- Journal of Neurology
- Clinical Neurology & Neurosurgery
- Clinical Biomechanics
- Journal of Biomechanics
- Computational Methods in Biomechanics & Biomedical Engineering

My national and international reputation is evident through my collaborations with National Cheng Kung University, Taiwan (PianoHAWK project) and EPFL, Switzerland (Hocoma Project and Muscle Synergies collaboration). In addition, I have **reviewed grant applications** for the following prestigious programmes and organisations:

- Canadian Scholarship programme in performance biomechanics
- European Commission FP7: Future & Emerging Technologies (FET) Open Scheme
- European Commission H2020: FET Open Scheme for Novel Ideas for Radically New Technologies
- EPSRC First Grant Scheme
- Royal Academy of Engineering Fellowship Scheme
- Dunhill Trust
- The Stroke Association
- University of Auckland, Mechanical Engineering Masters Programme examiner

#### *National*

During a three-year term on the **Life Sciences Interfaces Forum committee** I was responsible for coordinating student participation at both the 2<sup>nd</sup> and 3<sup>rd</sup> national conferences. I also edited the 2<sup>nd</sup> and 3<sup>rd</sup> LSI conference proceedings and I was on the organising committee of the 3<sup>rd</sup> LSI conference held in Southampton, UK.

In 2005 I **founded the first IEEE Women in Engineering Student Chapter in the UK**. This student branch has gone on to win national and regional awards by IEEE. I continue my involvement of the society as a member.

In 2009 (-2016), I was invited to join Headway – the brain injury association (Southampton Branch) on the **board of trustees**. Headway Southampton is a volunteer organisation and registered charity affiliated to the national headway group. Headway Southampton offers a wide range of services, including rehabilitation programmes, carer support, social re-integration and community outreach. As a trustee, I was responsible for overseeing the logistical and financial governance of the organisation.

In September 2010 I organised the first **UK Hand & Wrist Biomechanics Symposium**, which was hosted by the FHS. The objective of the meeting was to bring together leading researchers from around the UK in the field. The event was very successful; attracting delegates from Universities in Scotland and England, as well as clinicians from across the South. The outcome of the meeting was the formation of the **UK Hand & Wrist Biomechanics Network**, for which I am coordinator. Two national meetings have since been held in Glasgow and Cardiff.

Details for the last three years (including current year) together with a summary of significant activities in previous years.

In January 2011 I coordinated, with Professor Jane Burridge, a **KT-EQUAL workshop on Rehabilitation Technologies for Stroke**. This workshop was attended by a multidisciplinary audience, including a keynote speaker from the Netherlands. The workshop also included a number of national and European exhibitors who demonstrated upper limb rehabilitation technologies.

As part of my Enterprise Role and my international profile through the **SHAP Business Enterprise**, I was invited to attend the **Global Business Summit at the British Embassy** in London in September 2012. The summit was held for predominately industry sector and visiting international businessmen and women visiting the UK to coincide with the Olympic and Paralympic Games. Also as part of my enterprise role, I **chaired the Business Engagement Series**; a monthly seminar series coordinated by RIS to provide enterprise-specific training to the University ECR community. This ran throughout 2013/14 and 2014/15.

#### *Collaborators*

- Cambodian Society of Prosthetics & Orthotics – EPSRC GCRF Project
- University of Salford, UK – Child prosthetics and activity monitoring for prosthetic use
- National Cheng Kung University, Taiwan – PianoHAWK project
- EPFL, Switzerland – Muscle Synergies project
- Yale University, USA – Child prosthetics project
- Institut des Sciences du Mouvement, France – PianoHAWK project
- Morgan Innovation & Technology Limited, Petersfield, UK – Haptics Project
- Chemring Technology Solutions, Romsey, UK – Kinect Project
- London Sinfonietta, London, UK – AHRC Doctoral Collaboration Award
- Sound Media, London, UK – AHRC Doctoral Collaboration Award

### **COMMUNITY ACTIVITIES**

Details for the last three years (including current year) together with a summary of significant activities in previous years.

I actively engage in promoting my research and professional profile to the public in many different ways. My research has been publicised in the national and international media, including the **BBC, CNN, The Guardian, THE**, and more discipline-specific outlets such as **Pianist** and **The Engineer**.

In 2017, **three of my research projects** were developed into **public engagement exhibitions** presented at the Southampton Science & Engineering Week; Hands on Sound (users create music using gesture control), haptics (finger-worn devices that simulate sensory feedback) and Life at the Cutting Edge (investigating the skills required to use prehistoric tools). I also represented another multidisciplinary project with Bioengineering on our **GCRF project** to help widen access to prosthetic services across **Cambodia** at the **New Forest Show**. This exhibition was improved and expanded using funding from **UoS PERu** for 2018 at the Show.

During 2010 I **coordinated a book collection** and I liaised with the International Society of Biomechanics, to donate over 200 books to Moi University, Kenya.

In July 2010 - 14, I **coordinated the FHS component for the Bioengineering Smallpeice Trust** 1-week residential course to promote engineering careers for 16-year olds, providing three core modules on transcranial magnetic stimulation (TMS), the LifeShirt™ for measuring respiratory rate and motion capture. The motion capture session which I delivered was rated 93% (17 excellent and 6 good reviews).

Signed:



Date:	9 <sup>th</sup> February 2019
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