

# Philippe Malcolm

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## Education

- 2004-2010 Ph.D., Ghent University  
Thesis: Influence of intrinsic and extrinsic determinants on the transition from walking to running.  
Advisor: Dirk De Clercq, committee: Andre Seyfarth, Marc Van Leemputte, Jos Vanrenterghem, Kristiaan D'Aout, Eric Witvrouw, Wim Derave
- 2003 Second M.Sc., Academic Teaching Training, Ghent University
- 2000-2002 M.Sc. in Physical Education (Kinesiology), Ghent University,  
Grade: magna cum laude
- 1998-2000 B.Sc. in Physical Education (Kinesiology), Ghent University,  
Grade: cum laude
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## Positions

- 2015-Present Postdoctoral Research Fellow, Harvard University  
John A. Paulson School of Engineering and Applied Sciences  
and Wyss Institute for Biologically Inspired Engineering  
Role: Biomechanics team-lead in project on design and development of a soft lower-extremity assistive device  
Advisor: Conor J. Walsh
- Summer 2013 Visiting Scholar, Carnegie Mellon University  
Department of Mechanical Engineering  
Project: The influence of push-off timing in a robotic ankle-foot prosthesis on the energetics and mechanics of walking  
Advisor: Steven H. Collins
- 2010-2014 Postdoctoral Assistant, Ghent University  
Department of Movement and Sports Sciences  
Laboratory of Movement Science  
Advisor: Dirk De Clercq
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## Publications

### Journal papers as first author (\* is equal contribution)

Malcolm, P., Derave W., Galle, S., De Clercq, D., 2013. A simple exoskeleton that assists plantarflexion can reduce the metabolic cost of human walking. *PLoS One*, 8(2), p.e56137.

**IF 3.534, 52 citations, (1 citation in Nature), more than 9500 views**

Malcolm, P., Quesada, R.E., Caputo, J.M., Collins, S.H., 2015. The influence of push-off timing in a robotic ankle-foot prosthesis on the energetics and mechanics of walking. *Journal of Neuroengineering and Rehabilitation*, 12(21).

IF 2.74, 5 citations, more than 1800 views (in less than one year)

Malcolm, P., Breine, B., et al., Frederick, E.C., Cheung, J., De Clercq, D. 2013. Correlations between strike index and 5,000 and 10,000 m performance in male runners. *Footwear Science*, 5(S1).

Malcolm, P. et al., 2009. Experimental study of the influence of the m. tibialis anterior on the walk-to-run transition by means of a powered ankle-foot exoskeleton. *Gait and Posture*, 29(1), pp.6–10.

IF 2.576, 24 citations

Malcolm, P. et al., 2009. Experimental study on the role of the ankle push off in the walk-to-run transition by means of a powered ankle-foot-exoskeleton. *Gait and Posture*, 30(3), p.p.322–327.

IF 2.576, 14 citations

\*De Smet, K., \*Malcolm, P. et al., 2009. Effects of optic flow on spontaneous overground walk-to-run transition. *Experimental Brain Research*, 193(4), pp.501–8.

IF 2.256, 14 citations

### Journal papers as co-author

Breine, B., Malcolm, P., Frederick, E.C., De Clercq, D. 2014. Relationship between running speed and initial foot contact patterns. *Medicine and Science in Sports and Exercise*, 46(8), pp.1595–603.

**IF 4.459, 6 citations**

Breine, B., Malcolm, P. et al., 2015. Kinematic differences between (a) typical initial rearfoot and midfoot contact patterns. *Footwear Science*, 7(S1), pp.S102–103.

Galle, S., Malcolm, P. et al., 2015. Uphill walking with a simple exoskeleton: Plantarflexion assistance leads to proximal adaptations. *Gait and Posture*, 41(1), pp.246–51.

Galle, S., Malcolm, P., et al., 2014. Enhancing performance during inclined loaded walking with a powered ankle-foot exoskeleton. *European journal of Applied Physiology*, 114(11), pp.2341–51.

Van Caekenberghe, I., Malcolm, P., et al., 2013. A gradual shift in initial foot-to-ground contact patterns depending upon acceleration. *Footwear Science*, 5(S1), pp.S88–89.

Galle, S., Malcolm, P., et al., 2013. Adaptation to walking with an exoskeleton that assists ankle extension. *Gait and Posture*, 38(3), pp.495–499.

IF 2.299, **15 citations (1 citation in Nature)**

Journal papers under review or in preparation (\* is equal contribution)

Malcolm, P., Galle, S., Van den Berghe, P., De Clercq, D. Analysis of walking with unilateral exoskeleton assistance compared to bilateral assistance with matched work.

Malcolm, P., Lee, S., et al., Study of the isolated contribution of negative work assistance with a soft ankle exosuit during loaded walking.

\*Galle, S., \*Malcolm, P., Speeckaert, J., Collins, S.H., De Clercq, D. Minimizing the metabolic cost of walking by optimizing actuation timing and average power of ankle exoskeletons.

Breine, B., Malcolm, P., et al., Initial foot contact and related kinematics affect impact loading rate in running.

Breine, B., Malcolm, P., et al., Spatial distribution of impact intensity under the foot relates to initial foot contact pattern.

Lee, S., Crea, S., Malcolm, P., Galiana I., Asbeck, A., Walsh, C. 2016. Controlling negative and positive power at the ankle with a soft exosuit. In *International Conference on Robotics and Automation*. Stockholm.

Conference abstracts as first author (\* is equal contribution)

Malcolm, P., et al., 2015. Analysis of walking with unilateral exoskeleton assistance compared to bilateral assistance with matched work. In *Dynamic Walking*. Columbus.

\*Galle, S., \*Malcolm, P., Speeckaert, J., Collins, S.H., De Clercq, D. et al., 2015. Optimizing robotic exoskeletons actuation based on human neuromechanics experiments: interaction of push-off timing and work. In *Symposium on Adaptive Motion of Animals and Machines*. Cambridge.

Malcolm, P., Quesada, R., et al., 2014. Effect of push-off timing on metabolic cost during walking with a universal ankle-foot prosthesis emulator. In *Dynamic Walking*, Zürich.

\*Galle, S., \*Malcolm, P. et al., 2014. Exploring metabolic landscapes versus exoskeleton and prosthesis actuation parameters. In *Dynamic Walking*. Zürich.

Malcolm, P. et al., 2013. Powered biarticular exoskeleton with gastrocnemius mimicking configuration produces higher reduction in metabolic cost than soleus mimicking configuration. In *International Society of Biomechanics, XXIVth Congress*. Natal.

Malcolm, P., et al., 2013. A simple exoskeleton that assists plantarflexion can reduce the metabolic cost of human walking. In *Dynamic Walking*. Pittsburgh.

Malcolm, P. et al., 2012. Exoskeleton with optimal timing reduces metabolic cost due to EMG reduction. In *17th VK symposium*. Brussels.

Malcolm, P., Afschrift, M., et al., 2011. Feasibility of an exoskeleton powered by eccentric joint work for reducing metabolic cost. In *16th VK symposium*. Ghent.

Malcolm, P., Derave, W. & De Clercq, D., 2011. A plantarflexion assisting exoskeleton optimally reduces metabolic cost of walking when actuation onset coincides with push off phase. In *International Society of Biomechanics, XXIIIrd Congress*. Brussels, p. 437.

Malcolm, P., Galle, S., et al., 2011. An exoskeleton for fundamental research on human gait. In *Flanders innovation in assistive technologies*. Leuven.

Malcolm, P., Segers, V., Van Caekenberghe, I., et al., 2009. Resisting versus assisting the ankle musculature has a unidirectional effect on walk-to-run transition speed. In *14th VK symposium*, Leuven.

- Malcolm, P., De Clercq, D. & Van Lancker, W., 2009. Regression analysis on longitudinal kinematical data from one elite high jump athlete in competition. In *International Society of Biomechanics, XXIIInd Congress*. Cape Town, p. 170.
- Malcolm, P. et al., 2007. A pneumatic ankle-orthosis as a mean to experimentally validate hypotheses about the role of the tibialis anterior in the walk-to-run transition. In *Journal of Biomechanics*. pp. S711–S711.
- Malcolm, P. et al., 2007. EMG-analysis of resisted and assisted dorsiflexion during gait transition. In *12th VK symposium*. Ghent, p. 35.
- Malcolm, P. et al., 2006. A pneumatic ankle-foot-orthosis as a mean to experimentally validate hypotheses about the role of the ankle musculature in human gait transitions. In *11th VK-symposium*. Antwerp, p. 35.
- Malcolm, P. et al., 2005. Treadmill versus overground run-to-walk and walk-to-run speed in unsteady state locomotion conditions. In *10th VK symposium*. Leuven, p. 40.
- Malcolm, P. et al., 2005. Treadmill versus overground run-to-walk and walk-to-run speed in unsteady state locomotion conditions. In *International Society of Biomechanics XXth Congress*. Cleveland.

#### Conference abstracts as co-author

- Galiana, I., Wagner, D.A., Couture, A., Karavas, N., Lee, S., Malcolm, P., Panizzolo, F., Sivi, C., Popov, D., Granberry, R., Quinlivan, B., Eckart-Erdheim, A., Ding, Y., Morgenson, M., Holt, K.G., Walsh, C.J., 2015. Next generation soft wearable exosuits to assist human walking. In *7th Annual Wyss retreat*. Boston.
- Galle, S., Malcolm, P. & De Clercq, D., 2015. Walking with a plantar flexion assisting ankle-foot exoskeleton in an older population. In *International Society of Biomechanics, XXVth Congress*. Glasgow.
- Panizzolo, F., Galiana, I., Asbeck, A., O' Neill, C., Saucedo, F., Allen, S., Sivi, C., Malcolm, P., Holt, K., Walsh, C., 2015. Evaluation of a multi-joint soft exosuit for gait assistance. In *Symposium on Adaptive Motion of Animals and Machines*. Cambridge.
- Speeckaert, J., Galle, S., Malcolm, P., De Clercq, D., 2014. Optimization of exoskeleton assistance: timing of actuation and exoskeleton power. In *19th VK-Symposium*. Antwerpen.

- Van den Berghe, P., Malcolm, P., Galle, S., Calders, P., et al., 2014. Augmenting metabolic economy of walking with a unilateral or bilateral exoskeleton. In *Sport-medicine scientific conference: sports, movement and health*. Ermelo.
- Van den Berghe, P., Malcolm, P., Galle, S. & De Clercq, D., 2014. Unilateral exoskeleton assistance lowers metabolic cost in human walking. In *19th VK symposium*. Antwerp.
- Galle, S., Malcolm, P., et al., 2013. Assisted plantarflexion influences muscular activity in all leg muscles during uphill walking. In *International Society of Biomechanics, XXIVth Congress*.
- Galle, S., Malcolm, P., et al., 2011. A simple ankle-foot exoskeleton can lower the metabolic cost of walking. In *International Society of Biomechanics, XXIIIrd Congress*. Brussels.
- Segers, V., Van Caekenberghe, I., Malcolm, P. et al., 2011. Neuromechanics of walk-to-run transitions. In *ECSS, 16th Annual Congress*. Liverpool.
- Fiers, P. et al., D'Hollander, B., Malcolm, P., De Clercq, D., 2008. Study of the role of the plantarflexors in walk-to-run transition by means of a pneumatic ankle-foot exoskeleton. In *13th VK symposium*. p. 18.
- Van Caekenberghe, I. , Malcolm, P., et al., 2008. How to determine spatiotemporal variables on an accelerating treadmill? In *13th VK symposium*. Brussels, p. 31.
- Van Caekenberghe, I., Malcolm, P., De Clercq, D., 2007. Influencing ankle dorsiflexor stress during gait transition by means of pneumatic ankle-foot-exoskeletons has an effect on preferred walk-to-run transition speed. In *Sport & geneeskunde*. p. 19.
- De Smet, K., Malcolm, P., et al., 2008. Does optic flow influence the spontaneous overground walk-to-run transition? In *13th VK symposium*. Brussels, p. 26.
- De Smet, K., Malcolm, P. et al., 2008. Effects of optic flow when spontaneously accelerating towards the walk-to-run transition. In *North American Congress on Biomechanics*. p. 183.
- De Smet, K., Malcolm, P., et al., 2007. Flow can make you run: effects of optic flow on the overground walk-to-run transition. In *International Society of Biomechanics XXIth Congress*. Taipei, pp. 201–203.

De Smet, K., Malcolm, P. et al., 2007. The way to gait transition: spatiotemporal characteristics of the spontaneous overground walk-to-run transition. In *European Workshop On Movement Science*. Koln.

Verhelst, R., Malcolm, P., et al., 2007. Ground reaction force of a drop jump on different kinds of artificial turf. In *Vith world Congress on Science and Football*.

#### Other publications

Malcolm, P. & De Clercq, D., 2013. Best practice in biomechanics and how it can be used in high performance sport: The longitudinal follow-up during competition of an elite high-jump athlete. In *Managing High Performance Sport*. ISBN-10: 041567199X.

Malcolm, P., 2010. Influence of intrinsic and extrinsic determinants on the transition from walking to running. *Ph.D. thesis*, Ghent University. Faculty of Medicine and Health Sciences.

De Clercq, D. & Malcolm, P., 2009. Elite sports movement analysis: added value for training programs. *Flemish trainer school*.

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### **Invited Presentations**

- 2014 Optimization of a simple Assistive Exoskeleton through human biomechanics experiments, Biodesign lab meeting, Harvard University, Cambridge
- 2014 Optimization of actuation and configuration of assistive devices for walking through human experiments, 7<sup>th</sup> World Congress of Biomechanics, Boston
- 2013 Effect of actuation and configuration of assistive devices, Lab visit, University of Michigan, Ann Arbor.
- 2013 Bipedal locomotion seminar, Carnegie Mellon University, Pittsburgh
- 2013 A simple exoskeleton can reduce the metabolic cost of walking. Dynamic Walking Conference, Carnegie Mellon University, Pittsburgh  
Video: [www.youtube.com/watch?v=qXIfHBH4ry0#t=8656](http://www.youtube.com/watch?v=qXIfHBH4ry0#t=8656)
- 2013 A simple pneumatically powered exoskeleton can reduce the metabolic cost of walking, High Tech Systems, Eindhoven
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### **Hardware Demonstrations**

- 2015 Warrior Web demo: Harvard Soft Exosuit. *DARPA Wait What? A Future Technology Forum*, St. Louis.
- 2014 WALL-X : A semi-Wearable Assistive Lower Leg eXoskeleton for testing metabolic effects of ankle assistance. *Dynamic Walking conference*, Zürich.
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## **Awards**

- October 2013 Study of the week, literature update on mailing list sponsored by the International Society of Biomechanics  
Study: Adaptation to walking with an exoskeleton that assists ankle extension.
- April 2013 Study of the week, literature update on mailing list sponsored by the International Society of Biomechanics  
Study: A simple exoskeleton that assists plantarflexion can reduce the metabolic cost of human walking.
- 2007 Young Investigator Award, International Society of Biomechanics, XXIth Congress, Taipei  
Study: A pneumatic ankle-foot-orthosis as a mean to experimentally validate hypotheses about the role of the tibialis anterior in the walk-to-run transition.
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## **Grant Applications**

- 2015 Contribution to writing grant application for NSRDEC broad agency announcement  
Title: Optimizing wearable robotic joint actuation based on human motor adaptation studies  
Requested amount: 1 350 000 \$, Status: under review  
P.I.: Conor J. Walsh
- 2013 International mobility grant from Ghent University Hospital, Commission for scientific research  
Amount: 4 000 \$  
Used for travel and living expenses for 4.5 month visiting scholarship at Carnegie Mellon University
- 2013 International mobility grant from Flanders national research foundation (CMMI-1300804)  
Amount: 1 250 \$  
Used for International Society of Biomechanics, XXIVth Congress, Natal and 11<sup>th</sup> Biennial Footwear Biomechanics Symposium, Natal

- 2011, 2012 Contribution to writing industry grants obtained from Li Ning Inc. (A10-TT-1265)  
Title: Footstrike transitions in runners I and II, Amount: 85 000 \$  
P.I.: Dirk De Clercq, beneficiary: Samuel Galle
- 2010 Contribution to writing Ph.D. grant application that was obtained from Ghent University special research fund (BOF10/DOC/288).  
Title: Optimization and physiological application of a powered ankle-foot exoskeleton: an experimental study of the muscular determinants of sustained locomotion.  
Amount: 4 years Ph.D. salary  
Advisor: Dirk De Clercq, beneficiary: Samuel Galle
- 2007 Contribution to writing grant application obtained from Flemish Athletics Federation  
Topic: Scientific support of an elite female highjumping athlete between 2007 and 2012  
Amount: 60 000 \$  
P.I.: Dirk De Clercq
- 2006 Contribution writing to Ph.D. grant application that was obtained from Flanders national research foundation (B/08892/01)  
Title: Influence of visual determinants on the walk-run transition.  
Amount: 4 years Ph.D. salary  
Advisor: Dirk De Clercq, beneficiary: Kristof De Smet

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### **Consultancy Projects**

- 2011-2012 Footstrike Transitions in Runners, Li-Ning Company Ltd.  
PI: Dirk De Clercq
- 2007-2012 Scientific support project for an elite highjumping athlete, Flemish Athletics Federation, PI: Dirk De Clercq
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## **Popular Media**

- 2015 Citations in BBC news, The Economist and Popular Mechanics
- 2015, 2013 Two articles in Eos Magazine (Dutch and Belgian popular science magazine)
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## **Memberships**

- 2014 Robo8 leadership board (national board on assistive robotic devices with members from academia, healthcare industry and government agencies)
- 2007-2013 International Society of Biomechanics
- 2013-2014 iRunMan lab: user group of new sports science lab consisting of members from kinesiology, rehabilitation and engineering
- 2012-2014 Triathlon federation think tank
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## **Referee services**

Gait and Posture, Journal of Neuroengineering and Rehabilitation, International Journal for Numerical Methods in Biomedical Engineering, Journal of the Royal Society Interface, Medical Engineering & Physics, PLoS ONE, Transactions on Biomedical Engineering, Transactions on Neural Systems & Rehabilitation Engineering

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## **Academic Outreach**

- 2015 Family Day of Discovery, Harvard University: Soft Exosuit demonstration
- 2014 Kids university day, Ghent University: Lecture about biomechanical support of an elite high jump athlete
- 2009 Science night, Ghent University: Biomechanical support of an elite high jump athlete
- 2004-2014 Ghent University: Yearly open-lab days for high-school students
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## **Teaching**

- 2013-2014 Honors program in movement science, 1<sup>st</sup> and 2<sup>nd</sup> year of kinesiology M.Sc.: advanced internship to prepare students for a job as sports scientist or the start of a Ph.D.
- 2012-2013 Lecturer in individual movement activities 1<sup>st</sup> and 2<sup>nd</sup> year of kinesiology M.Sc.: coordination of sports and sports didactics courses from 5 teaching assistants on track and field, artistic gymnastics and swimming.
- 2008-2011 Movement analysis of fitness training, 1<sup>st</sup> year of kinesiology M.Sc.: EMG and isokinetic measurement practicum
- 2004-2014 Sport specific movement analysis, 1<sup>st</sup> year of kinesiology M.Sc.: demonstration of all measurement methods in sports biomechanics and hands-on projects of each students his sports-coaching specialization
- 2004-2014 Movement analysis, 3<sup>st</sup> year of kinesiology B.Sc.: practical exercises on gait analysis and lifting ergonomics with treadmill, force plate, video and motion capture
- 2004-2014 Biomechanics, 2<sup>nd</sup> year of kinesiology B.Sc.: practical exercises on ground reaction force measurement and data analysis in Excel
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## **Mentoring and Advising**

- 2015 Co-mentor of one design-engineering final project at Harvard University
- 2010-2015 Co-advisor Ph.D. thesis: Breine B.: Initial foot contact patterns in shod running, relationship with speed and impact intensity
- 2010-2015 Mentor Ph.D. thesis: Galle S.: Ankle-foot exoskeletons, from experimental optimization to practical applications
- 2011-2015 Advisor of eight M.Sc. theses in kinesiology and one M.Sc. thesis in electromechanical engineering
- 2013-2015 Mentor of two honors theses
- 2004-2010 Mentor of seven M.Sc. theses in kinesiology
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**Skills**

3D kinematics, anthropometry, biomechanics, bionics, biomechatronics, electromyography, Excel VBA, exercise physiology, exoskeletons, footwear, gait analysis, ground reaction force, indirect calorimetry, inverse dynamics, lactate testing, machine learning, Matlab, motor control, motion capture, orthotics, plantar pressure, prosthetics, basic prototyping skills, robotics, Simulink, sports performance support, ultrasonography, video-analysis, Visual3D

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**Languages**

English, French, Dutch

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**Personal**

2003-2012     Elite-level Olympic-distance triathlon athlete: member of a French 2<sup>nd</sup> division squad, multiple top-10 places at national championships, one 1<sup>st</sup> place in a national cat-1 race and one 3<sup>rd</sup> place on national Olympic distance ranking

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## Contact Information for References

Conor J. Walsh, Assistant Professor  
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and Wyss Institute for Biologically Inspired Engineering  
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and Delft University of Technology  
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