EMG-triggered surface FES for arm reaching in tetraplegia

Dimitra Blana, Edward K Chadwick
Institute for Science and Technology in Medicine, Keele University

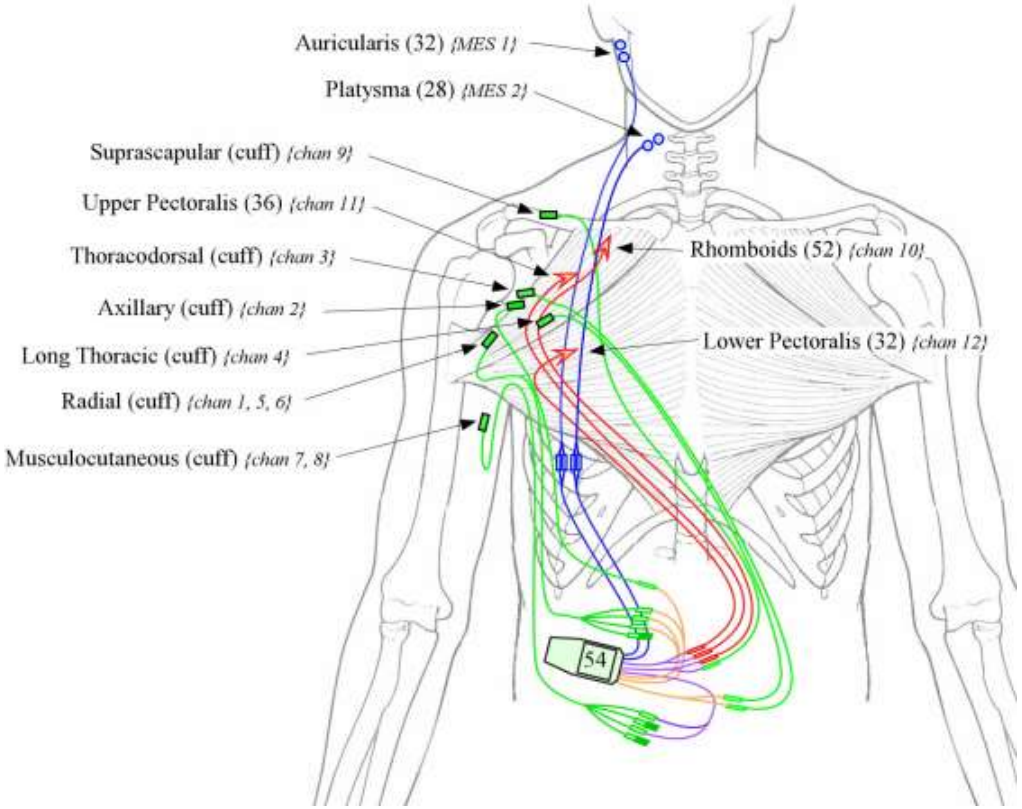
Neil Postans, Simon Pickard
Robert Jones and Agnes Hunt Orthopaedic Hospital, Oswestry

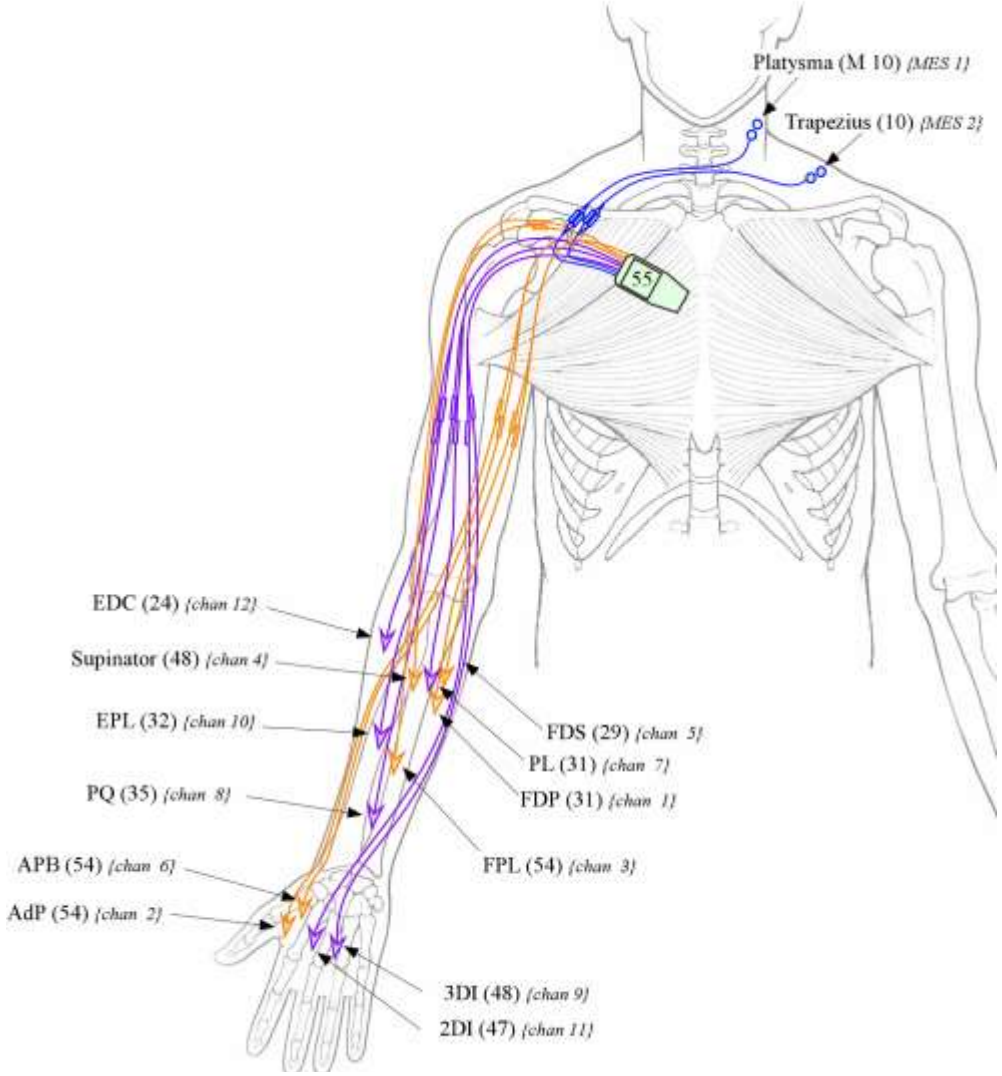
Implanted FES for restoring arm function

cleveland FES center

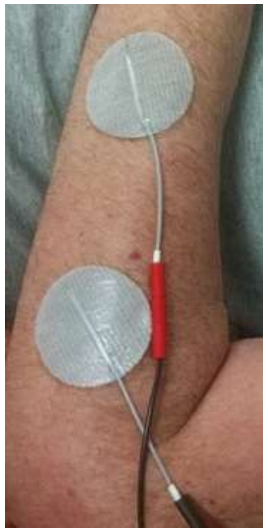
CASE WESTERN RESERVE UNIVERSITY

Implanted FES for restoring arm function



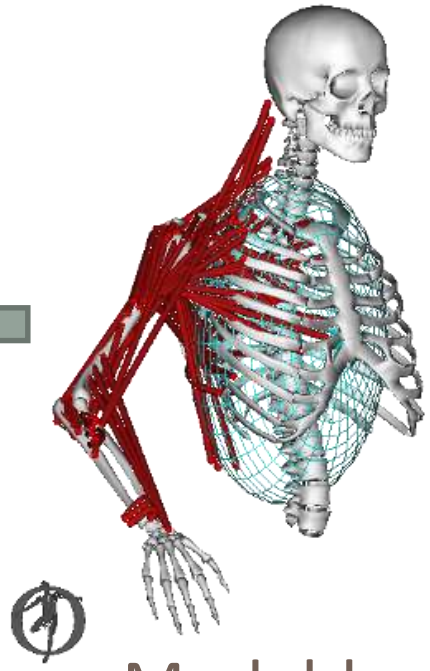


Surface FES for restoring arm function?



Surface FES

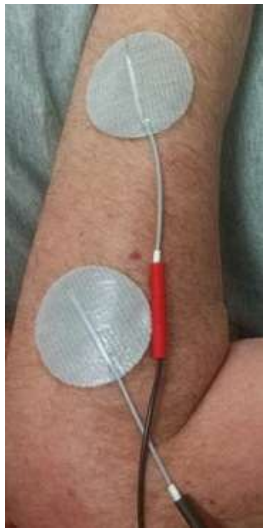
Orthosis



Model-based
FES controller

NHS

Surface FES for restoring arm function?



Surface FES

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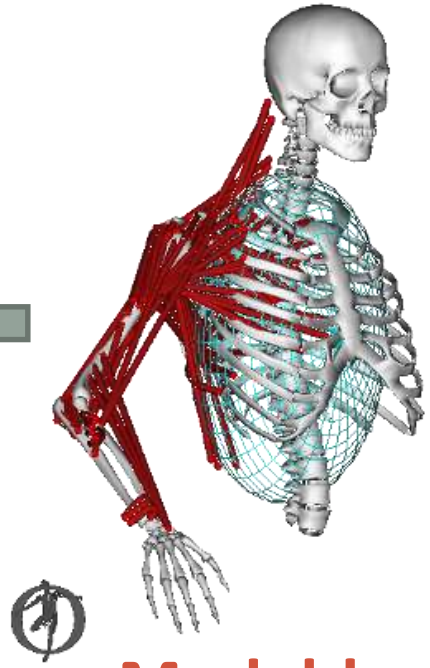

Model-based FES controller

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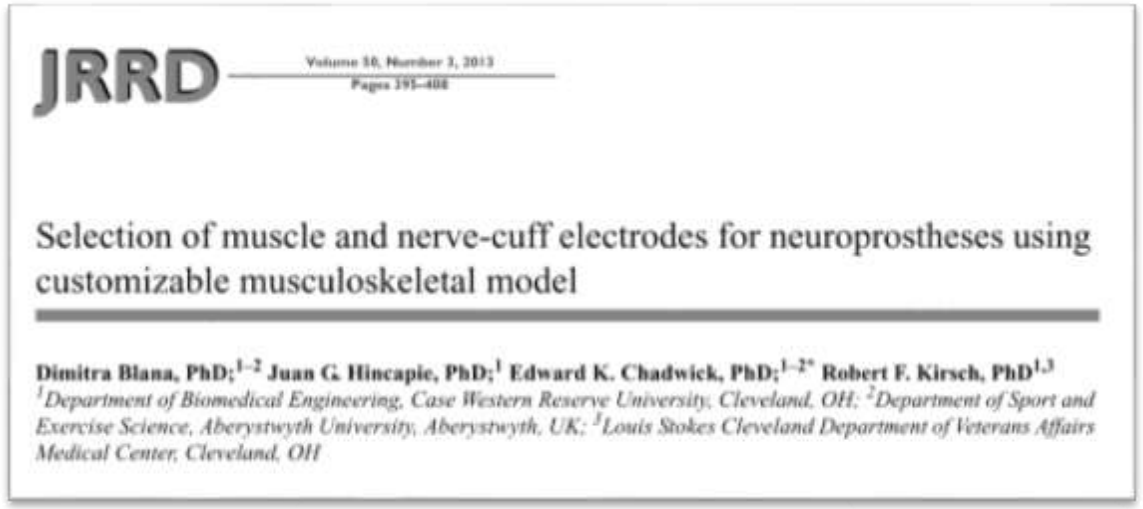
How do we use models?

- To optimise the design



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Selection of muscle and nerve-cuff electrodes for neuroprostheses using customizable musculoskeletal model

Dimitra Blana, PhD;[1–2] Juan G. Hincapie, PhD;[1] Edward K. Chadwick, PhD;[1–2*] Robert F. Kirsch, PhD[1,3]
[1]*Department of Biomedical Engineering, Case Western Reserve University, Cleveland, OH;* [2]*Department of Sport and Exercise Science, Aberystwyth University, Aberystwyth, UK;* [3]*Louis Stokes Cleveland Department of Veterans Affairs Medical Center, Cleveland, OH*

How do we use models?

- To optimise the design
- To be a testing platform

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COMMUNICATION

Continuous neuronal ensemble control of simulated arm reaching by a human with tetraplegia

E K Chadwick[1,7], D Blana[1,7], J D Simeral[2,5], J Lambrecht[1], S P Kim[3], A S Cornwell[1], D M Taylor[1,4], L R Hochberg[2,5,6], J P Donoghue[2,3] and R F Kirsch[1,4]

[1] Department of Biomedical Engineering, Case Western Reserve University, Cleveland, OH, USA
[2] The Center for Restorative and Regenerative Medicine, Rehabilitation R&D Service, Department of Veterans Affairs, Providence, RI, USA
[3] Department of Neuroscience, Brown University, Providence, RI, USA
[4] Louis Stokes VA Medical Center, Cleveland, OH, USA
[5] School of Engineering, Brown University, Providence, RI, USA
[6] Department of Neurology, Massachusetts General, Brigham and Women's and Spaulding Rehabilitation Hospitals, Harvard Medical School, Boston, MA, USA

How do we use models?

- To optimise the design
- To be a testing platform
- To act as (part of) the device controller

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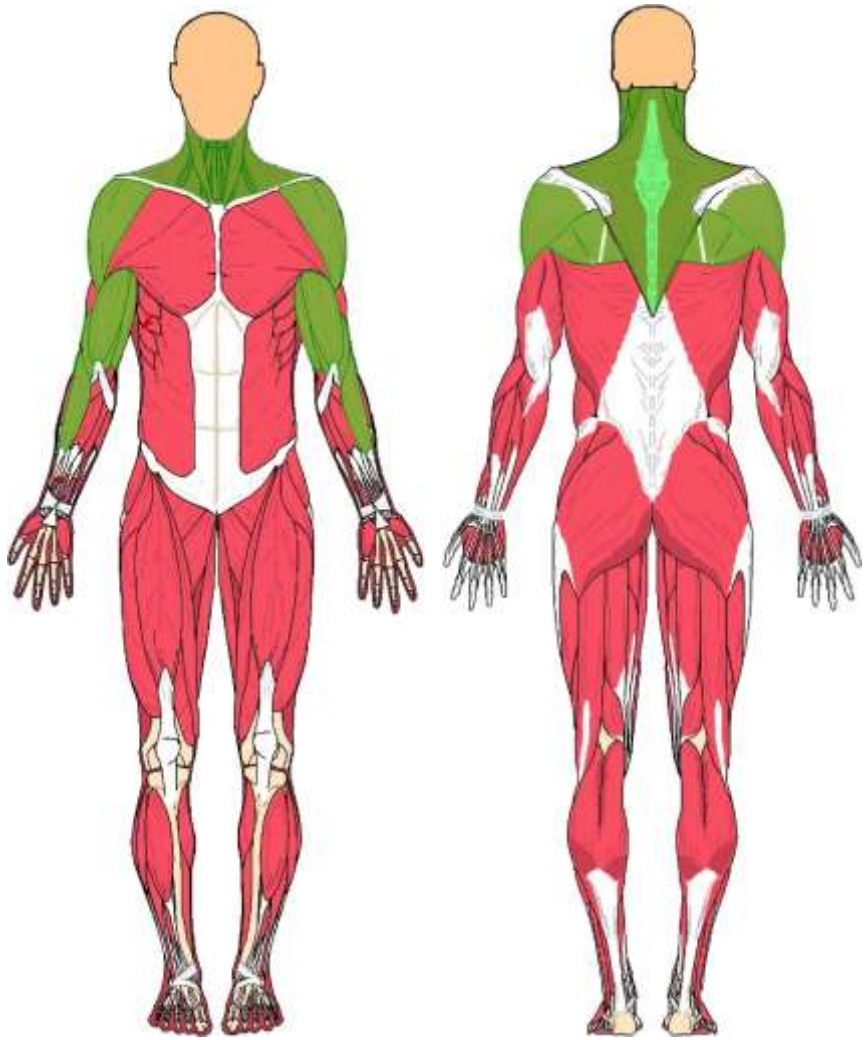
EMG-triggered surface FES

The patient was a 56-year old male, 19 months post injury (C4 Frankel A with some denervation at C8, but stimulatable C5,6 & 7).

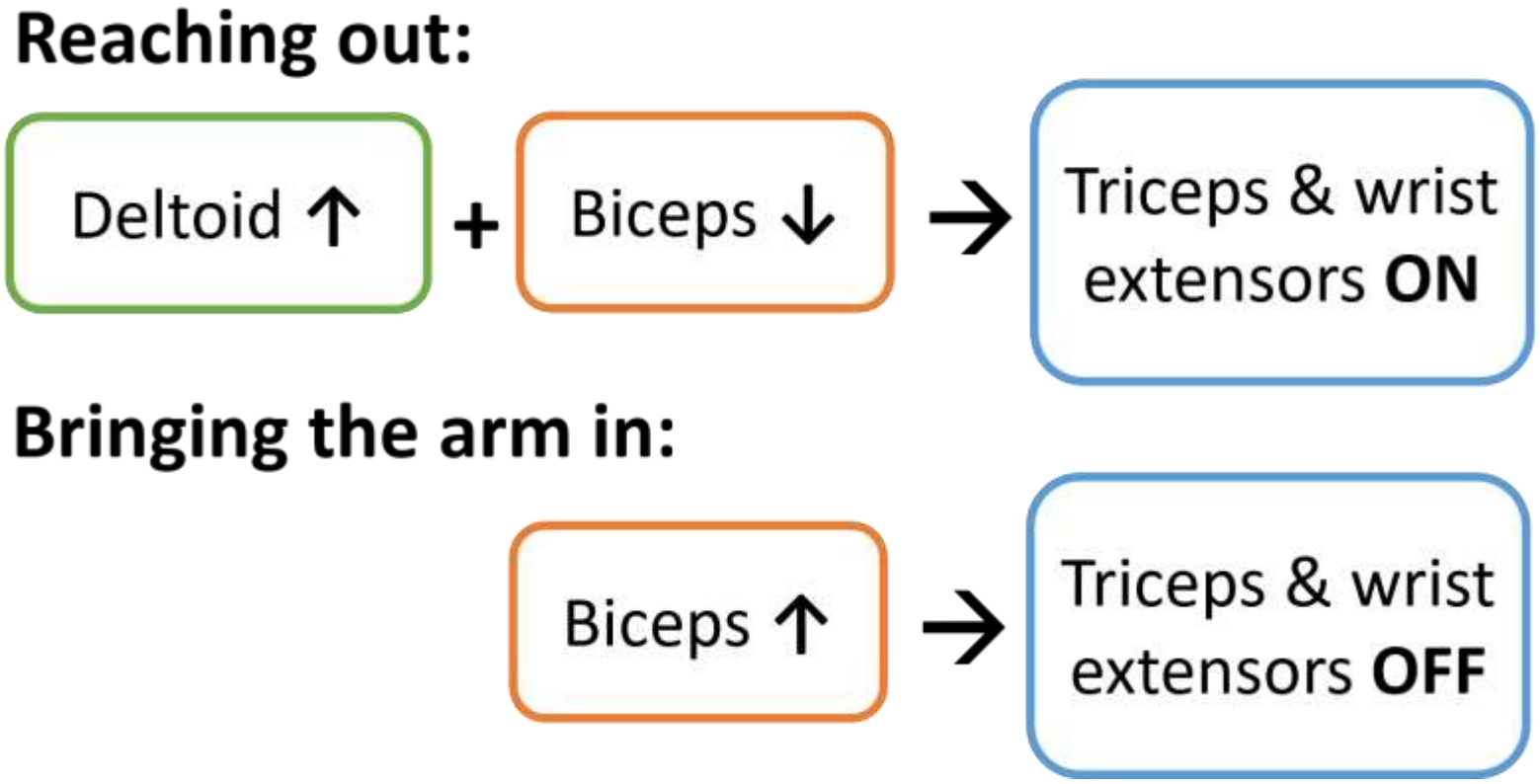


EMG-triggered surface FES

The patient was a 56-year old male, 19 months post injury (C4 Frankel A with some denervation at C8, but stimulatable C5,6 & 7).

We used an Ottobock STIWELL surface stimulator and placed recording EMG electrodes on the biceps and anterior deltoid, and stimulating electrodes on the triceps and wrist extensors.

The algorithm

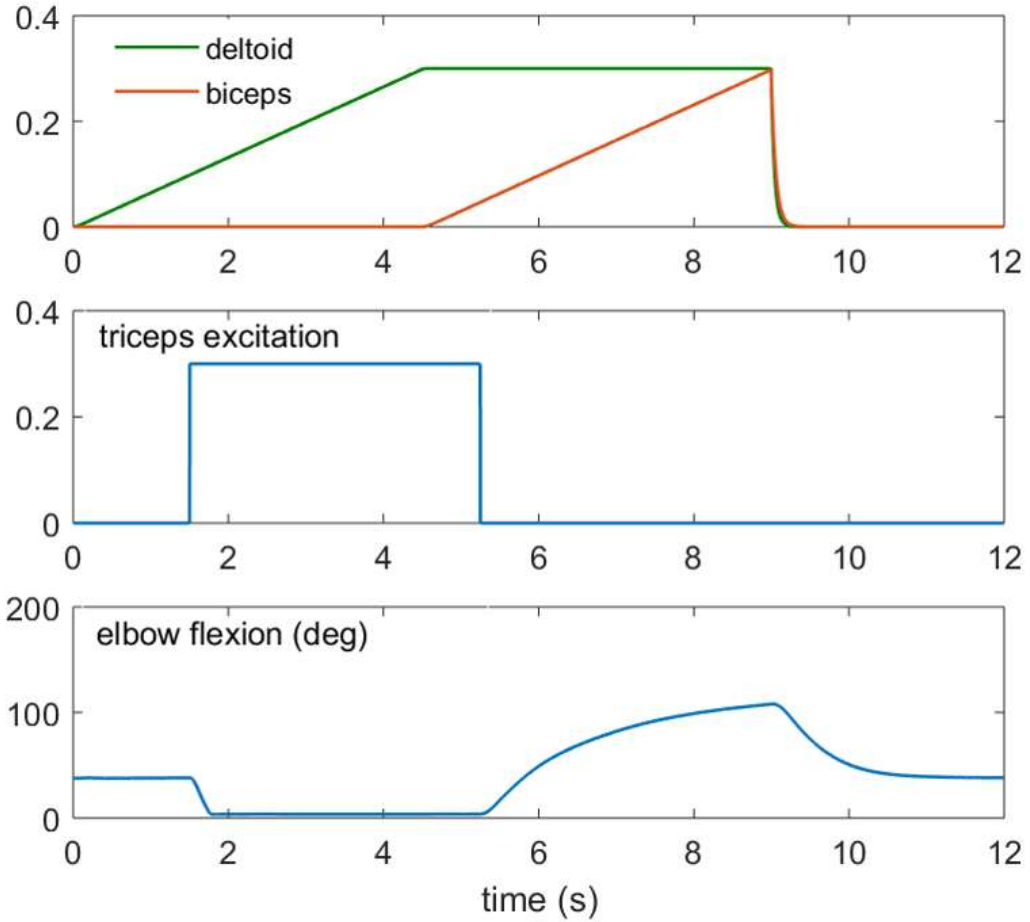


Example computer simulation

The deltoid activity is slowly increased while the biceps is off.

When the deltoid reaches the threshold of 10%

the triceps is stimulated and the elbow fully extends.



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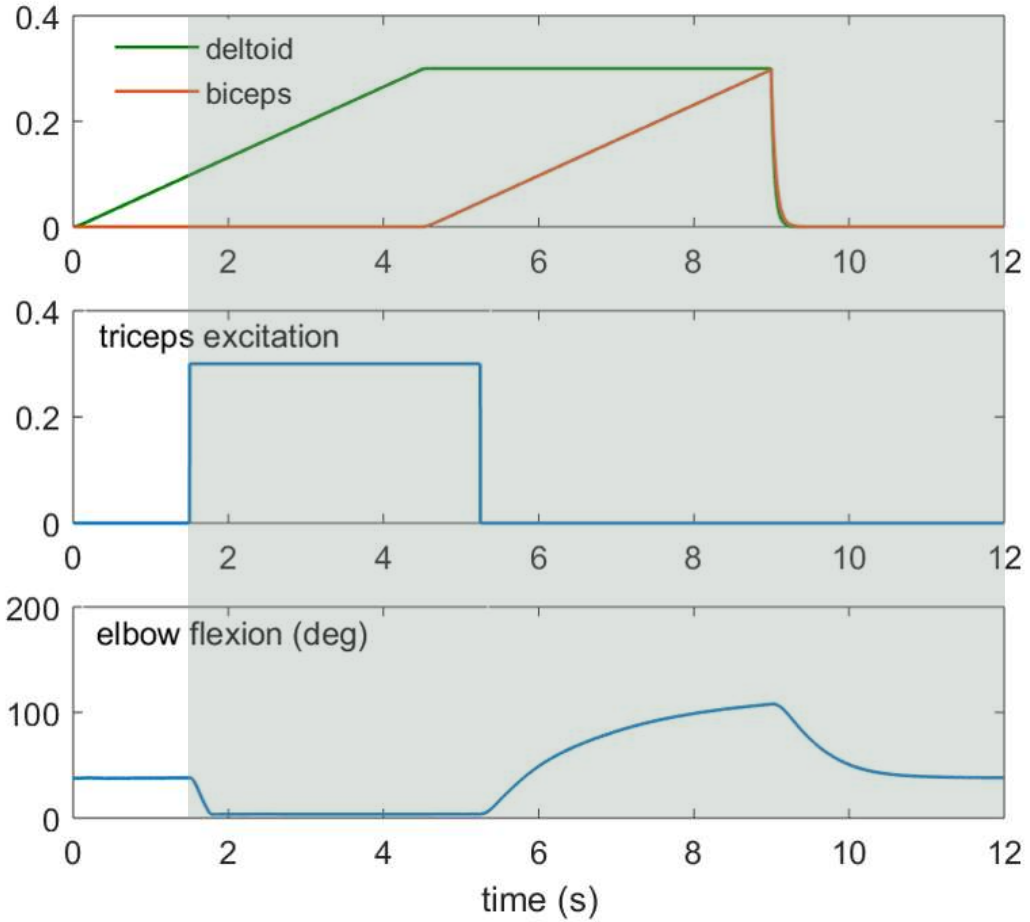

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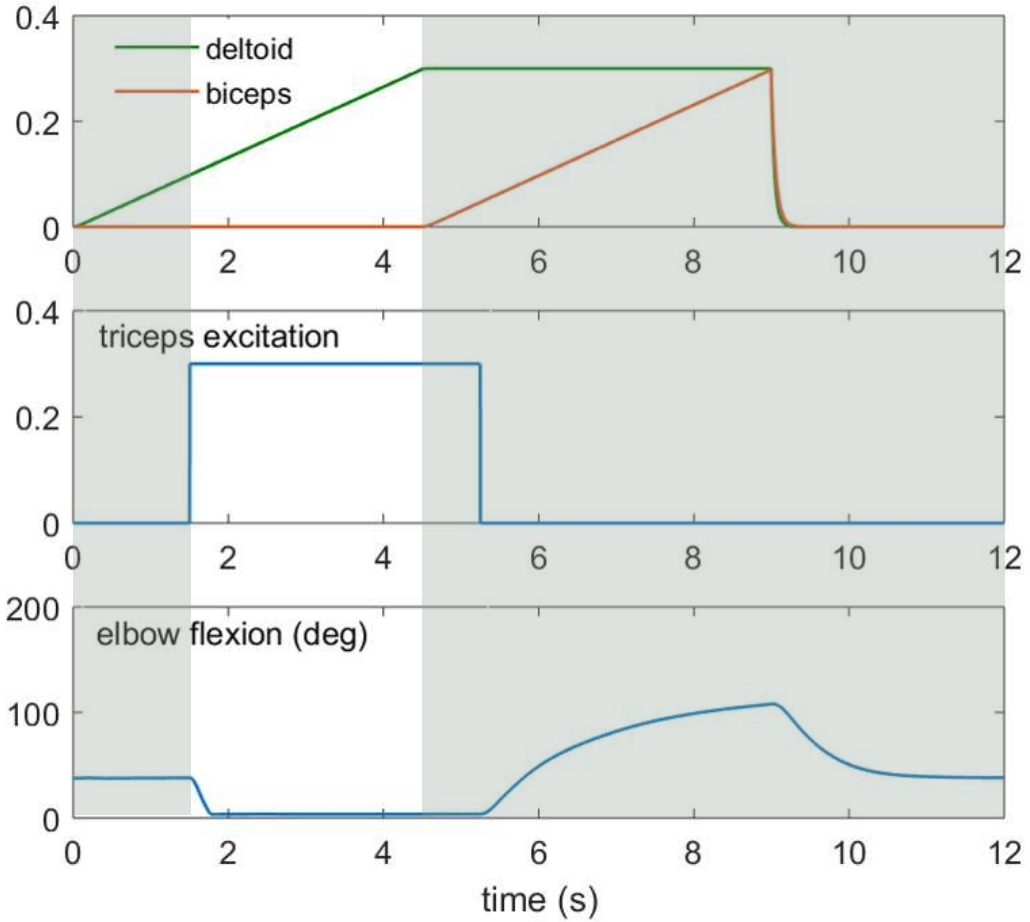
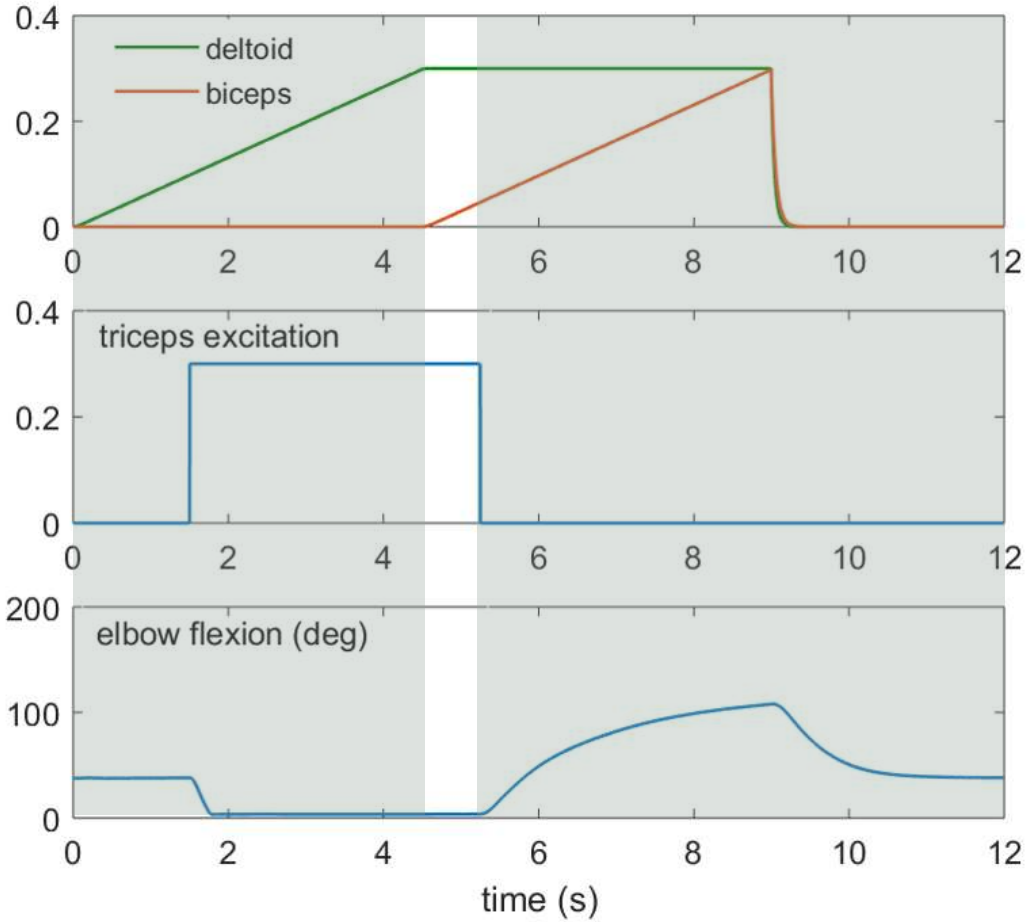


Example computer simulation

The biceps activity is then slowly increased.

When it reaches a threshold of 5%

the triceps stimulation is turned off and the elbow flexes.



Example computer simulation

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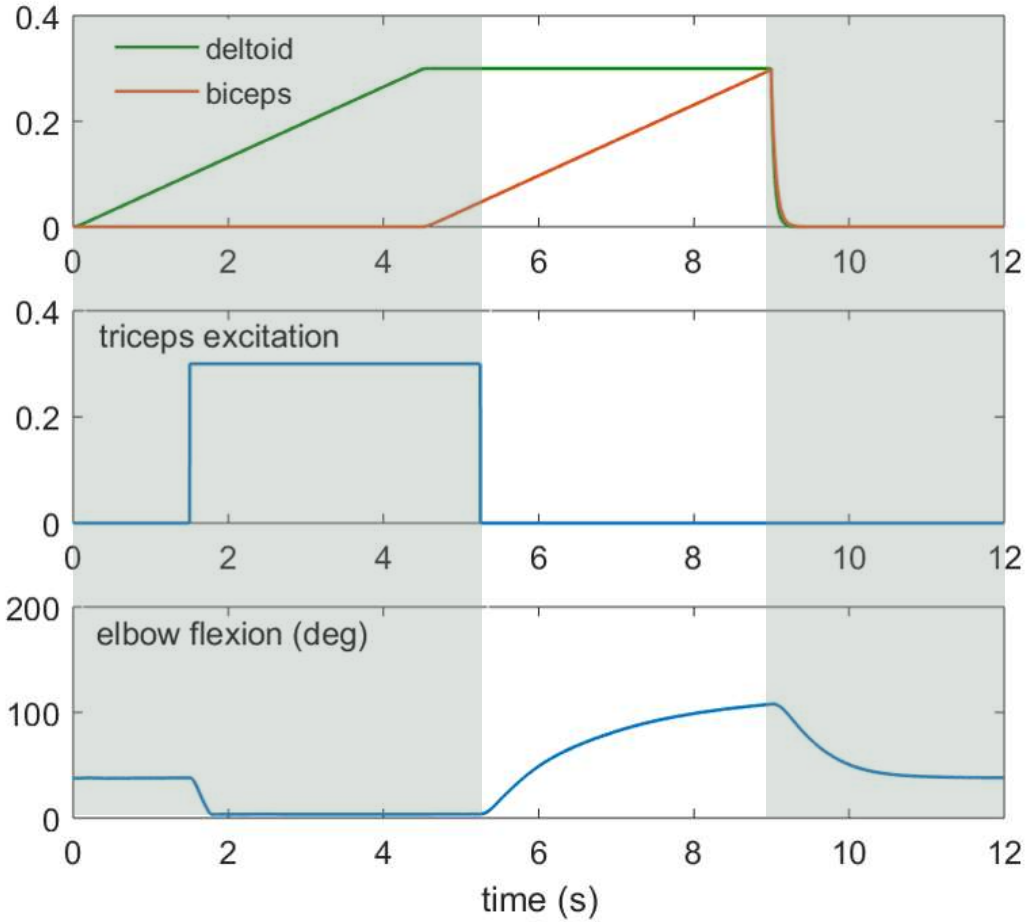
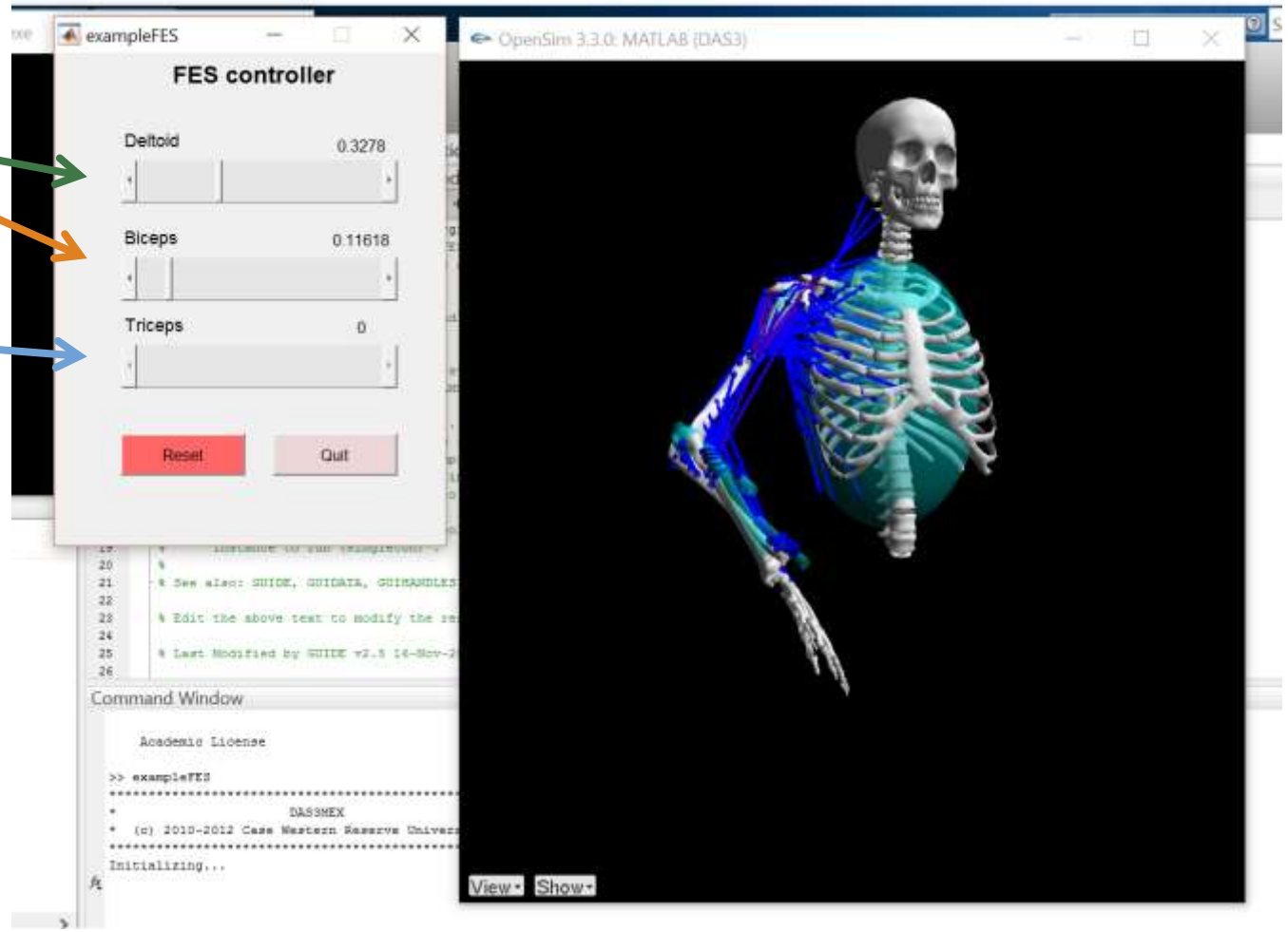


Graphical Interface

Sliders for deltoid and biceps “EMG”

control the triceps stimulation



Next steps

EMG-controlled

- Test ~~EMG-triggered~~ surface FES for arm reaching in tetraplegia
- Explore other technologies that could work with FES
- Optimize the choice and combination of EMG control signals using personalised computer simulations