Establishing Translational Research Pipelines for Smart Devices Using EMG Analysis to validate the stages to technological maturation of a Manual Wheelchair lightweight sensing hand rim

Background:

Methods:

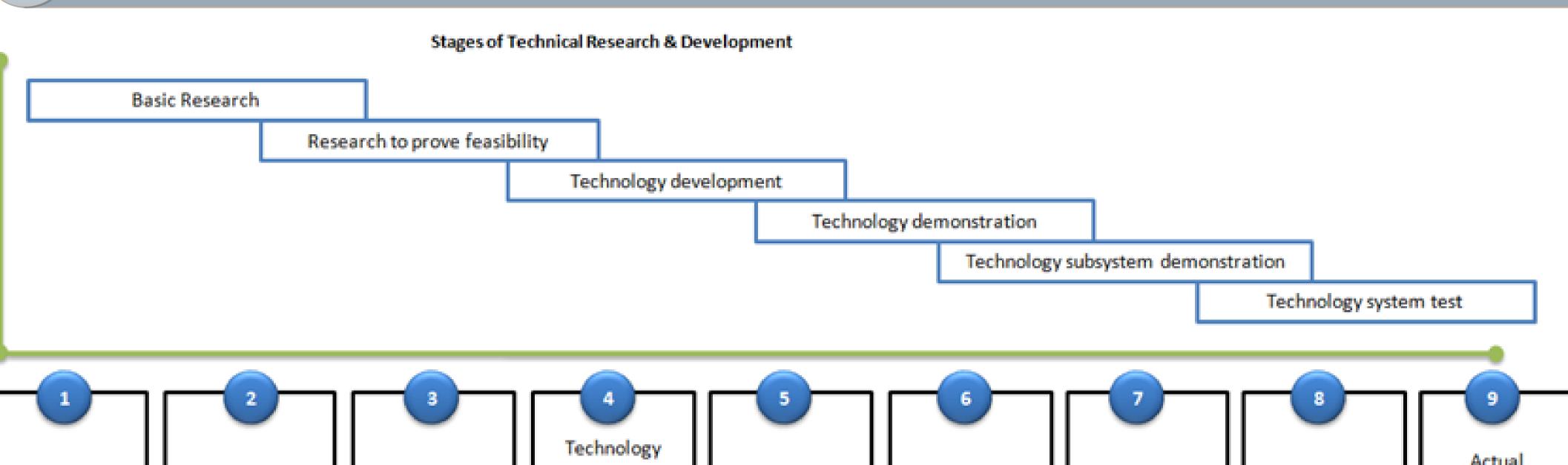
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The development of a translational research has traditionally been a haphazard path approach, filtering technologies so that the 'best' of breed' may ultimately succeed.

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The conversion ratio of brilliant ideas to useful devices remains suboptimal, as many 'fail to progress'. The reality of developing biotechnology transfer and Knowledge Transfer generally, is that the (KT) ability of multidisciplinary teams (MDT) to assimilate and then act upon information is becoming the rate limiting step for the building of complex projects. The model proposed here considers both the biological aspects of Life Sciences (LS) and the establishment of Technology Readiness for its implementation.

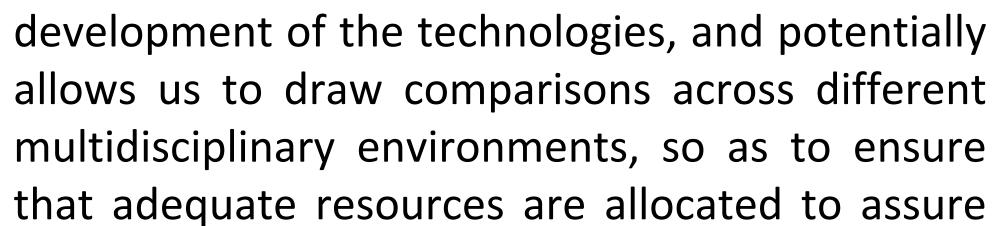


Basic principles observed and reported	Technology concept and/or application formulated	Analytical and experimental critical function and/or characteristic proof-of- concept	Component and/or basic technology subsystem model or prototype demonstration in a relevant environment	Technology component and/or basic technology subsystem validation in a relevant environment	Technology System / Subsystem model or prototype demonstration in a relevant environment	Technology Systems prototype demonstration in an operational environment	Actual Technology System Completed and qualified through test and demonstration	Technology System Completed and qualified through successful mission operations
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Technology Readiness Level Scale

By offering a sustainable generic structure for A case example applying this process to the development of the PowerWheel, a 'force sensing' lightweight the assimilation and transfer of technologies, at a hand rim for manual wheelchair allowed for the kinematic data to be compared with Electromyographic (EMG rate supported by the individual teams, the muscle patterning) data. This demonstrate that this strategic approach can be operationalized. By mapping potential is for standalone Web 2.0 enabled the EMG signals from the basic science experiments through to clinical evaluation, the groundwork was system components to be able to accommodate completed for assuring rapid integration of approaches for the afferent arm of novel 'autosensing' FES clinical research and governance needs. technologies.

The construction of a "signature", which This integrates with work practices across disciplines, so as to create a potential 'template' for integration reflects the current state of development, and into Standard Operating Procedures (SOPs). These accommodate established 'Good Laboratory Practice' (GLP) thus the rate progress of translation, the and also can meet the requirements for governance of the translational research framework.





The reality is that major scientific endeavour is now a global exercise. It is the ability to rapidly configure

groups to focus on challenges and complete stages effectively that will ensure their long term survival. Virtual

Discussion:

Results:

their interoperability within agreed timescales.

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Virtual Research Integration and Collaboration environment

Produced with the assistance of; Simon Grange^{1,2,3,5,} Liping Qi^{1,} Cy Frank^{2,} Martin Ferguson-Pell^{1,} Peter Smitham^{3,} Catherine Holloway⁴, Stephen Taylor⁴, Gary Wills^{5,} Nick Tyler⁴

¹Faculty of Rehabilitation Medicine, University of Alberta, Edmonton, Alberta, Canada, ²Alberta Bone and Joint Health Institute, Calgary, Alberta, Canada ³Institute of Orthopaedics and Musculoskeletal Science, UCL, UK ⁴Civil Environmental, Geomatic Engineering, UCL, UK ⁵Electronics & Computer Science, University of Southampton, UK

Keywords: Industrialization, Knowledge Transfer, Electromyography, Wavelet analysis, Biomechanics, Muscle synergy, Rehabilitation, Principal Component Analysis, Governance





Research Environments (VREs) are likely to play a central role in this in the future. This means that the teams need to respect the logical transition and the consistent extrapolation of an

argument from one step to the next. It is the provenance of data which ultimately secures the foundation of clinical intervention in a sound basic science evidence base. We must all adapt our technologies to ensure rapid, reliable and robust transfer through the progressive levels of readiness to the point that they can be implemented safely and securely for the benefit of all. The integration of the automated EMG signal processing in the Rehabilitation Robotics Sandbox reflects this philosophy.

Conclusions:

At different stages of the translational research pipe, demonstration of the consistency of EMG patterning across the validation steps, coordinated with consistent kinematic data collection, suggests that the wheel could transition to its next step for development, with confidence that it effectively adds value, passing through 'soft' and 'hard' governance review processes. These 'gates' included design reviews, ethical committee reviews and both preclinical and clinical trials.

This demonstration supported real collaboration across multidisciplinary teams representing Neurophysiology, Engineering, Rehabilitation Medicine and Orthopaedics. It covered initial University research and development (TRL1-3) plus engineering and evaluation in a healthy population, (TRL4-6) development stages. Rapid transition through to a nationally supported (UK NIHR i4i FDP1) clinical trial of spinal cord injured patients (TRL7), demonstrates the potential for this approach to develop a truly competitive edge in a global research and development environment.









Please contact us for more information: ange@ualberta.ca Or visit our website at; http://www.sandbox.ualberta.ca/ grange@ualberta.ca Or visit our website at;



This multidisciplinary work is set in the context of established teams collaborating

across Alberta

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UNIVERSITY OF The philosophy is widely established CALGARY across other centres in the musculoskeletal



domain, representing the foundations of the evolving 'Campus Alberta'

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