# Gravity Simulation in Walking: Insights into Integrating Mechanics, Physiology, and Control

John Bertram[1], Michael Butcher[2]
[1]*Faculty of Medicine – University of Calgary*
[2]*Department of Biology – Youngstown State University*

A great deal of attention has been paid to the neural aspects of control in locomotion. However, locomotion is fundamentally mechanical, so one can posit that the active control largely exists to integrate the dynamics of the individual with the constraints provided by the physical environment. Understanding the key mechanical determinants should provide for better interpretation of the integration process provided by neural control and allow the development of novel approaches to clinically relevant issues like rehabilitation and prosthetic design. But what is/are the key determinant(s) of locomotory function? We hypothesize that (1) human walking is coordinated to minimize the metabolic cost of locomotion and (2) that the major portion of that cost arises with the momentum loss associated with the transitions between contacts in walking. Evidence for the former comes from a variety of studies of simple constraints applied to the individual in which it is indicated that gait spontaneously changes, often in quite unusual ways, to minimize the locomotion cost . Evidence for the latter comes from a study of the kinetics of walking while constant positive and negative vertical force is applied to the subject, simulating increases and decreases in gravitational acceleration of the centre of mass. Individual weight support contacts from a serial array of four force plates are analyzed for the external power applied to the centre of mass of the individual. Results indicate that the positive and negative power during the transition largely determines the cost of walking under varying conditions of simulated gravity.