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Whole body motion biomechanics is at a point where its growth and major contributions will rely upon trans-domain research. True forward dynamic modeling is one area where motion biomechanics can have a very significant impact in helping those with human movement disorders in both the near and far term. To date, most forward dynamic simulations have been used to identify the contributions of individual muscles to a movement. This is important work; however, forward dynamic simulations will have their greatest impact in two other areas: 1) In predicting the effects of interventions in patients and 2) Increasing our understanding of motor learning and control.

Forward dynamic simulations of movement of the human mover with his or her redundant degrees of freedom are performed by optimizing upon some quantity. This is based upon the logical assumption and much experimental evidence that one of the important organizing principles of human movement is the optimization of some quantity (e.g. maximizing force or minimizing energy consumption). If the correct optimizing principle is chosen, predictions of the performance of the system corresponding to changes in the mechanical properties of the system can made. These solutions, after validation, can be used to assist the clinician in choosing the most appropriate intervention. Secondly, forward dynamic simulations can shed light upon how we solve the degrees of freedom problem to become skillful movers. Bernstein described coordinated movement as the “mastery of the degrees of freedom problem”. If researchers can develop an appropriate learning algorithm, time dependent solutions of the movement patterns during the learning of a movement task can provide insight into how we learn and organization our movements. Both of the above areas of research require biomechanists to work with computational, motor control, and motor learning scientists.

Recommendation: Researchers should investigate means by which physics based forward dynamic simulations can be performed in a more computationally efficient manner. This exploration should include codes optimized for multiple processors, improved optimization algorithms, and the identification of movement synergies that simplify the control of movement. In parallel, movement experiments should be designed and performed that can reveal the effects of measureable changes of the mechanical properties of a human mover. These experiments will provide data for implementation and validation of the forward dynamic simulations. Finally, researchers will need to model actual interventions to validate the predictive capability of their subject specific models.

Recommendation: As mentioned above, forward dynamic computations use optimization schemes to discover a *single* movement solution within the redundant solution space. The parallels between the numerical/learning schemes and human organization need to be explored. Combined with an appropriate learning/optimization algorithm biomechanic models can provide insight into motor learning and control by revealing how our movements emerge from a beginning solution (where often many degrees of freedom are frozen) to a skillful movement with increased degrees of freedom.