The present thesis investigated the gastrocnemius medialis (GM) muscle fascicle behaviour during stair negotiation to understand how the contractile behaviour of this muscle in this task is influenced by the series elastic component in conditions of different demands. The influence of physiologically meaningful variations in the task demands were investigated by manipulating gait velocity, step-height and body mass. Participants walked up and down a four-step staircase, during which kinetic data were acquired. Real-time ultrasound scanning was used to determine GM muscle fascicle length changes, while musculotendon complex (MTC) length changes were estimated from ankle and knee joint kinematics. During the lift-off phase of stair ascent, the GM muscle fascicles contracted near-isometrically, providing force, while the MTC shortened due to tendon recoil. The ankle joint moment peaked in this phase, also providing a positive joint power peak. During the touch-down phase of stair descent, there was a negative peak in the ankle joint power (and a high moment) due to MTC lengthening (ankle dorsiflexion). In contrast, however, the GM muscle fascicles shortened in this phase, performing positive work. In general, when the task demands increased (by increasing gait velocity or step-height), the GM muscle fascicles shortened more (even when the MTC lengthened during stair descent), mostly coinciding with an increased ankle joint moment. However, due to a change in strategy, increased body mass did not result in an increased GM muscle fascicle shortening. The main finding from this work is that the GM muscle fascicle behaviour does not parallel, and hence it cannot be predicted from, the MTC behaviour during stair negotiation. Further, although in general increasing the demands of stair negotiation lead to increased joint moments and more fascicle shortening, the response of the musculoskeletal system to altered demands is not predictable and seems to be specific to the method by which the demands are modified.