Systems which are inherently unstable require robust controllers to successfully plan and navigate the unstructured world that surrounds us. Creative methods of control become necessary when these environments are dynamic, and the systems have hybrid dynamics or are underactuated. This thesis argues that fast reaction and planning in dynamic environments is paramount for success when facing these challenges. This work uses trajectory optimizations and force control as the primary tools for synthesizing and assessing legged and aerial locomotion. We present 1) A hardware based bipedal balancing controller that remains stable on soft and quickly moving terrain, 2) A convex monopod motion planner that requires no predefined contact timing, sequence, or location, 3) A second monopod motion planner that is effective in resistive fluidic medias, and 4) A formulation to avoid multiple moving obstacles for both legged and aerial systems. As a general conclusion we find that rapid adaptation and re-planning are key for control across locomotion modes.