1. **Functional Reactive Programming for Interactive Engineering Simulation**

The aim of this project is to assess the suitability of Functional Reactive Programming for implementing interactive engineering simulations. Functional Reactive Programming is an approach to computer programming that emphasizes the use of mathematical equations, such as representing the position of an object as a function of time. As such, it seems promising as a way to enable non-specialist programmers to develop relatively complex physical simulations with only a small amount of code beyond specifying the appropriate mathematical equations. This project will involve choosing one or more specific simulations that appear suited to functional reactive programming, implementing them, most likely using the recent web based functional reactive language Elm [http://elm-lang.org/learn/What-is-FRP.elm](http://elm-lang.org/learn/What-is-FRP.elm), and then evaluating suitability of this method for implementing simulations compared to alternatives.

This project will involve writing computer programs, so some experience with programming will be beneficial. However, the functional reactive approach is quite different from most common programming languages, and the intention is that only relatively small programs will be involved.

2. **Functional Reactive Programming for Interactive Engineering Web Tutorials**

This project is similar to the previous one, but the application is instead the development of web tutorials designed to help engineering students learn one or more specific topics, leading to a somewhat different emphasis. Interactive simulation is likely to be one aspect of this, complemented by other kinds of interaction to aid learning of the specific concepts chosen. A significant aspect this project is the evaluation of the chosen tools, most likely including Elm [http://elm-lang.org/learn/What-is-FRP.elm](http://elm-lang.org/learn/What-is-FRP.elm) for the development of such tutorials.

This project will involve writing computer programs, so some experience with programming will be beneficial. However, the functional reactive approach is quite different from most common programming languages, and the intention is that only relatively small programs will be involved.

3. **Realistic Motion Combining Data-based Animation and Physical Simulation of Mechanical Systems Including Character Animation**

Techniques for simulating the motion of controlled entities such as people in virtual environments typically involve some combination of animation based on data describing fixed sequences of transformations over time for animations, such as joint rotations, and physical simulation which dynamically reacts to specific situations. However the combination is typically relatively shallow - often just swapping from fixed animations to ‘ragdoll physics’ when a character swaps from being actively controlled to a passive physical body (also called ragdoll physics). This project involves investigating richer combinations of these two techniques that e.g., allow adjusting motion capture and animator data from level
surfaces to specific physical situations such as inclines, steps, unstable terrain and physical collisions.

This project will involve surveying current research in the area of combining physical and mechanical simulation with animations generated via animation software or motion capture, choosing or developing a promising technique, and specifying it precisely mathematically with a view towards a prototype real-time 3D implementation. As such, this project could be completed with no actual program development, and no experience with software development is required, but some understanding of the capabilities of limitations of computer hardware would be a benefit.