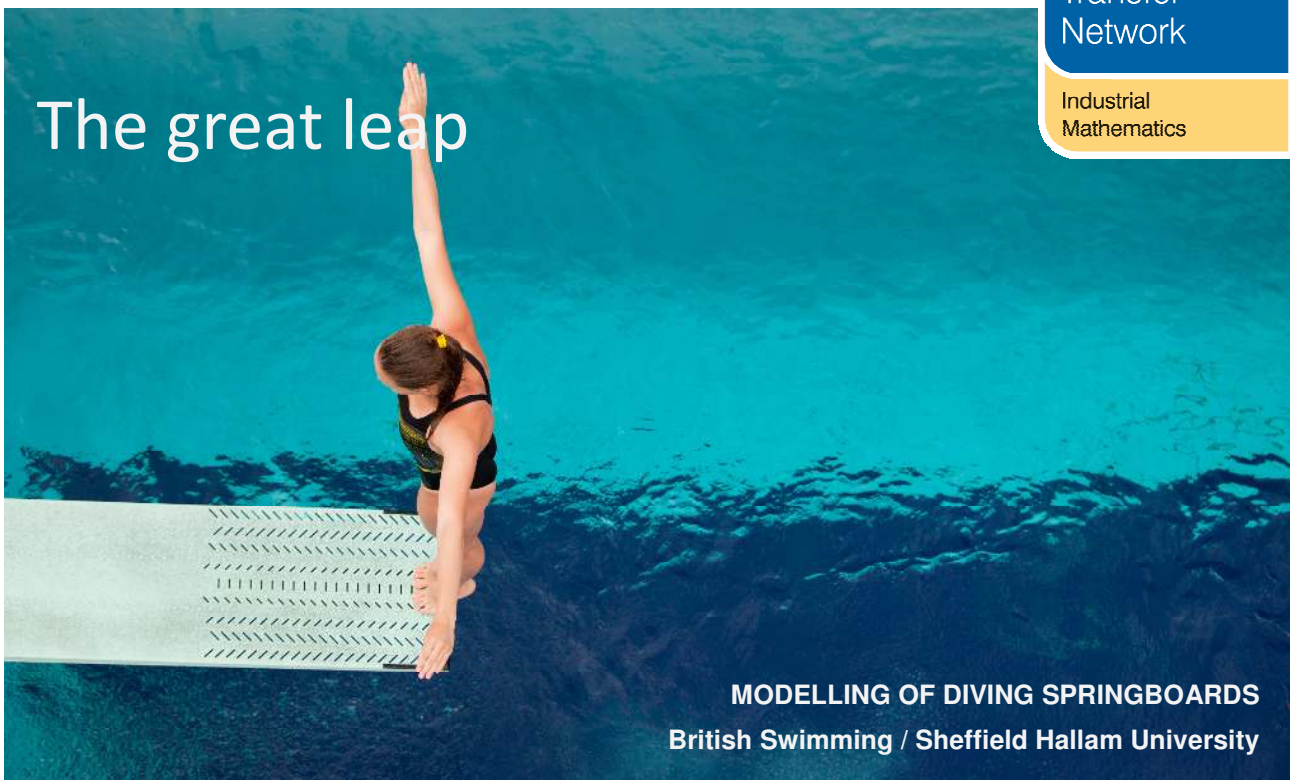
Technology Strategy Board
Driving Innovation

Knowledge Transfer Network
Industrial Mathematics



The great leap

MODELLING OF DIVING SPRINGBOARDS

British Swimming / Sheffield Hallam University

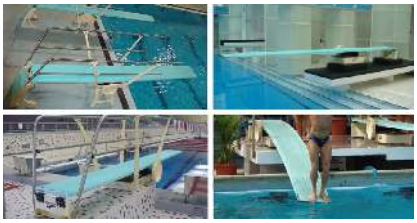
The need

British Swimming wish to optimise the use of springboards during dives. The material stiffness of the board is fixed, while the length can be altered by moving the board's main pivot point. The optimum dive can be achieved by setting the board oscillating during the 'hurdle-step' along the board and then timing the final jump at the end of the board to give the required linear and angular momentum at takeoff.

Based on experience, coaches currently have a qualitative method for assessing their divers during a performance. Combining this with a quantitative springboard model can provide coaches and divers with the opportunity to produce better results and to better assess reasons for variation in performance.

The outcomes

The collaborating university, Sheffield Hallam University, undertook a project on the 'Modelling of diving springboards' to create an integrated modelling environment for the optimisation of positions, velocities and accelerations of a springboard due to different inputs such as applied force, diver mass, fulcrum settings for simulated dives.



This internship project embedded novel models of springboards from classic beam theory, finite elements theory and computer vision methods. All these elements have been used to implement a model to analyse the most important parameters during a takeoff diving performance.

The project has provided Sheffield Hallam University with the ability to simulate dives and compare them with reality. This capability is intended for use by diving coaches during training sessions to be able to check how a dive could be improved.

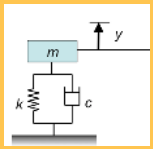
"We have seen some intriguing results from this project which has challenged some of our fundamental thinking in coaching in diving. We now want to take more video to corroborate this new thinking."

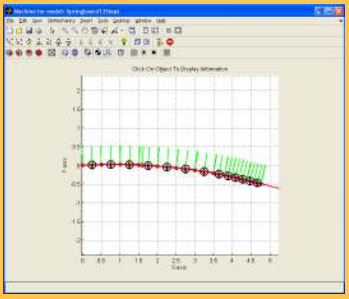
Adam Sotheran, British Swimming coach

Technical summary

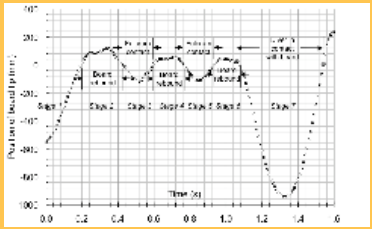
Currently, several types of springboards can be found in the market [4]. It was decided to study and model 'Maxiflex Model B' because this one is used in the official diving competitions and it was possible to make experiments with them at Pond's Forge International Swimming Pool in Sheffield.

Two different approaches were taken for developing the springboard model. The first was based on developing second order systems with 3 parameters: stiffness, equivalent mass and damping coefficient [1, 2, 3]. The second was based on developing a bidimensional finite element model using the geometrical and material properties of the springboard [1].





In order to calculate and validate the models, experimental data was required and experiments were carried out using a 'Maxiflex Model B' in the dry facility at Pond's Forge.



A Phantom v4 high speed video was used to film the experiments and an auto tracker system was developed to collect the required springboard positions. Data was used for calculating parameters in the first model and for validating the second one. Both models were developed using Matlab, Simulink and SimMechanics [5].

[1] Sprigings, E.J., Stilling, D.S. and Watson, L.G. (1989) Development of a Model to Represent an Aluminium Springboard in Diving. International Journal of Sport Biomechanics, 1989, 5,297-307

[2] Sprigings, E.J., Stilling, D.S., Watson, L.G. and Dorotich, P.D. (1990) Measurement of the Modelling Parameters for a Maxiflex B Springboard. International Journal of Sport Biomechanics, 1990, 6,325-335

[3] Miller, D.I. and Jones, I.C. (1999) Characteristics of maxiflex® model B springboards revisited. Research Quarterly for Exercise and Sport; 70, 4, 395-400

[4] http://www.duraflexinternational.com/

[5] http://www.mathworks.co.uk/

"...a great experience to take my research and contextualise it with diving coaches like Adam Sotheran...the developed model [will] *improve the research in my PhD...I'm better prepared for dealing with complicated mechanical models...I'm grateful to the University and British Swimming for giving me this opportunity."*

José Luis Gómez Esteve, Sheffield Hallam University

"...We realised that we didn't understand the bounce of the diving board well enough...José and British Swimming did a great job in providing...enough videos and information for analysis. This then allowed the models to progress through to a conclusion where they now are making predictions that may help our divers at London 2012."

Steve Haake
Sheffield Hallam University

This project was part of the programme of industrial mathematics internships managed by the Knowledge Transfer Network (KTN) for Industrial Mathematics. The KTN works to exploit mathematics as an engine for innovation. It is supported by the Technology Strategy Board, in its role as the UK's national innovation agency, and the Engineering and Physical Sciences Research Council, in its role as the main UK government agency for funding research and training in engineering and the physical sciences.

BRITISH Swimming

EPSRC
Engineering and Physical Sciences Research Council

Project Details

Partners
British Swimming
Sheffield Hallam University

Project investment
£12,000

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