# Development of a haptic device for Physiotherapy

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## BACKGROUND

The proposed research is derived from a commonly encountered teaching problem in Physiotherapy practice, spinal palpation. Spinal palpation is an essential skill that all physiotherapy students need to be able to perform safely and effectively. This skill is difficult to attain and success and competence usually follows years of supervised practice. This research is focussed on the design, development and manufacture of a ***'haptic device'*** which simulates palpation of a spine.

Physiotherapy students learn to appreciate how the human spine feels and moves when pressure is applied to it through the fingertips, thumbs and small bones in the hand. It is an essential technique that all physiotherapists need to be able to do. An appreciation of how the spine responds to palpation is essential in forming an understanding of a patient's problems, however teaching this skill as an instructor to pre-registration and post registration physiotherapy students/professionals is a difficult concept. It involves precise handling skills, cognitive appreciation and experiential practice. It is often time consuming for the teacher and currently it is difficult to check whether understanding has occurred. To date nothing has been developed to address this problem. Within the literature there is little standardization of approach and no specific model for using spinal simulation when teaching manual skills, that has been evaluated empirically.

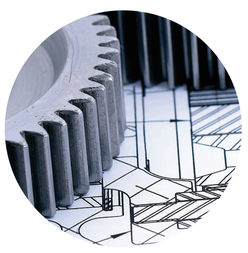
### Research aims

1. The first aim is to investigate the a priori relationships between spinal mobilizations and the four typical responses that are expected to occur.
    i. Hypersensitive, characterized by an output of pain by the patient.
    ii. In spasm, characterized by an output of increased unilateral or bilateral muscle spasm.
    iii. Hypomobile, characterized by a rigid response to palpation.
    iv. Hypermobile characterized by excessive movement upon palpation.
2. The second aim is to use this knowledge to develop a spinal simulator to teach manual skills.

### Research objectives

1. Establish what the expected response(s) are of the lumbar spine following injury.
2. Establish if it is possible to detect these responses using palpation.
3. Investigate the perceived difficulties of teaching / learning spinal palpation
4. Develop a working device that simulates these responses.
5. Establish the validity and reliability of the working device.

The proposed simulation device, in the form of a manikin, will be programmable to display each or several of the (i-iv) responses. The instructor will be able to easily set the device for both teaching and assessment. As this device does not exist, there is huge potential for exploitation within the commercial market place.



## METHOD

The research will incorporate a mixed methods and sequential approach.

Initially it is important to establish if the assumptions around lumbar spine responses (i-iv) following injury occur and if agreement exists. The aim of this stage is to establish normal values, which are quantifiable; thereafter the remainder of the research can be approached. Stage 1 will include a systematic review of the literature and a multi centered, prospective questionnaire using expert practitioners. Both methods will be utilized to underpin the current understanding of how a human spine behaves following injury, how this is rated and if agreement exists in relation to the responses (i-iv). The second stage focuses around the development of the haptic device (spinal simulator), the aim of this stage is to build a working aesthetic model that replicates the identified responses in a realistic manner. This stage will incorporate a qualitative approach utilizing semi-structured focus groups to extrapolate themes developed from a questionnaire. Additionally within this stage, the development of the spinal simulator will be tested in laboratory experiments. Stage 3 will mainly concentrate on the physical development of the device. Stage 4, will incorporate a quantitative approach to test the robustness of the simulator thoroughly, ensuring it is fit for purpose in both laboratory, teaching and clinical environments. Outcome measurement will vary between methodologies.

## PLAN OF WORK

Stage 1: Preliminary stage (leading to and overlapping with stage 2)
Jan-Apr 2013: a thorough review of the literature to establish what is known in relation to lumbar spine responses.
Leading up to Apr 2013: ethics submission
Apr-Aug 2013: explore the opinion of expert manual therapists in clinical practice
Stage 2: Exploration stage (leading to and overlapping with stage 3)
July to Oct 2013: ethics submission
Oct 2013-Feb 2014: explore the perceived difficulties of teaching/learning spinal palpation
Stage 3: Developmental stage (leading to and overlapping with stage 4)
Feb-Nov 2014: develop the tool that simulates spinal responses
Stage 4: Testing stage
Nov 2014-May 2015: explore the validity and reliability of the tool
Leading up to May 2015: ethics submission
Jun-Oct 2015: explore the responses of pre and post registration physiotherapy students when using the device.

## INTERDISCIPLINARY ASPECTS OF THIS RESEARCH

The interdisciplinary aspect of this research has several components. First, my supervisory team consists of researchers from different professional disciplines and sub sets within each discipline. Secondly they also reside in different faculties, including the Faculty of Health, Psychology and Social Care, the Faculty of Science and Engineering and the Business School. This collaborative approach means health, engineering and business expertise are combining their strengths in an interdisciplinary way.

The long term implications of this research will hopefully mean that all manual therapists who treat patients with mobilization and manipulation techniques will benefit from the development and use of this haptic device, by assisting, advising and adjusting treatment dosage where necessary. This pivotal research which is being led by Physiotherapy will directly influence and benefit other professions within the manual therapy communities. These include disciplines such as Osteopaths, Chiropractors, Sports Therapists and other medical professionals.

The specific inclusion of a business specialist within the supervisory team will hopefully ensure the device makes it to market in some form. This may be in the form of proprietary intellectual property, a modifiable solution or a finished working stand alone product. This diversity adds to the potential usage / adoption by unrelated disciplines or specialisms, truly encompassing interdisciplinarity.



## PRELIMINARY FINDINGS

Initial results gained from an in-depth literature review (stage 1 & 2) indicate that this idea and suggested solution to the problem is an original and unique area appropriate for further research investigation. The exploration of expert manual therapists (stage 2) in practice is work in progress but significant advances in the design, materials and development of the physical haptic device (stage 3) has occurred leading to early completion of this stage if funding can be secured to cover the manufacturing costs. Crucially through engineering discussions and laboratory testing, air controlled actuators (miniature pistons) have been calibrated to represent and behave like a human spine. This engineering solution forms part of the uniqueness of this research and offers a plausible solution to the researcher in meeting the overall research objectives.



## CONCLUSION

The literature review, PhD supervisory discussions and links with industry have all yielded positive outcomes with regard to this research. Currently it is only at the very early stages, however over the next year the researcher hopes to be able to understand and interpret the stakeholders' opinions and develop and conduct testing of the device.