Abstract
Advances in image-guided technology have resulted in a number of technologies to support surgeons in the identification of tissue and the tracking and navigation of surgical instruments in spinal surgery.

There are various existing and proposed systems to support registration and intra-operative image guidance based on fluoroscopy, Computerised Tomography (CT), Magnetic Resonance Imaging (MRI) and ultrasound (US) or combinations of imaging modalities. However, the user requirements for the design of such systems are complex, dependent on medical specialty in addition to the range of instrumented and non-instrumented treatments offered in the orthopedic and neurological domains.

A review of user requirements for intra-operative navigation in spinal surgery was conducted. The numerous outcomes measures for successful operations are outlined, that provide a basis for understanding the needs of surgeons. The review is being used to inform the design of an Analytic Hierarchy Process instrument that will be used to elicit detailed user requirements in Norway later in 2012.

Collaboration on a new 3D ultrasound system for navigation in spinal surgery

Questions
• What are the criteria of success (or failure) of neuro- and orthopaedic surgeons relating to image-guided spinal surgery?
• What are the design features of an innovation in image-guided surgery that is required to fulfill clinical and technical outcomes for multiple user needs?

Approach
• Meet the clinical and design personnel
• Conduct a literature and online review
• Construct a user elicitation instrument

Clinical review
172 relevant papers from PubMed and Web of Science, plus audits of the British Association of Spine Surgeons for three common spine operations. Orthopaedic and neurosurgery references with fluoroscopy, CT, MRI, Ultrasound imaging modalities. Extract clinical outcome measures.

Technical review
Pedicle screw placement – measures of importance from imaging research studies

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<th>Reference</th>
<th>Surgical goal</th>
<th>Imaging system(s)</th>
<th>Measure(s)</th>
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| Oertel et al., 2011  | Spinal stabilisation using pedicle screws. Single, bilevel and multilevel up to 4 levels | Medtronic O-arm 2D pre-op then 3D and Stealthstation Treon plus | * Mean surgical time
|                      |                                                   |                                        | * Percentage pedicle screw perforations
|                      |                                                   |                                        | * Percentage replacement of screws due to poor placement |
| Park et al., 2010    | Minimally invasive lumbar fusion with pedicle screw fixation. Single and multilevel | CT pre-op then O-arm and Stealthstation Treon | * Accuracy of screw placement graded as millimetre breaches
|                      |                                                   |                                        | * Overall misplacement rate |
| Nottmeier et al, 2009| Whole spine imaging. Multi-level.                 | C-arm fluoroscopy                      | * Timing of registration until start of navigation |
| Nakanishi et al., 2009| Instrumented treatment of scoliosis using pedicle screws in idiopathic, symptomatic and congenital spinal surgery | Stealthstation CT then surface registration on to CT | * Screw deviation
|                      |                                                   |                                        | * Duration of registration |

Conclusions
MATCH has reviewed outcomes measures for spinal surgery that should feed into the development process of technology innovations in image-guided spinal surgery. Criteria for success can be expressed in both clinical and technical terms and depend on surgical specialty. An understanding of these criteria informs the design of an Analytic Hierarchy Process questionnaire for spinal surgery to be conducted later in 2012.