COMPLIANCE WITH THE DATA PROTECTION ACT 1998
In accordance with the Data Protection Act 1998, the personal data provided on this form will be processed by EPSRC, and may be held on computerised database and/or manual files. Further details may be found in the guidance notes.

Standard Peer Review

none

Applicant Details

<table>
<thead>
<tr>
<th>Applicant</th>
<th>Organisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr Alan Smaill</td>
<td>University of Edinburgh</td>
</tr>
<tr>
<td>Dr Simon Colton</td>
<td>Imperial College London</td>
</tr>
<tr>
<td>Dr Andrew Ireland</td>
<td>Heriot-Watt University</td>
</tr>
</tbody>
</table>

Title of Research Project
A cognitive model of axiom formulation and reformulation with application to AI and software engineering

Review Information
Response Due Date: 06/11/2007
Reviewer Reference: 5MLGIU

Research Council Contact Details
EPSRC Administration Contact: Mr Chris Van Roon
Email: chris.vanroon@epsrc.ac.uk
Telephone: 01793 444033

Impact

Significance and Potential of the Research
Comment on the potential impact of the proposed research, in terms of its (1) ability to address a timely problem using the appropriate approach; (2) contribution to the UK's world research standing; (3) ability to advance research knowledge for the benefit of the research community.

This research is timely, and has been for decades! The approach is entirely appropriate - obviously I would suggest changes, but with a problem of this type there are never right approaches, only those that are likely to challenge and produce results.

Research of this type will, I believe, help us to re-assert UK research as more than skill-based, toolset, development to solve short-term problems. The potential areas of application (this is the wrong word, but is used deliberately to challenge) of this work are too numerous to discuss. It cuts across everything. My one fear is that the researchers may fall into the trap of wanting to "publish" within paradigm, and hence reduce much of the work to trite codifications within specific areas, thus reducing impact in the wider sense.

I am sure that knowledge will be advanced - the extent to which the wider CS community takes advantage of it is an open question, I believe a lot depends on the dissemination strategy.

Overall, the significance of the research is: Outstanding

My confidence level in assessing this is: High
Degree of Novelty or Risk

Comment on (1) the originality of the proposed research; (2) the degree of adventure and potential to produce a high return in knowledge advances and/or exploitation and; (3) the incremental nature of the research. Where the proposal is more incremental in nature, comment on the degree to which this is essential to the advancement of knowledge for the benefit of the academic community and/or business, and/or in facilitating a multidisciplinary approach.

This work is not novel, in the sense that others have asked the same questions and attempted to answer them before, but it is (to my knowledge) the first time that an attempt has been made to assemble a team capable of tackling the area in a broad and systematic fashion. It is, of course, incremental, almost by definition of the problem, it must be, but (as the project may well show) there is no simple mapping between this and innovation.

I believe this is entirely the correct approach to this problem area. I like the way that the team have been brave enough to tackle several aspects of the project at the same time - there is, of course, a risk associated with this, but the potential benefits are significant and more than justify this approach.

Overall, the degree of novelty and risk is:  
My confidence level in assessing this is:  

People and Development

Comment on the extent to which the proposal contributes to the training and development of highly skilled researchers, considering all levels.

I would love to employ the PhD students that come out of this project!! They will be extremely well qualified in a number of areas that many current Computer Scientists only hand-wave at in passing. There is a difficulty in finding such students (I have tried for several years), and the applicants may wish to comment on this in their response. The range of skills required, and the depth of understanding, is quite daunting.

I think there is scope for making a wider contribution to researchers at other institutions as part of this project (see under dissemination), but this is not an obvious requirement of the project.

The experienced researchers could develop a great deal, but only if they are prepared to really be challenged in the process (it is too easy to attempt to cling to the core paradigm - it is not clear how they will cope with this degree of reflexivity in such a project - learning about theory formation is obviously a theory formation issue - that degree of reflexivity does not sit easily with current Western research methods).

The degree of researcher training and development is:  
My confidence level in assessing this is:  

Collaboration

Comment on the nature, appropriateness and likely value of any partnerships proposed (e.g. with another department or institution, with business or overseas institution, or the absence of partnership).

This is a very good consortium. Obviously there are several other partners that could have been included, but this team is certainly strong and well considered. I hope that the team will take an inclusive approach, and invite others that might be interested to become involved in the project in various ways.

Overall, the value of the collaboration is:  
My confidence level in assessing this is:  

Applicant

Ability to Deliver the Proposed Research

Comment on the skills and experience of the applicant(s) and team (including any proposed project partners) to ensure delivery of the research described.

This is an excellent team. I have no doubt that they are well placed to deliver. My only slight concern is that the team might become too introspective, and that would be a shame, as they need to take this work into the wider community if it
Overall, their ability to ensure delivery of the research is:  

☐ Low  ☐ Limited  ☐ Significant  ☒ Major  

My confidence level in assessing this is:  

☐ Low  ☐ Medium  ☒ High  

Planning and Management

Comment on the planning and project management, including timescales, methodology, management of risks and dissemination plans.

This has been well thought through. I have no real criticisms of the methodology (unusually!) - the key is that the team seem to understand how complex this work is, and have planned accordingly.

I have one slight concern over dissemination. This is an inherent problem with the research, rather than a weakness of the applications, but the applicants might like to consider the issue and comment in their response. As they have noted, this work is quite innovative, and will likely force the community to reconsider some of its beliefs. This means, however, that standard dissemination routes, where papers are peer reviewed "within paradigm" might not be appropriate. Indeed, if the applicants massage their results to fit in, the impact of the work might be diminished.

The applicants might wish to consider this, and suggest one or two innovative approaches to disturb the community as well as working within paradigm.

Overall, the planning and management appears:

☐ Unsatisfactory  ☐ Adequate  ☒ Good  ☒ Very Good  ☐ Outstanding  

My confidence level in assessing this is:

☐ Low  ☐ Medium  ☒ High  

Resources Requested

Are the resources requested appropriate and justified?

It is always difficult to make this assessment for projects with multiple institutions, as there is undoubtedly an overhead associated with such projects. Taken overall, however, I believe that the resources requested represent good value for money.

Potential Contribution to Knowledge Transfer

Where appropriate, comment on the extent to which the proposal contributes to knowledge transfer / exploitation (e.g. in addressing challenges faced by users, in enabling the flow of knowledge between the research base and business, or society, or in proposing plans for the successful transfer and exploitation of the research outputs).

There is massive potential for knowledge transfer. Such transfer, of course, requires cooperation from all parties, and I believe that the major challenge will be a political one. As someone who has worked in this area for more than 20 years, I must confess that I am pessimistic about the willingness of many people to think outside of the paradigm and accept that there might be the need for significant changes (rather than a few new tools, methods or languages).

This does not mean we should not try, however. This section is titled "Potential Contribution to Knowledge Transfer", and I have rated this, rather than the more specific questions in the notes, which suggest actual planned contributions (which would have been lower).

Overall, the potential for knowledge transfer / exploitation is:

☐ Low  ☐ Limited  ☐ Significant  ☒ Major  

My confidence level in assessing this is:

☐ Low  ☐ Medium  ☒ High  

Overall Assessment

Your Conclusions

Please summarise your view of the proposal.

This is one of the best proposals I have seen in the area. It is well written, demonstrating a deep understanding of the issues, and the multiple facets demonstrate that the team really intends getting to grips with the problem, rather than re-defining it into trivia.

It is risky, unlikely to go to plan, difficult to disseminate, likely to be contentious, difficult to find suitable research staff - in
short everything I would expect from a genuine research project.

If the project goes ahead, I would suggest that the team makes some effort to review what has been done already (this is not easy to do, as it is distributed across many areas). I am aware of work by Wernick (Hertfordshire) and Loomes (now at Middlesex) who independently investigated the interactions between the philosophy of Science and the software development process, for example, which does not appear in the references - and is not bound into the AI literature.

The overall quality of the proposal, as written, is:

- [ ] Unsatisfactory
- [x] Adequate
- [ ] Good
- [ ] Very Good
- [ ] Outstanding

Recommendations

I believe this project:

- [ ] Should not proceed as proposed
- [ ] Could proceed as proposed
- [x] Should proceed

My confidence level in assessing this is:

- [ ] Low
- [ ] Medium
- [x] High

Reviewer Self Assessment

Your Area of Expertise

Please indicate the areas of expertise that are relevant to your assessment. Take care not to reveal your identity to the applicant.

I have worked extensively in the area of theory construction as applied to Software Engineering and Machine Learning for more than 20 years. This includes both formal methods and also cognitive aspects (I am currently exploring the social aspects). I have also investigated the application of these areas to Mathematics Education (in primary schools).