Two week, industrial placements for Masters students

What do they, and should they, do?

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INTRODUCTION

Short Industrial Placements (SIPs) are an example of 'learning-by-doing', recognised as a key strategy for developing graduates for the knowledge economy [1]. They support graduates in developing discipline skills as well as the ability to integrate, adapt and apply different knowledge sets in diverse contexts.

Preparing students to undertake SIPs is essential [2]. A study of the SIPs used [3] during an MPhil programme found, that these particular SIPs most closely resemble consultancy projects used in MBA programmes and, that a clear definition of what the students are required to do is a key aspect of supporting student preparation.

Despite over forty five years of experience in running SIPs, a consistent, evidence based definition of an SIP had not been captured. So the aim of this research is to develop a definition able to inform teaching and support student learning.

Defining SIPs in terms that stakeholders in both industry and Higher Education (HE) can understand and consistently interpret is challenging. An approach used in Australia [4] found that an activity basis was effective as this led to a more precise description that could be understood by both industry and HE. In addition, it was

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found that people were able to associate an activity to a higher level group of activities. So the proposed approach is to develop a high level framework supported by a list of key activities.

The context of this study is the Industrial Systems, Manufacturing and Management (ISMM) MPhil programme, run by the Engineering Department at the University of Cambridge. During this programme each student undertakes four different SIPs in pairs. Students are typically engineering graduates, with limited vocational work experience, seeking a practically focused programme to prepare them for accelerated careers in industry.

1. FRAMEWORK DEVELOPMENT

The development of the high level framework has drawn on consulting practice, problem solving and employability literature, as well as the knowledge generated through experience of running SIPs. Two of the practice guides reviewed [5, 6] featured multi-stage high level process models. Cope describes a seven stage process for consulting projects [5] and Rasiel and Friga provide a McKinsey perspective [6] including insights of 75 ex McKinsey consultants. Aspects of the McKinsey problem solving process relevant to SIPs are shown in *Fig. 1.* below.

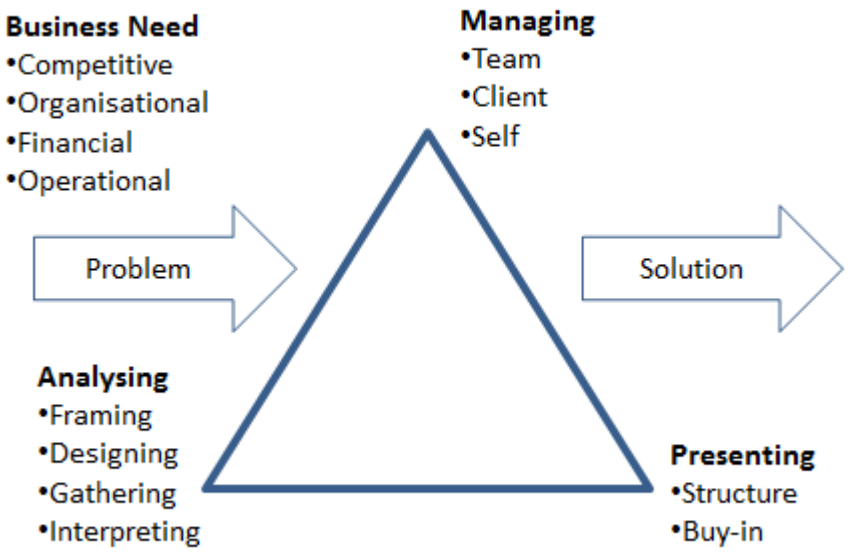

Fig. 1. McKinsey Strategic Problem Solving Model – Adapted by Shawcross

This process resonates with ISMM SIPs in the following ways. Firstly, students have to understand the placement problem related to its context and this is captured by the 'Business Need' stage of the process. Secondly, they are encouraged to use an analytical approach as they lack the credibility (usually gained through experience) to suggest solutions - this is captured in the 'Analysing' stage. These two stages also map well with the cognitive skill requirements of a Masters level programme. Thirdly, it is a requirement of the SIP that students present their work both as a business presentation and a report which reflect the 'Presenting' stage in the process.

As portrayed in *Fig. 1.* the 'Managing' aspect appears to be particularly related to the 'Analysing' and 'Presenting' stages. This might suggest that the other aspects do not

require managing. It is argued that managing a consultancy process must be a key element throughout a project and that all three aspects of managing the team, the client and self, described in the model, will be important.

The 'consultancy' perspective taken so far leaves a number of concerns. Much McKinsey consultancy work is targeted at major strategic issues in large companies. However, SIPs tackle a wide range of complex problems, from shop floor technical and operational issues to market and strategic issues, and, across the spectrum of company sizes. Other concerns are whether this model sufficiently reflects the significant activity groups from the perspective of a novice and that some groups of activities are not described at the same level of detail, such as those related to the development and evaluation of potential solutions.

A qualitative study of workplace engineering problems found [7] that these problems are ill-structured and complex. They can possess vaguely defined and conflicting goals, non-engineering success standards and constraints, multiple solution methods and, numerous criteria for evaluating solutions. The same study [7] contrasts these to typical problems found in engineering programmes which have specified parameters and one correct solution achieved by applying a preferred solution method. This would support the need to break down 'solution' related aspects for a novice.

Traditionally ISMM students were introduced to SIPs using a simple methodology involving six sequential steps of problem definition, data gathering, analysis, generate solution, implementation and report. Although not explicitly mentioned, the students are expected to prepare a detailed business proposal that enables the company to see the costs, benefits and resources related to a proposed solution. This is an activity likely to be unfamiliar to a recent engineering graduate. Combining the above perspectives a twelve stage process model was generated that is shown in the central section of *Fig. 2* below.

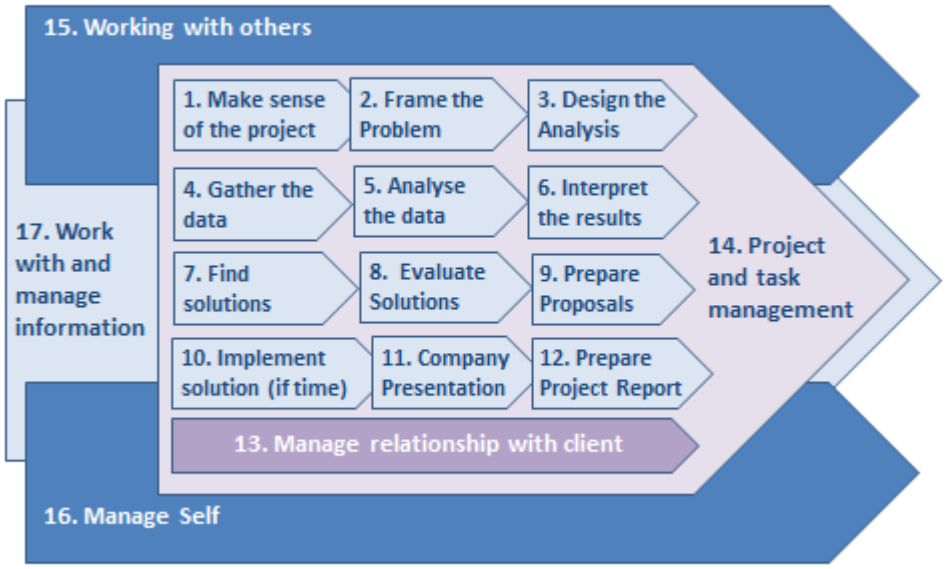

Fig. 2. SIP Activity Framework with Activity Group Reference Numbers

However this does not represent the whole picture as consultancy projects need to be managed throughout as recognised in McKinsey Model. Those activities closely related to the SIP such as 'Manage relationship with the client' and 'Project and task management' are incorporated as through placement activities grouped with the twelve process stages. Those more generic activities such as 'Managing self' and 'Working with others' were captured as underpinning the whole placement.

However, activities still remained that did not fit. Real world problems have incomplete [8] and/or distributed information [7] both of which ISMM students find problematic. A study of core and generic skills in HE and employment [9] identified four categories of skills; management of information, management of others, management of self and management of task. Three of these are already present in the framework so the addition of a further through placement activity group related to 'management of information' provided the final activity group. The complete framework of seventeen activity groupings is shown in *Fig. 2*.

2. METHOD AND RESULTS

The framework now required testing in practice and breaking down to the next level of detail i.e. key activities, so that it could be used to support teaching and learning.

An action research approach was selected for three main reasons. Firstly, features of the research such as a purpose to both inform and influence practice, the context specificity and the requirement for a participative and collaborative approach are well supported by this approach [10]. Secondly, the four rounds of SIPs each academic year, see *Table 1* below, would enable four action research cycles with the same group of students. Thirdly, it is aligned with the pragmatic world view of the researchers [11].

Table 1. SIPs during 2012-2103

Code	Placement Theme	Start Date	Duration	No. Placements
SIP1	Induction	Oct 29th 2012	2 weeks	20
SIP2	Industrial Systems	Dec 3rd 2012	2 weeks	20
SIP3	Marketing & Strategy	Jan 21st 2013	2 weeks	20
SIP4	Manufacturing Processes or Technology and Innovation Management	Mar 4th 2013	2 weeks	20
			Total No. Placements	80

The main risk with this approach was working with fixed SIP dates as this gave short timeframes to collect and analyse data, plan the next research cycle and feedback findings to the students. At all stages students were kept informed of the research and provided with the key findings so they could use them in practice in their forthcoming placements.

Each of the four action research cycles involved establishing an objective and method, capturing and analysing multiple streams of data, determining the results and action planning for the next cycle. As the framework and list of key activities developed the degree and breadth of scrutiny was increased to improve confidence in the robustness of the outcome.

The first research cycle resulted in the acceptance of the SIP Activity Framework as sufficiently robust to enable key activities associated with each of the seventeen activity groups to be captured for more detailed testing. Twelve students applied a

pilot data collection tool during SIP2 enabling an improved tool to be used by the whole class during SIP3. Data collected during these two SIPs enabled the existing list of key activities to be confirmed and refined and, additional key activities to be added. Eight tutor perspectives were captured after SIP3 on the overall framework and the list of key activities. Finally, following SIP4, groups of students undertook a critical analysis of the framework and provided their insights on what aspects they considered most important.

Three key strands of results are discussed below – the SIP Activity Framework, the key activities and the student perspective on what is most important during an SIP.

2.1 SIP Activity Framework

The seventeen activity groupings remained consistent throughout. Some refinements to labels and their descriptions took place to provide greater clarity. The visual presentation was amended prior to SIP4 to improve the representation of the interactions between the activity groups and the iterative nature of the placements. This is shown in *Fig. 3* below. The results of the analysis of both tutor and student perspectives indicates that the SIP Activity Framework is recognised as representing an SIP and, with some supporting guidelines, is ready for use to support future teaching and learning.

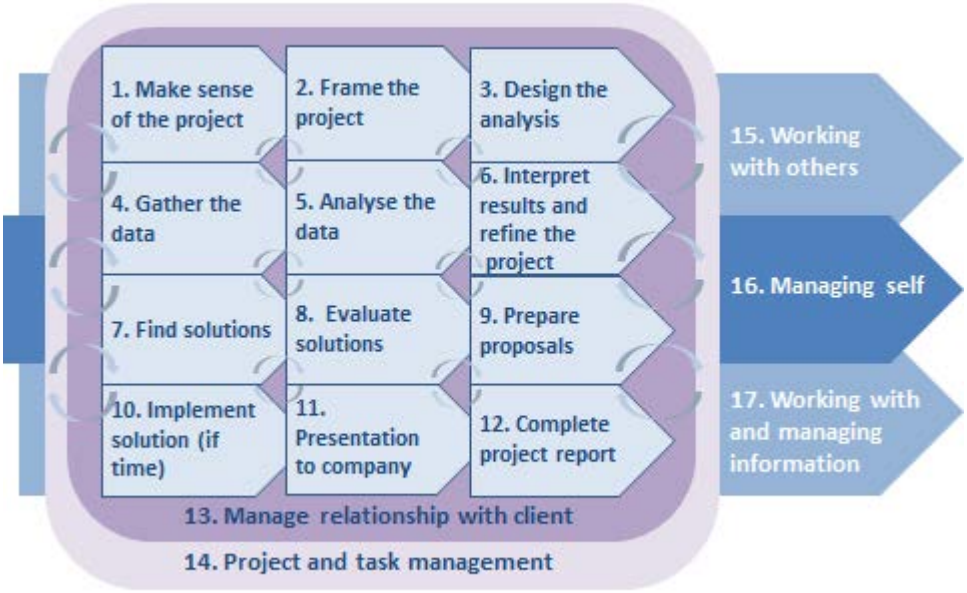

Figure 3. SIP Activity Framework

2.2 Identifying and testing Key Activities

Prior to SIP2, each activity group was broken down into key activities informed by literature [5-7], descriptions provided to students during preparation sessions and, where there were gaps, insights from the authors knowledge. This listing was then subjected to three cycles of testing and refinements which resulted in a final listing of sixty four key activities. During SIP2 and SIP3 students recorded their activities using the data collection tool. The data was assessed by looking at patterns at both the individual and whole class level i.e. when students did different activities, and

secondly looking at overall frequencies. All key activities listed were found to be significant. Student feedback showed that the majority of students entered data throughout the SIP, spent sufficient time completing it, and understood the terminology so there is a good level of confidence that the data was reliable.

After SIP4, student group discussions were held to critically evaluate the key activity listing taking a perspective over all four SIPs. The relative few and minor nature of the suggestions supported the view that the listing was robust. There were a number of issues that arose; determining definitions that worked across all types of SIP's, not all activities are required in all SIPs and, some activities are more significant in some placements compared to others. So achieving the right level and balance in an activity group was a consideration. One of the hardest elements was identifying if any key activities were missing as only a few students were able to do this. The different perspectives of the tutors proved valuable identifying, for example, that the start and end point was not clearly defined so further activities needed to be added.

Whilst the key activities associated with process stages one to twelve were captured those associated with through placement activities were more problematic. There were clear overlaps between some activities in groups 1 to 12 and the 'management' through placement activities of groups 13 and 14. So when they related to a specific activity group they were listed there and, so the more generic 'management aspects' were not forgotten, these were captured on the same page resulting in a format for the detailed framework as shown below in *Fig. 4*.

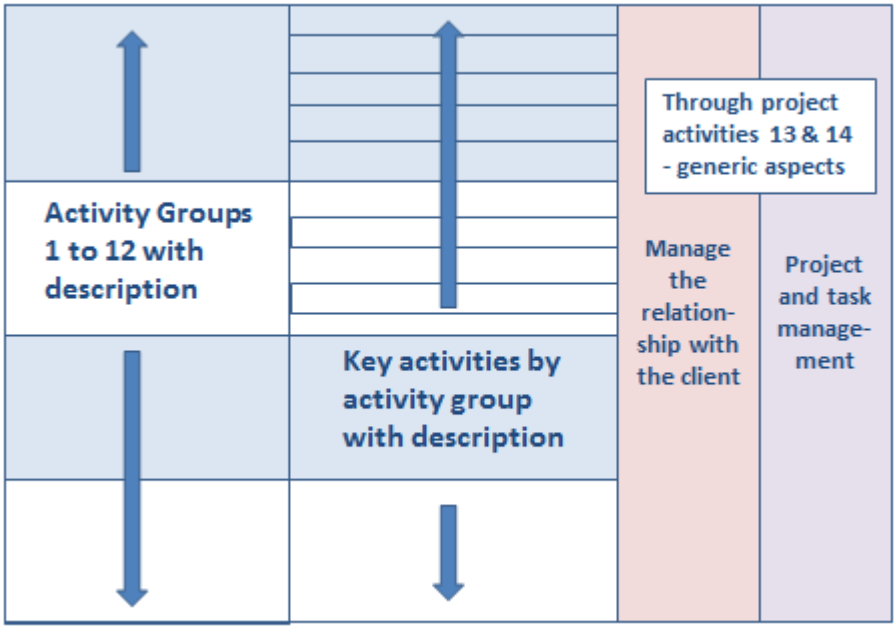

Fig. 4. SIP Activity Framework Structure with Key Activities.

However, the generic through placement activities, such as those associated with 'working with others' or 'managing self', have proved difficult to capture in a useful way. It was found that all the listed generic activities took place but describing them related to their many applications during SIPs was not practical.

2.3 What students 'should do'?

The student view of what most was important was not captured in the SIP Activity Framework and key activity listing. Post SIP4, groups of students developed a short

list of advice for future students identifying the activities they considered most important. These are captured by activity group or groups in *Table 2* below.

The key finding is that the students considered the through project activities to be more important than the process stage activities receiving 61 % and 39% of the votes respectively. This reinforces the need to be able to capture and describe the through placement activities and particularly the generic ones in a way that is useful.

Table 2. Top 6 Most Important Activity Groups – the student perspective

Activity Identified	**Activity Group Reference**	**% Responses**
Managing Self	16	25.0
Project & task management	14	16.7
Defining the project	1&2	16.7
Working with others	15	13.8
Managing the relationship with the client	13	8.3
Validation by Client	8 & 9	8.3

3. FRAMEWORK EVALUATION

The testing of the framework across all eighty SIPs during 2012-2013 has demonstrated that it works for the range of placements undertaken. The visual presentation of the model could probably be improved to better represent the interconnectivity of the different activity groups and representations such as those used by Cope [5] may be helpful. Any changes would have to be balanced with making it appear more complex.

The key activity descriptions have been refined over three research cycles so that they work across all different types of SIPs. It is recognised that there are still some activities which could be interpreted in different ways and describing what the activity is, does not necessarily convey what that activity should achieve or how one would go about doing it. A further break down of key activities into sub activities is not seen as a value adding process – it would make the framework even more complex, perhaps prescriptive and reduce its usability against the range of SIPs. This view is supported by student feedback that they found the framework was a helpful reference document as currently presented.

The key activities that have been incorporated so far are those that relate to the process stages activities. This aligns with the findings of Dowling and Hadgraft [4] that this is a useful approach. However this does not work for many of the through placement generic activities and particularly those that involve dealing with people. The issue of dealing with these generic activities will be an area of further work.

The SIP activity framework should be applicable to other Engineering programmes using similar SIPs over a similar set of placement types and it would be interesting to test this on a broader set of SIPs such as those used in business schools.

4. CONCLUSIONS

The SIP Activity Framework with its seventeen interlinked activity groups conveys a complex event that requires a wide range of activities. These groupings and their configuration have been validated over a number of projects from both student and tutor perspectives.

When the sixty four key activities are added the scale of a placement becomes apparent. This highlights the significant challenges of both preparing students to undertake SIPs and for the students to undertake them.

Sixty four key activities associated with the process stage activity groups have been validated. However, the many key activities related to the through placement activity groups remain un-captured in a useful format. It is important to represent these in a meaningful way as these have been highlighted by the students as key 'should do' areas critical to the success of the project. This will be the subject of further work.

The framework can be put to multiple uses supporting SIP teaching and student learning. This includes the development of improved assessment methods and identifying those activities that require further teaching input.

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