Debrief of PhD Project Practices

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I. INTRODUCTION

The PhD project is by far the largest individual research, writing, and software project that I have undertaken. This essay provides an information account of my project management experiences over the course of the project. This *project debrief* is presented as review of the practices that worked (Section II.), practices that failed (Section III.), and practices that will be considered if the project were to be repeated (Section IV.). Finally, the general principles and best practices are considered (Section V.).The motivation for this work was to articulate and capture the general *research project management* lessons learned as a guide for future project design and work ethic. This is a personal account, meaning that the applicability of the practices are relative to my experience and working style. Before the research project, I was a trained software engineer with four years of practical work experience in industry. The research project was completed in the field of Computational Intelligence, a sub-field of Artificial Intelligence, with strong themes of abstraction, information processing, and empirical simulation. The general work ethic involved an approximate 50-hour workweek, and explicit separation of *work* from *personal* with regard to both physical location and activities undertaken.

II. THINGS I GOT RIGHT

This section considers '*things I got right*' in terms of practices that resulted in productivity or a productive environment. The discussion is limited to the following practices: (1) implementation of a paper archive, (2) creation of a shared software library, (3) use of structured knowledge capture system, (4) work on mini projects, and (5) promotion work product awareness.

A. *Paper Archive*

A centre-wide repository for soft-copies of papers was instituted called the '*paper archive*'. The need for a repository was identified from the frequent repeated searching and downloading of papers, and the haphazard and disparate organisation of downloaded papers. The intent of this repository was three-fold: (1) to reduce the re-searching and re-downloading of previously read papers, (2) to communicate what papers have been read by others in the research group, (3) to provide a future jump-start on research topics.

The repository was implemented as a shared directory on a networked drive with open (read and write) access the whole group. A paper-naming convention was adopted as follows: '*papername (year).extension*' that efficiently communicated the distinct properties of a paper, and could be researched to retrieve bibliographic information. The organisation of papers by subject area was ad hoc, suited to the needs of each user. A per-topic subdirectory structure was suggested and generally adopted, involving the organisation of papers based on a given specific subject matter being researched. The replication of papers was promoted as needed. Text-file *placeholder* files were created for papers whose soft-copies could not be added to the archive. This may have included papers without electronic versions, books, or webpage versions. For some of the placeholder files, additional information was provided within the

text file regarding how to obtain the paper, such as a URL. In the case of books the tag '*[book]*' was added to the file either at the end of the filename (after the year) or at the begging of the filename (before the paper name). The paper archive promoted some exploratory browsing behaviour and cross-field interest with a restricted version of information grazing (browsing with brief reading) where the restriction was by what others in the research group found important or useful enough to download. The maintenance of a digital paper archive promoted a culture of reading publications on the computer monitor, changing the behaviour from printing publications and maintaining a hard copy paper archive. The archive also promoted the formation of specialised sub-repositories, including (1) *centre archive*, and (2) *dissertation bibliography*. The centre archive was a subdirectory (topic) with a folder for each associate of the research group past and present and all papers for which they were the primary author. Additional materials (work products) were also captured including technical reports, presentation files, and relevant software. This promoted information grazing of colleagues to gauge work output, areas of interest, level of quality, and dissertation organisation. Dissertation bibliographies were subdirectories created for specific topics (sub-fields) in which all PhD and Masters Theses known were stored. The naming convention was amended to reflect the degree type and in some cases the author. The repositories were used to assess the general organisation and level of detail expected for thesis in specific Computational Intelligence sub-fields. In two cases, the repositions were communicated through web pages and technical reports.

The paper archive as of the end of 2007 contained approximately 3GB of uncompressed information, with 135 base-directories most of which were Computational Intelligence sub-fields with large numbers of self-contained sub-topics. The archive was initially stored on a shared external hard drive, although was later moved to a secure network drive.

The archive met its goals and provided a seminal information resource throughout the project for at least two group members. The archive had three limitations, as follows: (1) unknown publication versions, (2) lack of bibliographic information, (3) limited adoption. Unknown publication version refers to the inability to differentiate pre-prints from published versions of publications. Generally, this had little (if any) effect on the interpretation of research, although is important distinction to make in the referencing of work. This was addressed in many cases with the addition of the tag '*[tech report]*' or '*[pre print]*' to the filename, although such differentiation was unknown for a vast majority of works, especially those downloaded from author's web pages. The archive did not maintain bibliographic information; the effect was that each group member maintained their own referencing system resulting in a replication of effort and information. This may be overcome in the future through the institution of a central shared BibTeX (or similar) database in the root directory of the archive. Given the utility of a central repository, the archive received limited adoption throughout the group. Reasons may have included (1) the lack of a strict organisational protocol, (2) lack of associated bibliographic information, (3) trust issues, (4) migration effort for existing personal management systems. Finally, it is expected that future implementations may involve web applications such as academic bookmarking web sites that would improve accessibility and search, improve the quality of information through crowd sourcing, and provide additional features such as tagging, reviews, and online bibliographic management.

B. *Software Library*

A shared '*core*' software library was created to limit the replication of effort in implementing common Computational Intelligence techniques, measures, and benchmark problem instances. The intent of the software library was to promote software engineering principles for prototype research projects. This included but was not limited to code-reuse to reduce effort, promote unit testing of modules to improve confidence in code, promote the use of source-control, and to promote the exploitation of off the shelf tools for visualisation and analysis. The common practice was for each researcher to implement their own software

prototypes and manage their own code base regardless of a programming or software background or not. This resulted in many disparate code bases in a variety of languages with an unknown per-case confidence in derived results. A private code base was developed in Java initially for the WEKA machine learning workbench and then later as a standalone toolkit that was specialised into a continuous function optimisation project and combinatorial optimisation (Travelling Salesman Problem) project. Integrated into the code bases was the use of open source libraries for visualisation, graphing, and simple mathematical functions. Eventually, the separate code bases were integrated into a singular open source project created on sourceforge.net. The integrated and publically available code base promoted more rigours testing and strong empirical method for simulation not limited to the use of automated experimentation and statistical tools in the presentation of results. The open source project was used to manage the core code base, with unpublished prototypes maintained as plug-in projects in private CVS repositories.

The independent code bases and ultimately the integrated project was exploited by at least two group members over its lifetime, and the public maintenance of the core codebase raised the profile of the researches involved. The limitations of the general computational intelligence software library include: (1) delayed consolidation and (2) limited adoption. The delayed consolidation and public release did not negatively affect the project, rather meant the benefits of exploiting a public open source project were not available until later. This may be addressed in the future by either the explicit creation of an open source project as a centre codebase early, or through the early adoption of an existing example of such a project. The independent projects and final consolidated codebase were not widely adopted within the centre, even with newer researches arriving an extended period after the consolidation event. Reasons for this may include trust or confidence issues of the code, the perceived and or actual learning curve in the adoption of an unknown software library, the public nature of the core codebase, use of an unfamiliar programming language, and not meeting specific needs.

C. *Structured Knowledge Capture*

A structured knowledge-capture system was personally employed early in the project. The system, like the paper archive, involved a series of directories each limited to a specific research subject or topic. The intent of the structured management of work was to (1) promote separation of ideas, (2) promote capture of diverse acquired knowledge, and (3) promote the exploitation of acquired knowledge. The system was devised out of the haphazard knowledge capture employed in the previous research project (minor thesis) in which all project material was maintained in a single directory of documents. The system began as a series of subdirectories, each assigned a subtopic area of interest related to the project. Each subtopic contained a collection of documents including technical reports, notes, and long unstructured rants on specific concerns or ideas. This system evolved into a partitioning into types of work such as reports, presentations, official communications, dissertation, and papers. This convention was then further partitioned over time, specifically by year, such that each year contained a series of subdirectories of specific types of work, and then specific topics for each subtype of work. Finally, this system evolved into an efficient mini-project organisational system (see Section II. D.). The structured knowledge capture promoted '*writing as the ground state*', providing a limiting effect on procrastination. The structure provided an easily navigateable filing system for completed work, thoughts, ideas, reviews, and all manner of project related work product.

The principle limitation of the structured knowledge capture included the creation of large volumes of unusable free form writing. The writing provided a cathartic mechanism that aided in crystallising understanding and ideas, although in excess provided lengthy documentation that was rarely if ever re-read. This meant that possible documented but unremembered insights may have been lost, and that writing effort was wasted. It was observed that small-scale free formed knowledge capture was beneficial, although large-scale

of such behaviour was counter-productive. Thus, the structured knowledge capture was maintained and redefined as the productive work on 'Mini Projects'.

D. *Mini-Projects*

Structured knowledge capture promoted *writing as the ground state* on the project that was further refined to involve the production of independent reusable units of work called mini projects. The intent of mini projects was to convert the mental and writing effort into '*work products*' that may directly contribute to the completion of the research project. The writing as the ground state principle fostered the skills required to complete the primarily deliverable of the project, a dissertation, and the intent of the mini projects principle was to exploit the first principle by producing measurable and reusable work units that contribute toward the dissertation. Work products included informal communications such as blog posts on related research and software version releases, presentations, and more formal work units such as technical reports, essays, papers, and thesis chapter releases. Given the diverse nature of the structured knowledge capture, the commonly created work product was a set of technical reports generally with low coupling to block out areas of concern related to the project, and with high cohesion (specialisation). Coupling was increased for short series of reports as needed. The 'low coupling high cohesion' principle of software engineering promoted the highest productivity seen in the project in terms of the production of technical reports that ultimately blocked out sections and chapters of the final dissertation. Reuse and repurposing of acquired knowledge was promoted through the general inter-report independence provided through the low coupling, and the strongly specialised and limited scope provided through high intra-report cohesion focused sustained effort.

Although mini projects were independent, the research project provided a common thread linking many of the work products. The limitations of this specialisation of structured knowledge capture included: (1) lack of explicit inter-product relationships, (2) repetition, and (3) integration inconsistencies. The lack of explicit relationship between the work products promoted constant reassessment of such relationships that aided in an improved understanding of such relationships although consumed a lot of effort. The relationships could have been managed explicitly and iteratively refined through improved understanding, instead this was left until integration in the dissertation. The independence of the reports promoted writing about ideas from varied perspectives that resulted in much repetition to ensure reports were coherent, even with referencing of related work. These varied perspectives had to be reconciled when the work products were integrated into the thesis, resulting in many iterations of thesis chapters to limit inconsistencies, repetition, and unrelated information.

E. *Work Product Awareness*

Mini projects ensured that structured knowledge capture was focused on work product. This resulted in a strict project principle of '*if it is not captured in a work product, then it does not exist*', limited to the scope of the project. In an effort to further promote the focus on reusable units of work, an awareness of work product was promoted through various forms with the intent of (1) measuring productivity, (2) discouraging procrastination, and (3) encouraging interest in research. Work product awareness was promoted through a number of ways including a personal website, hard copies, and explicit measurement. Technical reports, essays, and presentation slides were catalogued on a personal website. Some reports such as reviews or those without novel perspectives were converted to portable document format (PDF) and provided as downloads on the website. All software work products were also promoted on their own website, and updated for each new release. All written work product was printed as a hard copy and stored in a folder directly visible from the workstation, with folders partitioned by year. Each work unit was recorded in a spreadsheet with its name and date. This recording facilitated the graphing of work products over time to extract general productivity trends, as well as providing a reference to be drawn upon for faculty annual project review panels. Figure 1 provides a summary of PhD Work Product from 2005 to the

end of 2007. The plot clearly shows the effect of increased technical reports directly contributing to thesis chapters attributed to adopting the Mini Project practice at the end of 2006.
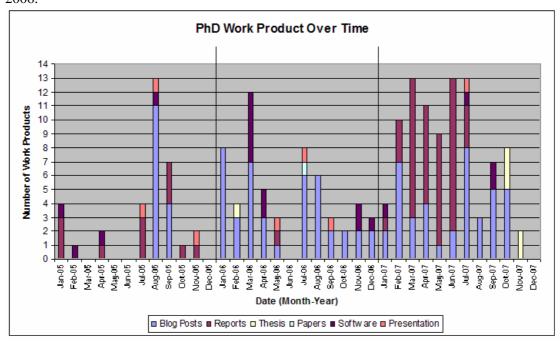

Figure 1 - Plot of PhD Work Product from Jan-2005 to the end of Dec-2007 by Month.

The awareness of the research project promoted on the personal website was indexed by search engines, resulting in measurable traffic (Google analytics), and E-mail correspondence from interested parties in the same and related fields of research. This public awareness also resulted in general personal awareness at international conferences, and the referencing of some of the released software and technical reports. Finally, the printing and management of hard copies of work product provided a *visual cue* and *tangible grounding* of the project and completed work with positive psychological effects.

III. THINGS I GOT WRONG

This section considers '*things I got wrong*' in terms of practices that resulted in non-productivity or an unproductive environment. The discussion is limited to the following practices: (1) lack of a consistent research goal, (2) lack of consistent formal knowledge capture, (3) limited pursuit of feedback on work, (4) few publications, and (5) an obsession with unarticulated concerns.

A. *Lack of a Consistent Articulated Research Goal*

The project did not have a clear and consistent scientific hypothesis, motivation, goals or research impact. All four were developed retrospectively whilst developing the thesis at the end of the project. This was a problem because the work completed throughout the project was completed without a clear idea of how it pertained to the broader project (work completed and work to complete). This had two negative effects on productivity: (1) a shifting project goal with an interrelated shifting motivation, (2) inability to effectively communicate the project to colleagues. An undefined project goal resulted in a work motivation that shifted with *research interest*, and was influenced by *colleague cynicism*. This fragility of project motivation was identified late in the project, and resulted in the assignment of a name to the concept (the *Moser Function*), and an intra-group understanding that discussion of project motivation was an antagonising behaviour. Specifically the Moser Function referred to the '*suspension of disbelief*' where the motivation of a research project as assumed to be artificial inflated to facilitate continued productive work and the grounding of

such motivation had a negative effect on productivity. This defensive measure promoted productive work, although was likely counter-productive to the robustness of research project goals. Further, this defensive behaviour discouraged the open discussion of project goals and motivations reducing the accessibility of research within the group. A clear research hypothesis, related research goals, motivation, and broader impact should have been defined at the beginning of the project and maintained over the course of the project. The prolonged maintenance is expected to both promote the clear articulation of the project marketing as needed, and result in a '*hardened*' project motivation and impact. Active discussion and criticisms should have been encouraged to effectively understand the *contributions* and *limitations* of the research project, the communication of which is *required* in the doctoral thesis. The early articulation and iterative refinement of a project goals and motivation would have provided a framework to which all work product could be related (or not so) to the research project, providing a explicit and consistent context for interpretation.

B. *Lack of Consistent Formal Knowledge Capture*

There was a lot of information knowledge capture throughout the project that was not reusable. This was identified late in the project and addressed satisfactorily (although not perfectly) with the mini project practice. The lack of formality resulted in large amounts of unfocused effort on subjects that were important, and the production of work that although clarified understanding could not be extended (Section II. C.). The important realisation was the need to build a formal knowledge base (such as technical reports and papers) with cross-referencing to reduce redundancy and promote elaboration. Examples of unfocused effort (informal knowledge capture) include blog posts, unfinished technical reports, and unstructured notes. Personal and centre blogs were an effective communication mechanism, although should not have been used as the primarily mechanism to record understandings of research core to the project. Such understandings should have been captured in review reports and papers and summarised or promoted on blogs. Unfinished technical reports were relatively uncommon throughout the project (a few per year), although represent the identification of a subject that was important enough to research and write about although effort that was wasted with the inability to deliver a reusable work product. So-called 'notes' were prolific throughout the structured knowledge capture system. Useful examples include those used to elaborate on completed work units called '*follow up notes*', and those used to propose a subject (mini project) for investigation that facilitated the prioritisation of proposed topics toward the effective application of effort. Examples of non-useful notes include unstructured rants and unstructured reviews of research. In the same category of wasted effort is the reading of papers on a topic and not recording an understanding or perspective.

Informal knowledge acquisition and capture played an important role throughout the project, although only the formally captured knowledge played a measurable role in the development of the thesis. The solution for 'notes' and research reviews is unclear, other than abandonment toward more formal practises such as essays and reports. What is clear is that if an alternative practice is adopted it is required to make such information available for reuse which means making it structured, coherent, and focused.

C. *Limited Feedback*

Insufficient feedback was sort and thus was insufficiently received regarding work product. This restricted work product assessment to a limited, relative, and personal-subjective evaluation, without a broader suggestion at the quality of the work. Further, if and when feedback was provided, it was not explicitly recorded and integrated into the work product. Feedback must be sort, recorded, and addressed. Criticisms need to be assessed objectively as potential limitations or bounds on work contribution or understanding. Related research that appears superficially similar should be embraced as confirmation of good and interesting ideas rather than shunned as an indictment. Finally, effective feedback was generally not received through passive publishing such as on a personal website or blog. It required explicit

elicitation such as peer review of a publication or a reciprocal reading arrangement (for example see Section IV. E.).

D. *Few Publications*

The conversion rate of work product to peer reviewed publications was very poor[1]. Publication was explicitly avoided primarily for fear of public presentation and for subjectively assessed low quality of published work. The lack of publications almost certainly has reduced the exposure and credibility of the project and related work product, and almost certainly negatively impacted career potential. Finally, the lack of effective publication has limited the much-needed feedback from the peer review process (Section III. C.). Publications of all sorts must be sort, with a measurable conversion rate of work product per month to publication output. An expectation of this rate is somewhere in the order of 3:1 for an average peer reviewed conference paper.

E. *Obsession with Unarticulated Concerns*

Some of the most unproductive times of the project involved obsession with unarticulated concerns and problems with aspects of the research. The concerns were not clearly identified and effectively communicated. In the context of the structured knowledge capture (documentation), the concerns became the topic of unstructured rant. In the context of software development, the concerns became the point of elaborate although unproductive software design. Concerns were not limited to topics such as the holistic unification of disparate work products, holistic integration of general pessimism in the field of study, and holistic integration of similar and related research. What was required when such a concern and unproductive cycle is identified, (1) the clear and formal communication of the concern and related issues, and (2) to address the facets of the concern in a piecewise rather than a holistic manner. The former step will provide a guide for the latter and induce continuance of productive work.

IV. THINGS I WOULD DO DIFFERENTLY

This section considers '*things I would do differently*' in terms of neutral practices or new practices that would be instituted if the project were to be repeated. The discussion is limited to the following practices: (1) the institution of an explicit and automated backup strategy, (2) actively marketing the research project, (3) add some structured to the project, (4) treat the thesis as a living document, and (5) initiate an effective reading group.

A. *Explicit Backup Strategy*

An ad hoc backup strategy was employed over the course of the project. For critical work such as the thesis, paper, or presentation, a backup was performed at the end of each day. A backup of the structured knowledge capture for the year was backed up approximately monthly, and the structured knowledge capture for the entire project was backed up approximately biannually. Backups consisted of the zipping of folders and the coping of the created archive to three locations (1) a backup directory on the local disk, (2) a backup directly on a locally connected external hard drive, and (3) a personal backup directory on a faculty network drive. Hard copy backups to compact disc were created annually and placed in the year's respective hard copy folder. The CVS version control system was used for all software development from early in the project with local and secure remote access. A self-managed document version control system was instituted from an early point in the project involving the copying and renaming of a given working document for each day or major change. Given the inherent un-reliance of digital media, and the ad hoc nature of the backup strategy used, an explicit and automated backup strategy should be employed. The project directory should be automatically archived to a local and network location daily using an

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[1] Given that the observation has been made, corrective steps should be taken to publish the work perhaps after the completion of the thesis.

incremental change policy. Two hard media copy should be made of all material related to the project on the first day of every month, with one stored locally and one stored at a remote location. Project 'material' refers to all documents, software, papers, personal web pages, email, and all other related material related to the project.

B. *Active Marketing of the Project*

The marketing of the research project was passive, limited to the release of some work products for download on a personal web site and limited discussion of the project. The project should be actively marketed using multiple marketing forms. The intent of the project marketing is ultimately to obtain feedback on the work products produced. Given a clear project hypothesis, goals, motivation, and impact (Section III. A.), a project webpage can be created with a user friendly summary of the project with links to related work products. Posters can be made to promote the project suitable for faculty open days. Local and remote experts in the field of study should be actively engaged to discuss the project in general or specific aspects periodically. Participation in faculty seminars should exploit the opportunity to promote a broader understanding in the project. The open source motto '*release early, release often*' should apply to project work product (including publication to assure priority), such that a continuous stream of project related work product is produced each month, with a portion made available or visible to interested third parties.

C. *Structured Project*

The project was relatively unstructured throughout in terms of the identification and investigation of ideas. This may be an artefact of a self-governed research project, although it is possible to impose a general structure over such a project. An example general structured is as follows: (1) pick and articulate research direction and continually refine the vision, (2) undergo a period of self-education in aspects of the field and related research articulating reviews and understanding, (3) proceed with the primary investigation continuing self-education as required. This simple *Vision-Education-Investigation* structure clearly highlights the importance of a research goal articulated early (Section III. A.) and continued formal knowledge capture (Section III. B.) in a piecewise manner (Section III. E.).

D. *Thesis as a Living Document*

The thesis, as is generally the case, was treated as document to be constructed from the work products created over the course of the project. An alternative perspective is to seriously consider the thesis as the primarily deliverable of the project from an early stage, and create a management system that treats it as a living document throughout the duration of the project. This would include the early creation or adoption of a thesis template and outline of chapters and sections. This structure would be refined and fleshed out in a continual process as realisations, understandings, and information reorganisations occur. It provides a productive basis for the continual development of the project's research hypothesis, goals, motivation, impact and most importantly criticisms and limitations. Finally, the living thesis document provides a context map in which to create relationships between work products as well as smaller concepts from the structured knowledge capture system.

E. *Reciprocal Reading and Reading Group*

Two practices that were trialled unsuccessfully and should be reconsidered were (1) the formation of *reciprocal reading associations*, and (2) the formation of a *research reading group*. In both cases, the trials were unsuccessful given the general lacklustre participation, restriction to locally available group members, misperceived participation effort, and culture of closed research projects. Reciprocal reading associations requires the formation of relationships with colleagues and or peers in which the members of the associations peer review each others formal work products. These relationships may be pair-wise or group-wise depending on existing associations, and would promote an open culture of constructive feedback (Section III. C.). The reciprocal association promotes an equitable trade-off in

effort dependant on the frequency, complexity, and length of work products exchanged. The formation of a research reading group requires the formation of relationships with colleagues and or peers in which members of the group read and assess single pieces of research and meet to discuss such assessments periodically such as weekly, fortnightly, or monthly. Group members take turns in proposing research papers for assessment, and participation in the reading group is voluntary. The system promotes continual education, objective assessment, and provides a resource for obtaining assistance in understanding difficult to interpret research.

V. CONCLUSIONS

This work provided a summary of the five most prominent PhD research practices that (1) resulted in productivity, (2) resulted in non-productivity, and (3) that would be instituted if the project were to be repeated. Five general principles regarding independent research project best practice that may be abstracted from this introspective discussion are as follows:

1. *Writing as the ground state*: Writing must become a reflexive behaviour when reading, thinking, working, and procrastinating. Writing is the primarily means of research communication, and as a research skill must be refined more than any other skill.
2. *Work toward formal work products*: Writing must be focused toward small semi-independent formal work products, such as a series of low coupling, high cohesion publications such as papers, reports, and essays. Ranting, note taking, and blog postings are insufficient. Formal work products must be reusable, requiring a higher level of writing quality, organisation, and focus. One may take the extreme perspective of extending the view '*it does not exist unless it is written*' from writing as the ground state, to '*it does not exist unless it is captured in a formal work product*' from the mini projects practice.
3. *All about the end product*: All effort exerted on a research project can be related or not related to the end product of the project, in the case of the PhD, a dissertation describing the extent of the research project. This requires the early and ongoing articulation of the goals, questions, motivations, impacts, and limitations of the project.
4. *Perpetually incomplete*: All work is incomplete or wrong, given the necessary tradeoffs required in time and effort to produce work products. This most importantly applies to the end product, in this case the dissertation. This principle does not suggest a neglect of rigor, rather it promotes the piecewise and iterative, self-education and conceptual refinement.
5. *Building a knowledgebase*: All effort exerted on a research project can be considered with regard to the construction of a knowledge base on a subject of (very) narrow scope. Perhaps the most important of all, this principle focuses effort and understanding on a project, promoting the cross-referencing and inter-connection of acquired knowledge.

Finally, given the assessment of practices and abstraction of general principles, one may document set of general important introspective changes or lessons acquired over the course of the project, as follows:

1. *Work*: No one else is going to do the work for you, you have to take responsibility, put your head down, and work hard. This is an important point, as the distinction must be made between genuine third party interest in your work and wiliness to do the work for you.
2. *Confidence*: Given that all work is incomplete, it is important to establish confidence in your own opinions and understanding of research. This is not a licence to be

arrogant, rather the requirement to be objective and sceptical where appropriate and to always think for yourself.

3. *Stubbornness*: Hard work requires persistence in the context of distractions and pessimism and ultimately a stubbornness to stick with the chosen research objective. Importantly, this requires hardened articulation of what that chosen research object is and why it was chosen, such that criticism is met with objective rigour rather than emotional defence.

4. *Honesty*: It is critical to be honest, and more so to be honest with yourself with regard to feedback, limitations, motivation, and related work. So-called suspension of disbelief promotes a culture of poorly motivated research, neglect of similar or related work promotes a culture of ignorance, and disregard of criticism promotes a culture of unbounded capability. Honesty promotes openness of research, which ultimately improves the quality of the work and the chosen field.

5. *Reflect*: Reflection provides a mechanism for explicitly highlighting strengths and weaknesses and promoting continual learning. Periodically consider what has been done and what needs to be done.