Abstract:
Entrepreneurship education differs significantly from the kind of skills transfer required to train scientists, engineers, or even management specialists. This is principally due to the high level of tacit knowledge transfer involved. This in turn requires a systems approach to properly deal with this interactive process. This theory paper examines the epistemology of transferring the embedded skills used by experienced new venture creators, to nascent upstarts. By applying frameworks and models derived from systems thinking, the complexities implicit in entrepreneurship education become clearer. These insights then pave the way to match these complexities with innovative but appropriate solutions.

Introduction:
It has long been recognised that successfully educating entrepreneurs requires a very different approach to those used in mainstream disciplines such as engineering, medical, or business education (Scott, Rosa and Klandt 1998). Entrepreneurship even has some significant differences when compared to close allies like small business management, a typical example being the entrepreneur's focus on high growth ventures (Gillin '91, Gillin et al '96). Recent research (Campbell 2007) has reiterated the need for a more holistic approach in entrepreneurship research (Kyrö & Kansikas 2004) especially when considering entrepreneurship education (Din & Gibb 1990). Equally, there is the recognition that a key element of entrepreneurship education involves Tacit Knowledge transfer (Polanyi 1968), typically addressed through the use of case studies and by including first-hand input from practitioners.

This theory-based paper explores the nexus between tacit knowledge transfer and a holistic approach, in the context of entrepreneurship education. Epistemologically, tacit knowledge is "locked up" in the experience of the practitioner, which in this
context is the entrepreneur. This tacit knowledge can therefore only be transferred once it is expressed in a way that makes it explicit to a wider audience (Pope et al 2003). This then allows us to use the entrepreneur’s explication as a vehicle or framework within which we can discuss, comprehend and ultimately apply the knowledge in a meaningful way.

Similarly, systems thinking is a framework which allows us to reduce complexity by dividing it into sections or constituent parts, while at the same time recognising the imperative of "putting it back the way we found it" so that the systemic integrity is preserved (Stevens et al 1998).

Entrepreneurship, as a complex but holistic phenomenon (Bygrave '89), can therefore benefit from the frameworks and methodologies of systems thinking, especially in the context of education where the integrated overview is so important to a successful outcome. Consequently, placing the complex and wide-ranging field of entrepreneurship education within these existing frameworks that have proved helpful for holistic approaches and tacit knowledge transfer, helps draw out some useful discussion and conclusions.

**Reductionism:**

In moving from education in isolation to a more systemic view, it is helpful to consider some background on systems thinking, and compare it to the reductionist thinking that underpins much of the engineering and scientific endeavour that is so helpful in many other fields.

The reductionist thinking advanced by Descartes in 1637 (Descartes 1968) has allowed science to progress rapidly and impressively over the intervening centuries. Our present-day body of knowledge in a wide range of sciences is both impressive and crucially supports the technological and other advances that have improved our living standards by orders of magnitude, when compared to the 1600s. Just 100 years ago for instance, the typical speed limit was 10mph, life expectancy was below 50 years, and 9 out of 10 homes did not have a telephone. Reductionism has played a vital role in underpinning the scientific thinking and research behind most of the spectacular advances that have been made over the past several centuries.

However at the beginning of the 20th century the emergence of a new field of enquiry began to encounter the limits of reductionist thinking. This was the "new science" of quantum physics. The following quote (Capra 1989: 76) captures the radical change of thinking required:

> Even after the mathematical formulation of quantum theory was completed, its conceptual framework was by no means easy to accept. Its effect on the physicists' view of reality was truly shattering. The new physics necessitated profound changes in concepts of space, time, matter, object, and cause and effect; and because these concepts are so fundamental to our way of experiencing the world, their transformation came as a great shock.

Clearly reductionist thinking on which scientists had relied for centuries, was beginning to reach the limits of its capabilities as science progressed into the 20th century. Another quote helps put this in perspective: *the more we study the major problems of our time, the more we come to realize that they cannot be understood in*
isolation. They are systemic problems, which means that they are interconnected and interdependent (Capra 1996).

Technology and Engineering which have applied so much of the physics and science theory, are particularly prone to accepting reductionism as the default thinking, for the very good reason that it has supported those endeavours over centuries. However, in order to apply those technological marvels within a social context in which people and organisations are inextricably involved, requires a wider worldview that will accommodate the full socio-technical system.

Some Background Literature on Systems Approaches

Systems Thinking thus emerged in the mid 20th century, partly as a holistic response to the increasing complexity and fragmentation within many scientific endeavours, and the applied sciences such as engineering and medicine that in turn put these into practice. It is especially in this interaction between theory and practice that systems thinking finds its place (Jackson 2000), within the social context of people and how they are managed within teams and organisations.

Systems Thinking is widely accepted as having been the initiative of Boulding (1956) and von Bertalanffy (1960). This is a holistic worldview, in which (Hansen 1995):

- Wholes cannot be taken apart
- Every apparent whole can be understood only in the context of the larger whole containing it
- A whole is more than the sum of its parts

Reductionist thinking on the other hand regards (whole) problems as divisible into as many parts as is required to understand each part, and relies on re-integrating the parts to make it possible to understand the whole problem. Thus a car's engine can be analysed by dismantling it until every component is understood, and piecing this together again will result in an understanding of the overall working of the machine. However, when not dealing with a machine, reductionism begins to break down.

Consider the baking of a cake. Once baked, it is impossible to separate it into its constituent parts. Also, before being baked, examining the eggs, flour or sugar on their own, will give little clue as to their mutual interaction during the baking process, and thus only tentative indications of the outcome of the process. Similarly when analysing people within socio-technical systems, these are clearly not simple machine-like situations, and reductionism is therefore much less appropriate. Systems approaches make sense in complex situations, most importantly as they also include the context of the team and organisational systems within which new ventures are created and grow.

The development of Systems Thinking can be understood by referring to Fig.1 which indicates the influence this holistic worldview had on Organisational Behaviour in the 1970s and 80s (also known then as Industrial Psychology). The textbooks of the time (e.g. Baron 1983) typically made much of the new-found systems worldview to understand an industrial world that was emerging from the era that had built the fortunes of machine-age entrepreneurs, typified in the likes of Henry Ford, into one
where "understanding and managing the human side of work" (Baron '83) was coming into focus.

The subsequent influences brought about by a resurgence of positivism and functionalism caused a split into the so-called hard and soft systems approaches. The hard systems approach can be typified by the now-ubiquitous V-diagram of Forsberg & Mooz and by the plethora of systems engineering methods and tools found in textbooks such as Blanchard & Fabrycky (1997). Hard systems approaches are therefore well aligned with the Engineering Sciences.

The so-called soft systems approaches are probably best characterised by the work of Checkland (1983) with the Soft Systems Methodology (SSM) still being among the best-known of these systemic approaches. Authors such as Senge, Jackson and others have added to this body of knowledge which can be classified as part of the Social and Management Sciences.

This paper is therefore concerned more with the right-hand side of Fig.1 in order to integrate the people-centric issues with those that are more technical in nature.

Jackson (2000) uses the depiction in Fig.2 to illustrate the progression that is typical in any piece of research. It begins with the theory framework (F) on the left, which is then embodied in the chosen methodology (M). This methodology is then applied in practice to the area of concern (A).

In the context of entrepreneurship education, the methodology (M) is the educational approach, and the area of concern (A) becomes the target of our education (the students). In this case we need to extend one step further to the right of Fig.2 to include the crucial outcomes of this education, namely the extent to which our students actually succeed in practice after they have graduated from the educational program.

Returning to the left-most part of Fig.2 it is therefore clear that for a systemic approach to entrepreneurship education we need to ask what basic theory or "framework of ideas" (F) we have chosen to underpin our educational approach. Some suggest this choice of theory is implicit, maybe it is also unconscious, or sometimes even inadvertent. However we arrive at the chosen theory, the point

![Fig.1: Development of Systems Approaches](image-url)
illustrated in Fig. 2 is that the theory (F) that underpins our educational approach will largely determine the educational methodology (M), and crucially the final outcome.

Perhaps we simply choose a method which seems to have worked in the past, and then begin to set about our teaching activities, in what later turns out to be a largely reductionist way, expecting all the pieces to simply "come together" in the end, in a machine-like fashion. Science and engineering courses are taught very much in this way, beginning with the detail "building blocks" such as mathematics, physics, and so on, with the complete systems view only emerging in the final years of study.

The very different nature of systems approaches are for instance highlighted by observing that systemic educational approaches involve people interacting with the educational context to deliver outcomes not achievable by either the context itself or the people working alone. In a system it is not the elements that are most important but their interactions.

In the context of systemic approaches to entrepreneurship education, the MEI at Swinburne University is a good example. Before examining this in more detail, some background on the nature of the knowledge we need to transfer to budding entrepreneurs.

**The Nature of Tacit Knowledge and its Transfer**

Knowledge takes on both explicit and tacit forms. Simply put, explicit knowledge can be expressed and written down. We can therefore capture it, store it, and then pass it on to others with relative ease. This is the typical classroom situation where a lecturer educates incumbents in a certain field of expertise using material from written or other stored sources. In this situation models, frameworks and diagrams are often used to help transfer and embed this explicit knowledge in a way that becomes "the student's own" by relating it to a familiar context.
Tacit knowledge, in contrast, is less easily expressed and is in fact often inaccessible to the very experts who possesses the knowledge. It may be easy for them to "show how" by relying on their intuitive experience but these experts are at a loss when asked to describe or explain the knowledge cogently. Polanyi (1968) produced the seminal work in this field and he describes it as "the knowledge which cannot be explicature fully even by an expert and can be transferred from one person to another only through a long process of apprenticeship". Research in the medical field describes the nature of tacit knowledge as "less visible and consisting of skills learned through experience. This tacit knowledge seems to require direct personal contact between an expert and a learner for transmission to take place" (Pope et al 2003).

This would typically necessitate a hands-on approach where the tacit knowledge bearer and the incumbents are in an open and interactive environment. Tacit knowledge, despite its intangible nature, thus plays a key role in distinguishing 'experts' from 'novices' by the level of tacit knowledge acquired. This has significant implications for entrepreneurship education.

**Entrepreneurship Education and Tacit Knowledge:**

The management sciences have an enviable record when compared to the entrepreneurship literature, with entrepreneurship only recognised by the Academy of Management in 1986, when the Entrepreneurship Interest Group attained division status. This places Management literature, with its many theories, frameworks and models, firmly in the category of explicit knowledge.

Entrepreneurship on the other hand, despite a wealth of solid academic research, has yet to agree on such basics as a single widely-supported definition of the phenomenon. It still tends toward the realm described by Mitton (1989:9) where "you know it when you see it but don't know how to define it". This places the elusive entrepreneurial skills, that lead to the creation of successful new ventures, largely in the domain of tacit knowledge.

Of course without sound management basics, most new ventures will flounder. Some describe these business basics as the "race qualifiers" that place one in the running. However to actually run the entrepreneurial race and succeed at it, requires far more. It requires that "something extra" and this paper's thesis is that these crucial aspects are chiefly to be found in the domain of tacit knowledge.

To educate successful nascent entrepreneurs therefore requires a combination of explicit and tacit knowledge. It is essential to impart the basics that apply generally to enterprise creation, and this can be done in a variety of ways using traditional education approaches such as lectures or on-line methods. However if we are to differentiate our education as entrepreneurial, this needs to be mixed with the essence of entrepreneurial acumen. Crucially, the literature on tacit knowledge indicates that traditional approaches simply cannot be employed in transferring this knowledge. The only approach is to create a learning environment where the experienced and inexperienced interact in a way that facilitates the transfer of this tacit knowledge.
A Systemic Approach to the Transfer of Tacit Knowledge:

The so-called V-diagram of Forsberg & Mooz, a well-worn tool of systems analysis, is typically applied to the management of large and complex design projects (Fig.3). We begin at the top-left of the V by defining what the whole system should look like. Following the arrow downward we move to progressively more detail until we have the finest granularity required. Each detail element is then verified (in isolation). Next, following the upward arrow, we begin to integrate the detail elements to ensure they fit with one another and then finally reach the stage where the system is verified as a whole. At this stage it should be an accurate replica of the system that was planned in the beginning at the top-left of the V.

This simplified depiction of the V-diagram is invaluable in practice as it provides a constant check that one has the integrity of the system clearly in view, especially the top-left of the V, namely the desired systemic outcome. (It should be noted that Fig.1 indicates that the V-diagram emanates from so-called hard-systems. However it is a readily understood tool, and suited also to the so-called softer systems of management science, in which context it is applied here.)

To illustrate how this may be applied in practice, the MEI Program (Masters in Enterprise and Innovation) at the AGSE, Swinburne University will be used as an example. The approach implicit in this educational program will be compared to the V-diagram model used in Systems analyses, to help illustrate the type of structural integrity that such a systems perspective can create. While there are doubtless many similar programs to be found elsewhere, this is an established and successful entrepreneurship education program, and thus serves as a good example.

The program starts with courses on Leadership and Opportunity Recognition. Both are high-level courses aimed at a systemic view of the venture as a whole. In this way students gain a view of the whole enterprise before they are required to deal with the finer details of what each function within the enterprise is, or how it operates.

Importantly, it is at this systemic overview stage that the transfer of tacit knowledge comes into play. To ensure the students receive this knowledge they need to be exposed at this early stage to learning environments such as case studies, guest lectures by real entrepreneurs, and importantly to 'pracademics'. Pracademics help bridge the gap for the experienced entrepreneurs who are rich in tacit knowledge but relatively inarticulate in expressing it in a way that is readily understood. These pracademics are typically practicing entrepreneurs who have completed an academic
course and therefore familiar with business frameworks and enterprise models with which to communicate their complex skills.

Earlier the point was made that tacit knowledge transfer requires a type of apprentice-mentor situation, with the 'novice' and 'expert' in close relationship. The use of guest lectures by entrepreneurs and facilitation by pracademics are thus well suited to this goal. Case studies are also a particularly rich environment for tacit knowledge transfer, especially when supported by an experienced facilitator who can help students draw out aspects of the case study that make sense to them individually and which they can apply to their own entrepreneurial context. More generally, effective transfer of tacit knowledge will be enhanced in open, verbal environments and some researchers find that informal and emergent communication methods work well. This is especially true as technology continually suggests new ways to communicate (Desouza 2003).

Returning to the MEI program, once the systems view of the enterprise is clearer, the courses then progress to fill in the detail of aspects such as management, legal matters, finance or marketing. In this way the student can now place these details in the context of the whole enterprise, and begin to appreciate the key role played by each part. Importantly, the interactions among the parts also become clear.

Significantly, from an educational point of view, were these stand-alone details to be presented in courses at the beginning of the program, their significance would be obscured. Not only would the students' motivation to learn thus be reduced, but their ability to integrate this knowledge into the enterprise context would be unduly taxed. Importantly, the opportunity for the transfer of tacit knowledge would also be limited by this kind of piecemeal educational approach, as it would lack the systemic overview necessary to place the knowledge in the framework of a new venture.

**Implications and Conclusions:**

In general, the following conclusions about tacit knowledge transfer may be drawn from the literature sources and discussions in this paper:

- Tacit Knowledge Transfer is vital in the context of Entrepreneurship Education
- The level of Tacit Knowledge distinguishes between the Novice and Expert

Tacit Knowledge Transfer is enhanced in contexts where:

- Expert and Novice(s) are in close, interactive communication
- They share similar conceptual frameworks that help to transfer knowledge
- Experienced entrepreneurs share anecdotally (war-stories)
- Case Studies and their rich detail are used to contextualise knowledge
- Informal and emergent communication methods are encouraged

It is also clear that a systems approach helps significantly in aiding the learning process, making it not only more effective from the students’ point of view but also by ensuring that the key element of tacit knowledge has the best chance of being imparted. Explicit knowledge is certainly important – without it the odds of survival are considerably reduced. However, without the transfer of tacit knowledge we have
"merely management" rather than the dynamic and wealth-creating nature of entrepreneurship. Knowing how to facilitate this in entrepreneurship education programs is thus a crucial ingredient for successful student outcomes in the long term.

A revealing implication of tacit knowledge transfer comes from the field of medical education where the role of tacit knowledge is similarly vital. "The endurance of the clinical apprenticeship model of learning and the passing on of tacit knowledge via exposure and informal routes (such as the anecdote) attest to the importance of this other necessary form of knowledge". (Pope et al '03)

The implications of effective tacit knowledge transfer are especially relevant for educators in their quest to help realise the full creative potential of budding entrepreneurs. Applying a systems approach to the program design is a central tool to ensure this happens in the best possible way.

Finally, the points made in this paper are also helpful to practicing entrepreneurs who are considering some form of education to spur them on to new levels of success. It is hoped that this paper will help dispel the expectation that mainstream explicit knowledge alone will prepare them for the dynamics of new venture creation.

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