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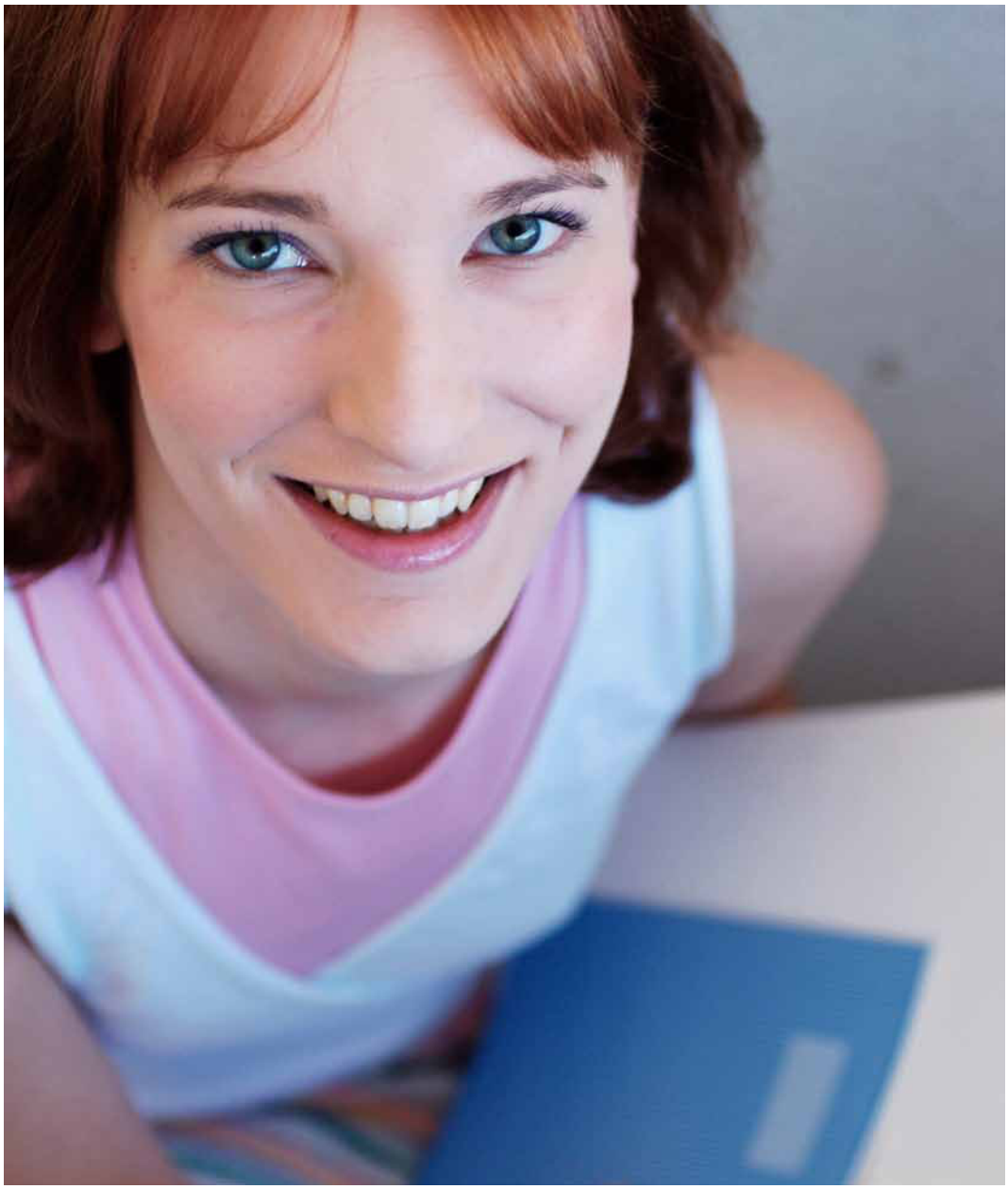

Methodological Summer School for Masters Students

Kouvola, June 2013

Handbook

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Methodological Summer School for Masters Students Handbook

Contents

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We acknowledge the contributions of some of our present and former colleagues to the thinking in this handbook, particularly that of Jacquie Wilson

Introduction

This handbook has been designed to provide supporting information for a one-week inter-disciplinary summer school for masters level students. The aims of this course for Masters students are to:

- Promote the enhancement of their research, development and innovation skills in a multi-professional environment;
- Encourage the investigation of the common challenges of different professional fields in an inter-professional context;
- Develop and enhance student skills relevant to undertaking a thesis and more generally in research, development and innovation.

Multi-disciplinary and other such activities require the individuals who are involved in them to develop a range of abilities in addition to domain specific knowledge. These abilities can be collectively termed as implicit knowledge; this is the knowledge, for example judgement, which enables individuals to use and apply domain specific knowledge in the appropriate way. Such abilities are crucial in enabling individuals, who partake in multi-disciplinary activities, to act both as contributors (of ideas and expertise) and collaborators (for example in collective decision-making) at the same time. Combining these two roles, of contributor and collaborator, in an effective way requires a balanced, objective, reflective and analytical approach to the task in hand.

Using terms such as *inter-disciplinarity* and *multi-disciplinarity* can lead us to trip up on our own terminology and perhaps cause confusion in the reader. We have tried to be consistent in our usage, which is based largely on that of Hugh Barr (1996). Catherine Scott and Anne Hofmeyer (2007) have produced a more detailed review of cross-disciplinary terminology.

- We regard as *multi-disciplinary,* activities where students or professionals from different disciplines learn or work in the same space, but each discipline from its own standpoint.

- We define as *inter-disciplinary,* activities where students from different disciplines learn and work together, sharing views and discussing issues across disciplinary boundaries.

- *Trans-disciplinary* activities are those where students work or learn together on issues that defy disciplinary boundaries or where the students learn with, and from, teachers from another discipline.

But the above are not clear-cut definitions and there is considerable scope for overlap in meaning, particularly where a group migrates from a multi-disciplinary to an inter-disciplinary approach.

The following sections cover some of the different abilities that an individual requires to enable them to work effectively in a multi-disciplinary team, and to develop as professionals in the workplace.

The first section deals with reflective practice. An individual's ability to review and analyse events, experiences and observations significantly affects their decision-making and problem-solving abilities and therefore the outcome of activities that they undertake or are involved in. Reflective practice is a crucial part of a professional's work and impacts on the quality of their work.

It is not sufficient only to develop domain specific knowledge and reflective practice. Each individual in a team needs to behave in an appropriate and professional manner, be able to effectively communicate their knowledge, collaborate with others and develop an effective approach to problem-solving. The following sections expand on these themes.

The final section, on the creative problem-solving process describes the activities that should generally be followed when addressing open-ended or complex problems or tasks.

Some of the content of this handbook goes beyond what is strictly needed for the course but will form a basis for participants to engage in further inter-professional activity.

Section 1
Reflective Practice and Reflective Writing

Introduction
Many professionals keep a journal. This often combines sketches, notes and larger pieces of text. This is a ***reflective*** document and provides a 'space' in which to describe, evaluate, think about and respond to experiences and events and record ideas for future use. The most interesting and productive journals are those that begin with questions about experiences and observations (some of which cannot be immediately answered) and provide an insight into an individual's progress and development over a period of time.

Reflective writing can promote questioning, evaluation of and responses to experiences and insightful observations. Reflective writing should be used to record activities undertaken, and, outline your interpretation of events, ideas and concepts in order to reflect on how your ideas and approaches can evolve and develop in the future.

> **Reflective writing, when used as a developmental tool should have a purpose and show a level of commitment, ambition and engagement.**
>
> **Commitment** is needed so that, for example, regular and frequent journal entries are made that are thoughtful, thought-provoking, lively, varied and developmental. An entry should be long enough to reflect extended thought.
>
> **Ambition** is needed so that, for example, journal entries regularly pose questions which engage the writer, but for which the writer may have no ready answer. Entries should show a willingness to speculate and try to make connections between different experiences and activities. Entries should demonstrate that the writer is clearly trying to get as much from the reflective writing as possible.
>
> **Engagement** is needed so that, for example, journal entries show that the writer has regularly reconsidered earlier entries in order to comment on them, contradict them as a result of newly acquired knowledge, or find some message in them. Over time, questions, issues, or concerns evolve which are specific to the writer, and specific entries identify and explore these issues.

Reflective practice is an important part of both the learning process, the development of problem-solving abilities and is core to professional development.

Why is reflective practice important?
Professional bodies and employers are insistent about the development of employability skills in Higher Education courses, in addition to the acquisition of discipline specific knowledge. Important among the employability skills are the following:

- The ability to reflect on one's own skills, attitudes and abilities to underpin professional practice and professional development;
- The ability to work successfully and collaboratively with others.

Employers, when considering the suitability of graduates all are interested in people who have developed beyond being able to get the right answers in exams. Higher Education is about developing much more mature skills than this, for example developing the abilities to cope with open-ended problems which do not have 'right' answers. In your professional lives, you will often work in teams of people who may not have the same disciplinary, cultural or national backgrounds, and, your employers will expect you to work well in such teams, research your 'deliverables' and develop a highly professional manner with your colleagues.

In employment, appraisals of your work will focus on your ability to understand and articulate your own progress; this is an example of where reflective writing to consider self-development over a period of time is useful. Reflective practice is not divorced from the work you do but it goes hand-in-hand with it. All professions view this ability to reflect as very important. We need to know how to analyse our professional selves and track our development as well as to know how to reflect on the decisions we make and the dilemmas we face, just as much as we need to develop our discipline-based knowledge.

The Nature of Reflection

Reflection (or *reflexion* as it is sometimes spelt) has a range of meanings in everyday life. A quick glance in a dictionary or thesaurus will give you concepts of: the return of an image or sound or object; thought or consideration; repute [or ill-repute!]; contemplation or meditation; copying or reproduction; regression or recoil. We may share many of these views of reflection but, in this context, we are looking at the more introspective aspects of thought, consideration, contemplation or meditation. Perhaps a more useful term is *self-reflection,* which conveys introspection rather than simply musing. In normal usage this still does not convey the sense of *reflection-in-action* (see below) that underpins reflective practice as reflection should not be seen as purely narcissistic.

The Reflective Loop

A key stage in an elementary model of reflective practice is an event, experience or observation which prompts some thought about the success or otherwise of that event, which in turn leads to action to develop or improve performance or outcome in the future. Already we have the makings of a 'feedback loop', but the important element in reflective practice is to make the leap back to the start, to evaluate the results of the action, experience or observation and therefore to continue the cycle. Thinking about what we do is not sufficient; for reflective practice to be effective we must be acting upon our thinking and evaluating the results of our actions.

Learning and Reflection

Boud *et al* (1985) see reflection and learning almost as two sides of the same coin and suggest that there is much reflection in any process of learning, but we do not always recognise it as such. They make three key points about this interaction:

- Only learners themselves can learn and only they can reflect on their own experiences.
- Reflection is a purposive (done with a purpose) and purposeful (intentional) activity. Reverie and meditation may help in the process but are not, themselves, goal-directed critical reflection.
- The reflective process is one in which cognition and feelings inter-relate and interact. Negative feelings can raise barriers, distorting perception, but positive feelings can enhance the process and provide motivation.

Argyris (1991) suggests that many "well-educated, high-powered, high-commitment professionals" fail to learn because they misunderstand what learning is and how to bring it about. He suggests two sources of misunderstanding. First, the failure to critically reflect on his, or her, own behaviour - and how this contributes to problems - leads to too narrow a perception of learning. He contrasts *single loop* learning, focusing on identifying and correcting errors in the external environment, with *double loop* learning which requires understanding how the very way that they go about defining and solving issues can be a problem in its own right.

> "Highly skilled professionals are frequently very good at single-loop learning. After all, they have spent much of their lives acquiring academic credentials, mastering one or a number of intellectual disciplines..."

The second mistake, Argyris believes, is to underestimate the part that defensive reasoning plays in blocking learning. Because professionals infrequently encounter failure they fail to recognise it and attribute *blame* to external factors. This not only represents a missed opportunity but also reinforces the defensive behaviour.

> "People at all levels of the organization must combine the mastery of some highly specialised technical expertise with the ability to work effectively in teams, form productive relationships with clients and customers, and critically reflect on and then change their own organizational practices."

On the other hand, Schön (1982) maintains that this does not cover a wide range of professional situations where the individual makes use of what Polanyi describes as 'tacit knowledge'. Tacit knowledge is often defined as knowledge that we cannot recall having learned (for example judgement) and which, sometimes, we find difficult to verbalise. Schön gives the example of building a road:

> "When professionals consider what road to build, for example, they usually deal with a complex and ill-defined situation in which geographic, topological, financial, economic, and political issues are all mixed up together. Once they have somehow decided what road to build and go on to consider how best to build it, they may have a problem that they can solve by the application of available techniques."

To overcome the deficiencies in the epistemology, Schön advocates 'Reflection-in-Action'

> "When someone reflects-in-action, he [sic] becomes a researcher in the practice context. He is not dependent on the categories of established theory and technique, but constructs a new theory of the unique case. His inquiry is not limited to a deliberation about means which depend on a prior agreement about ends. He does not keep the means and ends separate, but defines them interactively as he frames a problematic situation. He does not separate thinking from doing, ratiocinating his way to a decision which he must later convert to action. Because his experimenting is a kind of action, implementation is built into his inquiry."

Johns (1994) gives a model with four stages of structured reflection. Using these four stages as the sequence which to follow is useful as it provides a framework to support 'Reflection-in-Action'. Reflective Practice is founded on questioning and Table 1 below gives examples of the types of prompt questions that can be used to promote reflective practice. Adapted from the model set out by Johns the table sets out the stages and the types of questions that an individual could ask him or herself about an event that they have experienced.

The four stages of structured reflection	**Questions to prompt reflection**
Identify the issue for reflection and put it into context	• How can the experience be described? • What essential factors contributed to the experience? • What were the significant background factors to this experience?
The reflection process	• What was I trying to achieve? • Why did I act as I did? • What were the consequences of my actions for others? • How did I feel about this experience when it was happening? • How did colleagues feel about it? • How do I know what colleagues felt about it? • What factors influenced my decisions and actions? • What knowledge affected my decisions and actions?
The alternative actions possible	• Could I have dealt better with the situation? • What other choices did I have? • What would be the consequences of these other choices?
Learning from reflection	• How do I now feel about this experience? • How can I make sense of the experience in the light of past experiences • What have I learnt from this experience which will affect my approach in the future?

Table 1: Examples of questions to prompt reflection

A framework for reflective practice

The process of reflective practice, as has been seen, can be described as an iterative learning circle, which 'closes the loop'. New knowledge is added each time the stages within a cycle are completed. Progressively adding to existing knowledge can change our understanding of a situation and our future actions or decisions. The learning is based on reflecting on previous experiences and situations in a purposeful manner. Reflective practice is considered to be a core element within professional development and a number of writers such as Schön (1983) have developed frameworks for reflective practice. He describes the activity of reflection as "a reflective conversation with the situation".

To summarise, the process of reflective practice can consist of the following phases.

- After an experience, or situation, describing it in an analytical way.
- Reflecting on what the experience/situation may mean, and how valid one's perception is.
- Developing the meaning through analysis and evaluation.
- Arriving at a conclusion, or response from which emerges an action plan for the future.

Reflective writing should therefore show, in some measure, that an individual has progressed through the following stages.

- Has put together a description of an event, experience or situation.
- Has set out what they feel about the experience and arrived at an underlying meaning.
- Has reflected on what was good, bad or different about the situation, leading to analysis.
- Has come up with a conclusion or an action plan which will impact on his or her approach to future actions, decisions or tasks.

The aim is that, through the reflective practice, individuals are prompted to raise their awareness of the following.

- That the ability to reflect, in a meaningful way underpins professional practice, and is important in all aspects of life.
- That reflection should be a positive, purposeful, activity so that thinking about experiences, events or situations becomes an integral part of personal and professional development.
- That the process of reflection is based on insightful questioning and that thinking deeply about a diverse range of questions increases the effectiveness of reflective practice.
- That the activity of reflection should be a dynamic process; therefore it is beneficial to reconsider experiences and situations, and our responses to them, and to question whether our approach should be changed in the future.

Reflective practice underpins not only the development of abilities, and activities such as problem-solving but also, for example, the practice of professional ethics as Robinson *et al* (2008) state.

> "The skills of ethical reflection are central to the practice of engineering and management. Sometimes these reflections are practised via legislation, such as in the area of Health and Safety, or the process of consultation as a major project is developed. Sometimes ethics simply emerge in the context of a project because of work-based practices that are questionable, because of conflicts that arise out of basic ideas, purpose or values."

Although the above quotation refers specifically to the two areas of engineering and management, the core message being communicated applies to any field of life or work.

Summary

The ability to reflect in a meaningful way is considered to be important in all aspects of life and underpins professional development.

- The activity of reflection should be a positive action which uses thinking about events, experiences and observations to underpin individual development. The process of reflection should therefore have a purpose and reflection should lead to action.

- The process of reflection is based on insightful questioning; a wide range of insightful questions together with a very thoughtful approach increases the effectiveness of the process.

- The activity of reflection should be a dynamic process, therefore it is useful to revisit and re-evaluate experiences and events, monitor our own responses to them and consider whether and how our approach should be changed in the future.

Section 2
Ethical aspects

What do we mean by ethics?
Ethics is a complex subject and most would agree that it is difficult to arrive at one definition. Ethics can be said to be:

- The philosophical study of what is right and wrong in human behaviour;
- The study of what makes actions right or wrong;
- The standards based on what is 'moral' or 'right' behaviour;
- The standards of conduct and decision-making which promote the common good.

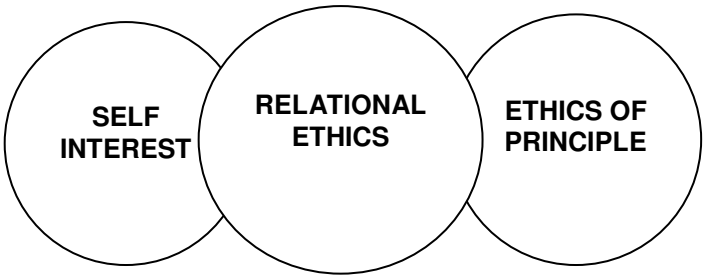
Ethical theories
Ethical theories and their application have been debated for centuries. There are many theories and each theory is based on specific moral concepts which promote additional and difficult questions.

One theory is the Utilitarian theory; here the ethical concept is based on considering the consequences of actions and decisions and the overall aim is to maximise the greatest good for the majority. The challenges of this theory are that what is good has to be defined and this is difficult. This theory also raises the question of whether the end justifies the means, as for example minority groups can be disadvantaged.

The Deontological theory on the other hand proposes that 'right actions' are dictated by duties, that achieving happiness is not the aim. The basic duties according to Kantian Ethics are keeping promises, being fair and truthful, and avoiding harm to others whilst repaying kindness. Here a duty is considered to be a moral requirement to do something. Those who challenge this theory state that if ethical practice is based on absolute principles the temptation would be to apply these uncritically, without thought for the consequences.

Business Ethics is an example of how issues, specific to a discipline, can affect the ethical approach.

> "An adapted Kohlbergian framework proves a useful summary model for considering issues in business ethics, in that the recognition of legitimate self-interest is a key motivator in business behaviour":



When considering what to do, think about the three different aspects:
Self Interest – What is the impact on me or my business?
Relational Ethics – How are others affected? (E.g. environmentalism, communitarianism)
Ethics of Principle – What is the right thing to do in principle? (E.g. human rights, maxims of duty etc)

Figure 1: The three aspects of 'Business Ethics'
Author: Roger Cook, University of West London

Why should we consider Ethics?
Many professional bodies have a code of professional conduct that spells out the standards of behaviour that are expected from their members. Where there is a clear danger to life (as in the medical profession) this is obviously a good thing, but not all bodies have such codes and in some cases where they do exist they are voluntary.

Why should ethics be important to university students?

Views on what are, or are not, appropriate standards of behaviour for university students depend upon the culture of the country and sometimes more local considerations and even whether they are attending a taught course or one with elements of research. Students need to be aware of the behaviour that is expected of them so that they can effectively partake in the educational context in which they are studying. A sense of personal ethics is also an important part of learning - the *affective* domain in Bloom's taxonomy is about learning judgement, discretion and other personal attributes that might be regarded as part of Ethics (Krathwohl *et al,* 1956). Although this can be taught formally, much of the behaviour is learned from observing how the teachers tackle difficult issues.

Marilla Svinicki (1994) suggests that those in the academic arena have ethical responsibilities towards one another and towards their discipline. In the context of the relationship between teachers and students, she further suggests that these responsibilities are as follows.

- To demonstrate the free pursuit of learning
- To demonstrate respect for students
- To respect confidentiality
- To model the best scholarly and ethical standards
- To foster honest academic conduct
- To ensure fair evaluation
- To avoid exploitation, harassment or discrimination

We would accept many of the values implied in these statements, but the ways in which we accept them may vary according to our culture, or gender or age. For example, the fostering of honest academic conduct is probably something that we could all agree to be important; but what would we regard as `honest' and what would we regard as `cheating'? In some cultures students might be encouraged to collaborate to provide answers, in other cultures this might be regarded as cheating. Another aspect of this is in romantic or sexual relationships between students and teachers - this might be acceptable in some cultures but unprofessional or illegal in others.

Where there are no professional standards laid down, the individual has to rely on his or her judgement and Svinicki sets out six questions that a professional can ask himself or herself.

- Am I acting in ways that respect freedom and treat others as autonomous? *[Autonomy]*
- Am I causing harm through either commission or omission? *[Malfeasance/nonfeasance]*
- Do my actions benefit the other person rather than myself? *[Beneficence]*
- Do I treat those for whom I am responsible equitably? *[Justice]*
- Do I uphold my part of any relationship? *[Fidelity]*
- What are the assumptions on which I base my actions and are they valid? *[Act consciously]*

It would be beneficial to add two further questions:

- Are there any rules, regulations or codes of practice governing this situation? *[Legitimacy]*
- Are there any cultural differences in the expectations of the student, the institution or me that might affect the outcome or how it is perceived? *[Culture]*

The answers to these questions will depend on the culture - professional or organisational as well as national - in which you are working and will be conditioned by the values that you have absorbed from your teachers. They will not guarantee to give you the right answer but they should help to keep you out of trouble.

Ethical issues in academic study and research

Taking the above eight precepts into the context of postgraduate education, a number of issues might need to be considered in respect of scholarly study and research and these are listed below. You may be able to think of others (in addition to those listed) but these are important issues to address when setting out on any research study. You may need to seek approval from an ethics committee before conducting surveys, interviews or experimental work and it is important to think through these issues before you do so. You may also wish to consider just how appropriate your proposed approach is, in the light of ethical considerations.

- Academic honesty
- Data privacy
- Handling human and animal subjects
- Impartiality
- Professional accountability
- Conflicts of interest
- Confidentiality
- Intellectual property

Section 3
Culture

Introduction

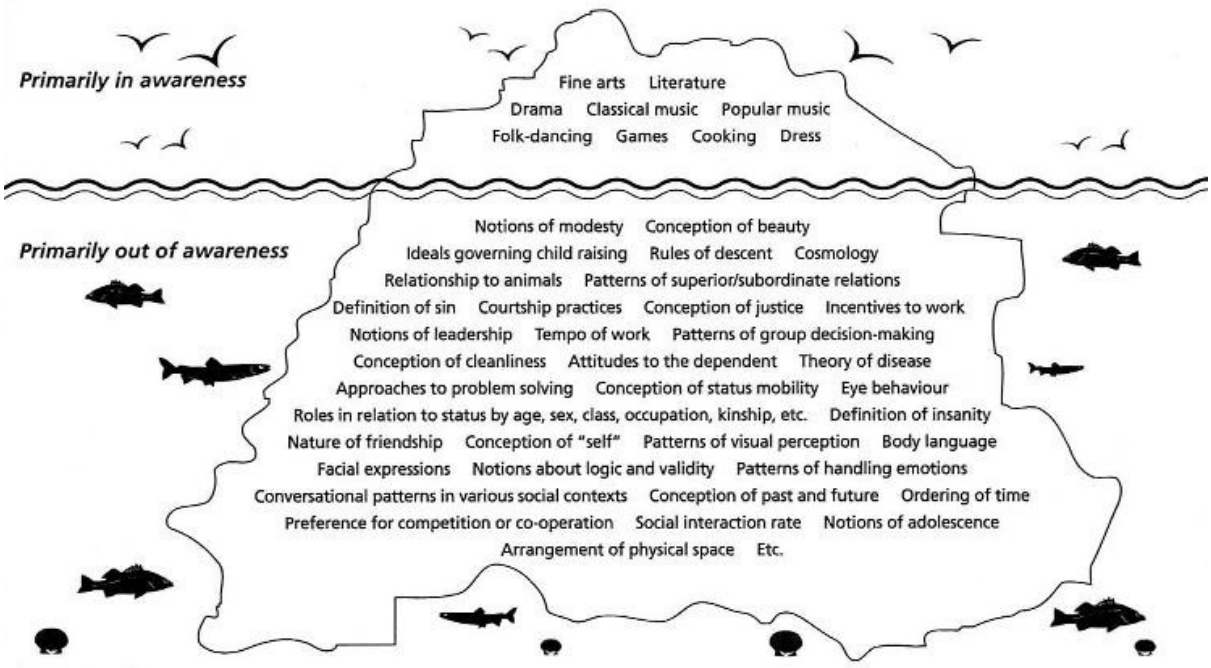
When we think of 'culture' we tend to think of national cultures but the concept is broader than that. Cultural differences may be encountered across professional or subject boundaries or even between institutions or departments within an institution. Although the boundaries concerned are cultural boundaries, it is important to distinguish between what Bob Garratt (1986) refers to as macro-culture and micro-culture. In this context, it is possible to look at how national/ethnic culture impacts on us as macro-culture and the effects of the individual profession or subject culture as micro-culture. In the context of higher education, examples can be as shown in the table below. In inter-professional cultures you can probably see parallels and even other ways in which the 'culture' of a discipline or profession can act as a barrier to collaboration and co-operative working.

	Macro-culture	Micro-culture
In HE situation:	Trans-cultural learning	Inter-disciplinary learning
Exemplified by:	Students *and* teachers from different national cultures; Different learning styles; Different expectations: eg priorities, communication patterns, roles.	Effects of sub-disciplines and extra-disciplinary reference groups; Differences in professional language Different understandings: eg truth, evidence, theoretical constructs.

Table 2: Examples of macro-culture and micro-culture in Higher Education

What do we mean by culture?

We have already looked at the different concepts of micro-culture and macro-culture, but even in the realms of national culture our very use of the word is often limited. The 'Iceberg' figure below demonstrates some of the concepts of culture that often lie hidden in our imaginings. In awareness are literature, manners, customs, language, history and folklore, but as with an iceberg, there is much more that we are less aware of.



Source: p.14 AFS Orientation Handbook Vol.4, New York: AFS Intercultural Programs Inc., 1984

Figure 2: The 'Culture Iceberg'

Edward Hall has put forward the view that, in addition to learning other's languages, we must also grasp the need for cultural literacy. Broadly speaking, this is the ability to be sensitive to, and understanding of the ways of being that are determined by different cultures. For example, Triandis (1975) relates how an American visitor asked his Greek acquaintance what time they should come to his house for dinner. The Greek villager replied 'anytime'. In American usage, apparently, the expression 'anytime' is a non-invitation that people give to appear polite but which they hope will not lead to anything. The Greek, however, actually meant that the Americans would be welcome any time, because in his culture, putting limits on when a guest can come is deemed insulting (from Furnham, A and Bochner, S, 1986).

Edward Hall's books are full of anecdotal accounts from all over the world of such breakdowns in communication. These can be useful but we need to avoid stereotyping other cultures, whether national, regional or professional.

> 'Honest and sincere people in the field continue to fail to grasp the true significance of the fact that culture controls behaviour in deep and pointing ways, many of which are outside of awareness and therefore beyond conscious control of the individual'
> (Edward T Hall)

Hall proposes five major categories of difference between cultures.

1. Space (Proxemics)

Hall sub-divides this into five sections

a. Interpersonal space

Cultures have different conventions about the space between individuals in social situations. For example, people from some cultures stand and converse at much closer distances than Europeans. Feelings of discomfort can soon be generated in such circumstances by the person who feels their space is being 'intruded'.

b. Olfactory space

Cultures have different ways of using the sense of smell. In Middle Eastern countries it can be a way of sensing the other person, whereas in other countries, perfumes are used to screen out natural smells.

c. Thermal space

The experience of space can be sensed through thermal sensations eg 'feeling hot under the collar' or blushing.

d. Visual space

We use space visually to gather and convey information.

e. Sociofugal and Sociopetal space.

These terms relate to the different ways in which cultures use furniture arrangements, for example, that either enhance or inhibit interactions between people.

2. Time

a. Monochromic time

This refers, in general terms, to the western dominated view of the twenty-four hour day in which only that time system for measurement exists.

'The train leaves at . . .'
'Come to dinner at . . .'

We are also informed of the subdivisions of monochromic time that have enormous implications for the relationships between people of different cultures.

i. Appointment times

If we say 7pm, do we turn up ten minutes before or precisely on time or an hour later? Different cultures have different expectations and practices. 7pm does not necessarily mean 7pm.

ii. Discussion time
In 'business' meetings who is involved, who takes the decisions, how can decisions be taken and when?

iii. Acquaintance time
The time considered polite in which to establish an acquaintanceship before moving on to business matters.

iv. Visiting time
How long meeting or social gatherings last is also determined culturally

v. Schedules
The creation of time schedules, also, is an area full of difficulty if the persons involved have different cultural origins.

b. Polychromic time
This is a much less well known view of time but is practised by certain cultures. Hall cites the example of the Hopi Indians in the United States who have a belief in each thing, each person, having their own time.

3. Verbal Behaviour
This is a much more obvious division between cultures, especially where languages differ. However, even in the case of both participants using the same language, the use of similar words may have different meanings, there will be different conventions for expressing opinions, etc, and the capacity to which empathy may be extended to culturally different others may, be quite limited. Between professional cultures such linguistic variations may also occur – think of the difference of the concept of 'proof' to a lawyer and a scientist.

Also, not only what is said but how things are said (*paralinguistics*) can have significantly different meanings for different cultures. Ums, ahs, sighs, grunts, accent, intonation, stress, pitch, are all culturally determined. Verbal behaviour also includes how information is structured, who manages the conversation and who says what, when.

4. Non-Verbal Behaviour
Cultural differences in non-verbal behaviour can be categorised as follows:

a. Kinesics
Movements of the body (head, arms, legs, etc). Gestures in one country will be quite inappropriate in another country.

b. Oculesics
This is the use or avoidance of eye-to-eye contact. The British use eye contact as a sign of listening behaviour. Research in the United States demonstrated that many American black people listened with their ears and looked elsewhere which proved disconcerting for white speakers who considered they had not been heard! In many countries there are elaborate patterns of eye avoidance which are often linked to considerations of deferential respect, many of which we would have very little insight into.

c. Haptics (touch)
Where, how and how often people can touch each other while conversing are culturally determined patterns of behaviour.

The differences of role, class and status are also arenas for considerable confusion between cultures as the various signals and cues to infer these positions are often quite invisible to 'outsiders'.

5. Context
Hall draws broad definitions between what he terms *high context* and *low context* cultures.
In low context cultures words are presumed to carry all meaning. In some cultures, words and meaning do not have such a direct connection. Notions of truth, consequently, are relative and culturally based. In low context cultures, there is also a tendency towards fragmentation of experience evidenced by the development of all sorts of experts and a proliferation of legalistic documents and contracts. By contrast, high context cultures tend towards conservative rigid class structures where individual needs are sacrificed to group goals. However, these are cultures in which 'a person's word is their bond'.

Few of these will have parallels in cultural differences across professions or disciplines, but the general concepts that there are differences in the ways in which certain groups work and that we can attune ourselves to those differences are important ones.

Communication across inter-cultural barriers

"Bennett (1993) developed a model examining the progression made from ethnocentricism (all cultures are like mine) to ethnorelativism (cultures are relative to each other), in which he proposed the following six steps:

1. Denial: Does not recognise cultural differences; inability to construe difference
2. Defence: Recognises some differences, but sees them as negative
3. Minimisation: Unaware of projection of own cultural values; sees own values as superior, focuses on superficial differences usually insisting people are basically the same;
4. Acceptance: shifts perspectives to understand that the same "ordinary" behaviour can have different meanings in different cultures - beginning of ability to interpret cultural phenomena, contextually
5. Adaptation: Can evaluate other's behaviour from own frame of reference and can adapt behaviour to fit the norms of a different culture. This marks the beginning of ability to communicate interculturally, and there is an effective use of empathy to understand difference;
6. Integration: Can shift frame of reference and deal with resulting identity issues so that bicultural or multicultural values develop."

Bennett, M. (1993) "Toward ethnorelativism: a developmental model of intercultural sensitivity," in R.M. Paige (Ed.) Education for the Intercultural Experience Yarmouth, ME: Intercultural press, p7.

Section 4
Communication

Introduction
Communication involves two people, or more; one is the sender and the other (or others), the receiver. We use different methods of communication. We can communicate verbally, visually and by writing. Communication is not a simple process, but one influenced by many factors.

Generally we combine two or more methods of communication; for example we use non-verbal cues when speaking. These cues can change a non-threatening message into a threatening message, because of the many factors which affect how something is interpreted. The sender therefore may communicate some things consciously and some unconsciously. An example of this is the written word, which is often open to a range of different interpretations; therefore using a different method of communication, for example including diagrams, can clarify and expand on the points being made.

We generally assume that when we communicate something to another individual they will understand the message we want to convey. This, however, is often not the case and there are numerous examples of misunderstandings. Misunderstandings can occur for many reasons; the core problem is often that the listener interprets and therefore understands the message differently to the way intended by the sender. It is important therefore to be aware of our own and others' communication styles and the inherent bias in the way we all communicate or interpret messages (written or verbal or visual) from others.

Barriers and gateways to understanding
The way the sender communicates is affected by such factors as their perceptions, priorities, past experiences, gender, culture, age and the context. The way the listener understands the message is also affected by all the above factors.

The receiver interprets the signals they have been sent, these produce feelings, and the receiver responds by making judgements about the sender's intentions. The same sender can evoke different effects, and therefore different responses, in different receivers.

Communication is a complex activity. It is important to be aware of the challenges we face when trying to communicate our messages so that the appropriate skills can be developed and improved. Below are three lists; these set out some of the barriers when sending messages, some barriers to receiving messages and some gateways to communication.

Barriers when sending
- Lack of a common language
- Lack of clarity
- Lack of continuity and or logical progression in the message
- Not knowing the receiver
- Having negative attitudes and feelings
- Being distracted by noise
- *Can you think of anything else from your own or others' experiences?*

Barriers when receiving
- Lack of a common language
- Hearing or reading what you expect to hear or read
- Evaluating and/or pre judging the source
- Having different perceptions
- Having different intentions
- Ignoring non-verbal communication
- Being distracted by noise
- *Can you think of anything else from your own or others' experiences?*

Gateways to communication

- Using a common language
- Being clear
- Using a logical framework
- Having positive attitudes and feelings
- Minimising noise and other distractions
- Allowing an opportunity for feedback and questions
- Allowing communication to flow in two directions
- Reducing any physical barriers
- Avoiding or limiting interruptions

Improving communication

Fisher and Ury (1991) as cited in Burgess (2003) consider that there are four rules that can improve communication, especially in conflict situations. These are set out below.

- **Active Listening**
  The aim here is to understand what the sender is saying and for the receiver (listener) to understand how they are responding. This requires the listener to pay close attention to what is being said, ask for clarification when necessary, and actively indicate that they are listening.
- **Direct communication between the sender and receiver**
  This is found to promote understanding as it removes layers of 'interpretation' and enables the sender to focus on clearly conveying their message.
- **Focus on the 'I-message'**
  It is important that the sender focuses on explaining their feelings and their perceptions so that the information is presented in a way that does not immediately provoke a hostile response. 'You-messages' suggest blame whereas 'I-messages' simply state the problem and therefore if 'I-messages' are used it should be easier to resolve issues in a collaborative manner.
- **Focus on 'speaking for a purpose'**
  This basically means that the sender should think before they speak, and therefore they should carefully consider what they want to communicate, why, and how to do so in the clearest way possible.

There has been much debate and research about how to improve communication and how to strike a balance between communicating one's own message whilst at the same time respecting others' points of view.

It should be noted that what is important to the sender in terms of the type of information they are sending, and which they wish to be heard, may not be as important to the person that they are communicating with. How you communicate to others can be a source of mutual understanding and positive action - or a source of frustration and misunderstanding. Effective communication takes place when the person or persons communicating send messages that are:

- Clear and direct (not confused with unnecessary detail);
- Specific (provide enough detail so the other person knows what you are talking about);
- Non-punishing (anger and sarcasm will often cause the other party to stop listening).

Effective communication requires a clear message to be sent and the receiver to understand the sender's intentions. Each should listen and give feedback so the other person can be assured their message is being received as intended. **There is a shared responsibility for effective communication**. Responsibility lies with the receiver as well as with the sender. There are many techniques for effective communication, some of which are listed below.

- Use feedback to show comprehension (see 'Body Language' below)
- Use multiple methods of communication
- Be sensitive to the receiver and to a lesser degree the sender
- Be aware of symbolic and cultural meanings
- Use simple language
- Use repetition

Body language (non-verbal cues) is important in creating the appropriate atmosphere for effective oral communication. The following is a list of a range of non-verbal cues that can enhance communication.

- Be relaxed yet alert
- Be actively involved
- Minimise distracting gestures
- Maintain effective, and appropriate, eye contact
- Acknowledge the communication non-verbally
- Face the other person squarely but not in a threatening manner
- Maintain an open position
- Lean slightly towards the other person
- Use appropriate gestures
- Nod or smile

Comprehension

Immediately following a speech the average listener has comprehended approximately 50% of what they heard, however within 48 hours that comprehension level has dropped to 25% or less. If a listener can be actively involved in receiving the message, comprehension improves.

Occasional questions asked during a conversation tell the other person you are interested in what they are saying but you should note the following.

- Ask one question at a time
- Allow time for the person to answer fully
- Ask open-ended questions
- Restate in your own words what you have heard
- State your perceptions
- Use summarising to bring to a close parts of the conversation
- Avoid expressing approval or disapproval of the other person's feelings, as feelings are facts to the other person
- Ask yourself how you would be feeling in the other person's shoes.

Section 5
Teamwork

Introduction

What is Teamwork?
The terms 'team' and 'group' are often used interchangeably. Most however agree that a team has specific characteristics based on having a common goal and a shared responsibility. The quotation below succinctly defines what a team is.

> 'A team is a group of people with complementary skills who are committed to a common purpose and hold themselves mutually accountable for its achievement'.
> (Katzenbach and Smith, 1993)

Why develop team-working abilities?
Most organisations base their activities on teamwork and employers value team-working skills very highly.

> 'Successful teamwork requires that each member of the team understands what the others are doing and respects them, and that they are united in a common purpose, to produce good architecture.'
> (Arup 1985)

Team-working has many benefits:
- There is a better outcome if several individuals unite to combine their expertise and knowledge;
- Large, complex problems can often be more easily defined and solved;
- Professional judgement is developed through learning from others.

Teams can promote:
- Understanding of the problem or task;
- The clarification of aims and objectives;
- Lateral thinking, creativity and the motivation to succeed.

Ground rules to promote successful teamwork
To best ensure successful team working a few ground rules are helpful. It is crucial for a team to discuss and agree ground rules at the outset. These ground rules generally fall into three main categories.

- **Team culture**
  Fostering and promoting an effective and beneficial working environment
- **Team members' roles and responsibilities**
  How individuals' behave within a team
- **Team organisation and management**
  Generic activities which underpin the work of any successful team.

Below are set out examples of ground rules within each category.

Team culture
There is a need to:
- establish a team culture to promote co-operation and democratic decision-making and to avoid conflict, which would hinder successful team working;
- establish a code of conduct to promote democratic behaviour, which is supportive of the individual, to balance the needs of the individual with the needs of the group;
- promote the best use of an individual's skill and expertise, to ensure that their potential is developed.

- recognise when motivation and support is needed and to provide it;
- promote an atmosphere in which each group member is allowed to speak without being interrupted;
- ensure that discussions do not include criticism of an individual, as this is detrimental to both individual and group moral; any comments should be constructive;
- ensure that team members should be able to admit when they are not happy - they should not suffer perceived problems in silence;
- and ensure that all individuals' opinions should be equally respected.

A team member's responsibilities (being a good team player)
A team member should:
- be respectful of other team members and listen to their views;
- be patient and tolerant of others, not resorting to intimidating behaviour;
- be prepared to keep an open mind and adapt to change;
- be prepared to share ideas and show initiative;
- be prepared to be an active responsible member of the team and provide input frequently;
- ensure that as an individual they understand the team's goals objectives and tasks;
- be willing to take on responsibility and thereby support the team;
- be organised so as to meet deadlines;
- plan for meetings by preparing their input in advance;
- not undertake tasks without prior consultation with the team;
- not have a hidden agenda or abandon the team;
- and be prepared to develop their communication skills as these can assist the exchange of ideas, promote team discussion and avoid misunderstandings.

Team organisation
A chairperson or co-ordinator, and a secretary or record keeper should be selected. In addition time should be provided for team members to get to know each other.

Robust procedures need to be put in place to:
- promote regular communication and feedback;
- recognise and resolve conflicts;
- and to support team members.

Task-related activities need to promote democratic decision-making by ensuring:
- that goals, aims and objectives are discussed, leading to an action plan;
- that priorities are clearly identified, understood and agreed;
- that there is agreement concerning the definition and delegation of tasks;
- and that positions of responsibility reflect expertise.

Ten Steps: a framework for successful teamwork
The 'Ten Steps' framework sets out the sequence of activities that can be followed to promote team success.

Step 1: The team members
Building trust and respect between team members is important for successful teamwork. The first stage is to get to know other team members.

(a) Talk to each other!
(b) Spend some time finding out what you have in common.
(c) Provide each member with a list of everyone's email and phone numbers.

Step 2: Team organisation and management
If we are to benefit from working in a team it is important to ensure that there is enough time for the evaluation and discussion of any activity or decisions, that this is based on an investigation of the task or problem, and this requires organisation.

(a) Hold regular meetings.
(b) Agree ground rules, and review these from time to time.
(c) Agree roles and whether they are to be rotated
e.g. Chairperson - to provide leadership,
and a secretary – to take notes and prepare minutes of meetings etc.

Step 3: Ensure aims and objectives are understood, and agreed

To be successful, the outcome of the process needs to match the criteria set during the investigation of the problem or task. The following questions **should** therefore be discussed, and clearly set out, so both the team members and those who evaluate the outcome can follow the reasoning.

(a) What is the problem to be solved, or task to be undertaken?
(b) What criteria are to be used to measure the outcome?
(c) What is the process by which requirements and criteria are to be fulfilled?
(d) How should the outcome be presented to match assessment requirements?

Step 4: Plan the process

How appropriate the process is, and how well it is planned, will directly affect the success of the outcome. Planning the process is fundamental as this ensures all the necessary activities are undertaken within a set time frame.

(a) Set out a timetable, review it at every meeting and adjust it as necessary.
(b) Allocate, monitor and review the work done and the work to be done.
(c) Plan the frequency of meetings to relate to task/project complexity and timeframe.
(d) Plan purposeful team meetings.

<u>Example of meeting agenda</u>

1. Attendance - those present and apologies from any team members not present.
2. Review the minutes of the previous meeting - are they a true record of what was said and actions agreed?
3. Discuss 'Matters arising from last meeting' - what progress has been made on actions agreed?
4. Discuss main 'Agenda' items and agree actions – these are the core items for discussion at that specific meeting.
5. Discuss 'Any Other Business' - issues not listed but which need to be discussed.
6. Set next meeting - date, time, place and purpose of next meeting.

Step 5: Process review

If the outcome of the team's work is to be successful a review process must be put in place to ensure that the outcome will match the original question posed, or problem or task set.

(a) Is the process appropriate and are the criteria set being met?
(b) Has anything important been overlooked?
(c) Are deadlines being met?
(d) Have unexpected problems arisen and how can these be overcome?

Step 6: Relationship between individuals and the team

Each individual within a team has a responsibility both to contribute to the project and collaborate with other team members to address the task in hand. It is important therefore that each team member evaluates his or her contribution. It is also important that the team recognises each contribution and provides help and support as necessary. Each team member should periodically ask themselves (reflect on) the following:

- Am I doing my fair share of work?
- Am I meeting the deadlines set?
- Am I contributing fully to team meetings?
- Do I need help?

Step 7: Problems within teams

It is very important that all problems are openly discussed in a non-judgemental manner and solved by the team if possible, or outside help sought. Problems should be dealt with immediately as they arise or there will be a detrimental effect on the team's performance.

Problems can be divided into five categories; which relate to those associated with the task and those associated with the team members or management. These are listed below.

CLARITY of procedures (practical project management)
"So we all thought that someone else was submitting the report?!"
"We need a deadline to make sure all the material is compiled in time for editing."

CULTURE of the team (what is accepted as normal behaviour)
"Most of us thought it wasn't right, but none of us liked to say so in case it upset the team."
"I'm sick of always being told what to do by one or two pushy people, rather than the group coming to a consensus on decisions."

CONDUCT of individuals in the team (dealing with unacceptable behaviour)
"Of course I shouted at him - he's a complete idiot, he deserves to be shouted at!"

COMMITMENT of individuals in the team
"I couldn't make the meeting as I had a cricket match"
"Sorry I was late again. I haven't done any research as I had a big assignment on this week."
(NB. Analogous to sustainability: balancing of private benefit with public or common good.)

COMPETENCIES of individuals in the team (differing levels of skills and experience)
"I tried my best, but this is the first time I've ever done academic referencing."
"I have told you, I can't understand what is being discussed when you all speak so fast."

Examples of recurring problems are given below.

Problems associated with the task

- The aims and objectives have not been clearly identified.
- There is a lack of time to complete the task due to poor planning.
- There is a lack of resources due to poor planning.
- Progress is not being reviewed to ensure the outcome will fulfil requirements.

Problems within the team

- Meetings are difficult to organise due to time constraints.
- Agreed ground rules are not being followed.
- Team members are not contributing and there is no procedure to deal with this.
- There is a lack of team organisation and leadership, therefore a lack of team spirit.

Step 8: Completion of project or task on time

It is important that a final check is undertaken to ensure that the project or task is complete. This requires that criteria are set during the initial planning phase against which the outcome can be measured.

(a) Has the original question been fully answered – what is the evidence for this?
(b) Is the presentation format as required?
(b) Has the deadline been met?

Step 9: Reflection on experience

Each experience adds to your implicit knowledge. This type of knowledge includes abilities such as judgement and evaluation. It is therefore important to reflect on your experiences to fully understand what you have gained from them.

(a) Have I learnt more by working in a team, if not, why not?
(b) Has this been an enjoyable or frustrating experience, and why?
(c) Which skills have I improved e.g. listening, leadership or negotiation?
(d) What factors contributed to the success or failure of the project?
(e) What more could I or others have done?

Step 10: Lessons to carry forward
It is important to carry forward any lessons learnt as this increases chances of success in the future.

(a) Ask all team members to reflect on and note down what could be improved.
(b) As a team consider how any potential improvements could be implemented.

Some things to avoid when working in teams!

Social loafing
Some individuals do not always work as hard in teams as they do when on their own. They show no commitment to the joint effort, but assume others will. A solution to this is to promote team culture and participation, focusing on team roles and responsibilities.

Team inefficiency
The quality of the outcome (or solution) of any problem-solving process depends on the quality of the process. The outcome evolves as progress is made through the various stages (problem-solving etc), and as decisions are made at crucial points.

To promote success there is a need to ensure that the decisions made are of high quality, and therefore founded on evidence. Also decisions should be collective, namely accepted by all. A lack of experience leads to a focus on the task alone, ignoring the process; the result of this approach is often a lack of success.

'Groupthink'
There is a tendency to push team members to think alike and to ignore alternative points of view. This is the basis for mistakes, some very significant e.g. the destruction on take-off of the Space-shuttle Challenger.

Risk-shift phenomenon
Unclear roles lead to a diffusion of responsibility and lack of accountability. Both individual and team accountability are essential to lessen risky decision-making.

Roles in Teams: an introduction to Belbin

Meredith Belbin (1981) undertook research into team performance and devised a list of role types. His work now forms an important part of our knowledge of teams, team roles and how to promote success. Belbin's research, and that done by others, shows that:

- Each individual team member wants to benefit from being part of a team;
- The team as a whole needs to benefit from the teamwork;
- An individual's objectives and the team objectives may differ;
- Time imposes constraints on developing the appropriate team culture.

The focus of some of Belbin's research was into how the range and combination of role types within a team affected a team's performance.

Belbin (1981) found the following.

- People in teams have a predisposition for some roles and therefore undertake specific roles
- Some individuals are able to play a number of roles, and switch between roles
- In some cases individuals are focused on only one role type
- No role type is better than any other
- Successful teams have the appropriate mixture of role types
- Unsuccessful teams are missing a specific role type or types
- Some individuals can adopt missing role types
- Observation and reflection is required to identify whether roles are missing

Belbin Team Roles		
Role type	**Positive Qualities**	**Allowable weaknesses**
Implementer (executes and realizes actions))	Organising ability, practical common sense, hardworking, self-discipline.	Lack of flexibility, unresponsiveness to unproven ideas.
Co-ordinator (manages and plans)	Capacity for welcoming all potential contributors on merits. Strong sense of objectives.	Can often be seen as manipulative. Offloads personal work.
Shaper (manipulates, influences and develops)	Drive and readiness to challenge inertia, ineffectiveness, complacency.	Prone to provocation, irritation and impatience.
Plant (the ideas person)	Creative, imaginative. Solves difficult problems.	Up in the clouds, inclined to disregard practical details or protocol.
Resource Investigator	Capacity for contacting people and exploring anything new. Ability to respond to challenge.	Liable to lose interest once the initial fascination has passed.
Monitor Evaluator	Sees all options. Judges accurately. Discrete.	Lacks inspiration or ability to motivate others.
Team-worker	Ability to respond to people and situations and to promote team spirit.	Indecisive at moments of crisis.
Completer Finisher	Capacity to follow through. Painstaking, conscientious. Delivers on time.	Tendency to worry about small things. Reluctance to 'let go'.
Specialist	Single-minded, dedicated. Provides knowledge and skills in rare supply.	Contributes only on a narrow front. Dwells on technicalities.

Table 3: Belbin Role Types and their positive qualities and also weaknesses (Adapted from Belbin, 1981)

Action Learning and Action Learning Sets

Research, and the experience of practitioners, has shown that the benefits of working in teams can be harnessed to develop an individual's learning.

Reg Revans (1907 – 2003), the first Professor of Industrial Management at the University of Manchester, is credited with developing and using Action Learning, a method of collaborative learning applied to real-world problems, now widely used for professional development.

Action Learning is based on small groups of individuals (Action Learning Sets) meeting regularly to work together on specific issues. The process is based on the concept that all members of an Action Learning Set are considered as equals who freely share their knowledge and experience, learn from their own and others' experiences and have common goals relating to individual and group development and the addressing of common issues.

Section 6

Visualisation: the use of a 'visual language'

Introduction

We are used to seeing symbols, diagrams and pictures in everyday life which communicate ideas very quickly and effectively and these can be thought of as a language. In the UK we even use terms such as 'traffic lights' to describe a method for labelling foods; so we transfer our understanding of a commonly used symbol to another topic to enhance our communication.

What is a 'visual language'?

A 'visual language' is the tool used by problem-solvers and designers to communicate, clarify information, investigate issues, evaluate solution options and set out instructions for others (for example for manufacture). This language can be specific to a discipline or it can be in a more personal form. It is a method by which annotated diagrams, symbols and pictures are used to communicate, for example, concepts, designs, processes and instructions. Designers often refer to this language as a 'design language'.

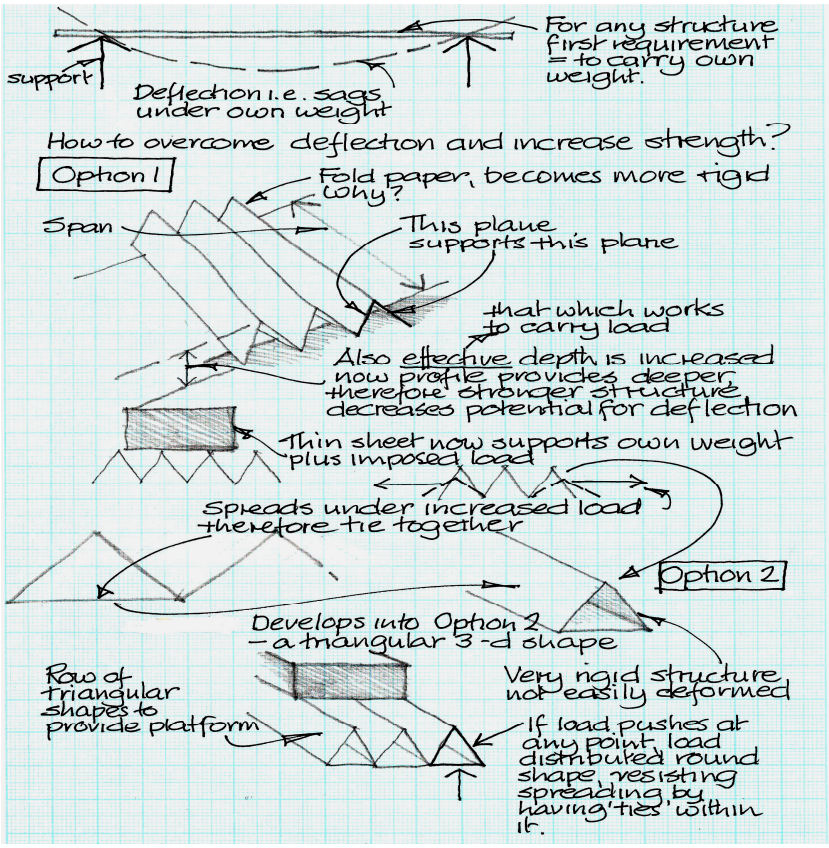


Figure 3: An example of an annotated diagram

All problem-solvers and designers, in their everyday communication, use a language which combines annotated diagrams, sketching, flowcharts, symbols and other graphic or pictorial representations to help them think, to underpin the development of ideas and to communicate with others. You certainly, however, do not need to be able to draw well to develop or use a visual language.

It is very important for a problem-solver to develop a visual language and to learn how to use the specific form appropriate to their discipline, if one exists. The reason for this is that text alone is limited in the types of message or information that it can convey and in the level of preciseness that can be achieved. A visual language provides problem-solvers with the ability to communicate complex information to themselves and others.

Each individual's approach to using annotated diagrams will be slightly different and therefore a characteristic style may emerge. However it is very important that the notes, symbols, scales and or annotations used are universal and easily understood by all, or agreed by a specific group. A visual language needs to be precise and be able to deal with complex details and therefore should combine diagrams, symbols, sketches, flow charts and pictures with, when appropriate, copious annotations and information concerning scale.

The use of a visual language is an integral part the problem-solving process. It is therefore both a method of communicating and a tool which supports the development, visualization and realization of ideas. Below are listed some of the ways in which we use a visual language. Think about the following; can you play noughts and crosses using just words, without drawing a grid and drawing the noughts and crosses?

The stage at which the problem-solver is in the problem-solving process, will determine the type, level and preciseness of the visual language. For example at the product manufacturing stage a blueprint is needed whilst at the initial design stages hand drawn sketches are appropriate.

Examples of the uses of a visual or design language are listed below.

- **Used as a tool for problem-solving or designing**
  For a problem-solver or designer it is natural to set out and clarify thoughts using annotated diagrams as this activity answers questions such as 'how do these aspects of the problem relate to or depend on each other?' Also different viewpoints can be illustrated.

- **Used as a tool for visualisation, communication and prediction**
  Problem-solvers and designers work for clients and users, so they need to provide an image or model of the concept or chosen solution or system, which will form the basis of predicting how the product or service will work and look. An alternative would be to make a prototype, however, in many cases a prototype cannot be made until a very late stage in the process and in some cases a prototype cannot be made at all.

- **Used to present information to aid acceptance of ideas and decision-making.**
  Other problem-solvers, designers, clients, manufacturers and users need to be convinced that the proposed solution option meets their needs, or other's needs and can be realized.

- **Used to support the integration of an individual's expertise, when complex problems are worked on by teams.**
  When working in a team the communication is often based on annotated sketches and diagrams, as different viewpoints and aspects of an idea can be quickly communicated and complex interrelationships clarified.

- **Used as a method of communication between a client and others; for example in product development, between a client and the design, management and manufacturing teams**
  Those involved in a project need to be able to predict what something will look like or explain how something will be work; all this requires communication using illustrations, annotated diagrams and 3-dimensional representations.

- **Used as instructions to a manufacturer or others to describe what has to be done**
  The word 'blueprint' is sometimes used instead of the word 'design'. In different disciplines different terms are used to describe these instructions, for example in engineering these could be 'engineering drawings'.

- **Used as part of mandatory approvals legislation and contractual documentation**
  Most products are subject to legislation (e.g. Health and Safety) and need to be clearly described when they are the subject of a contract between parties (e.g. Patent information). Annotated, precise drawings to scale are therefore used as the instruction to manufacture and as part of legislative or contractual documentation.

- **Used as a tool for recording information e.g. 'as made' information**
  Information recording what has been done is required for many purposes, for example for maintenance of a product or system.

- **Used as evidence in disputes or as a record of an event**
  Drawn records provide evidence of how and when something happened and what the sequence of events were; this information is often used as the basis for a report or when disputes arise.

Mind maps and Flowcharts

Mind mapping is a very powerful tool combing methods of communication. A mind map is a very effective way of setting out issues and factors, and their relationships in respect of a particular topic or problem. Mind mapping reflects the way that we develop our thinking about a specific issue and enables us to organise information. Mind maps can be used to take notes, to develop ideas, and determine interrelationships between issues. Mind mapping can be used by an individual or by a team.

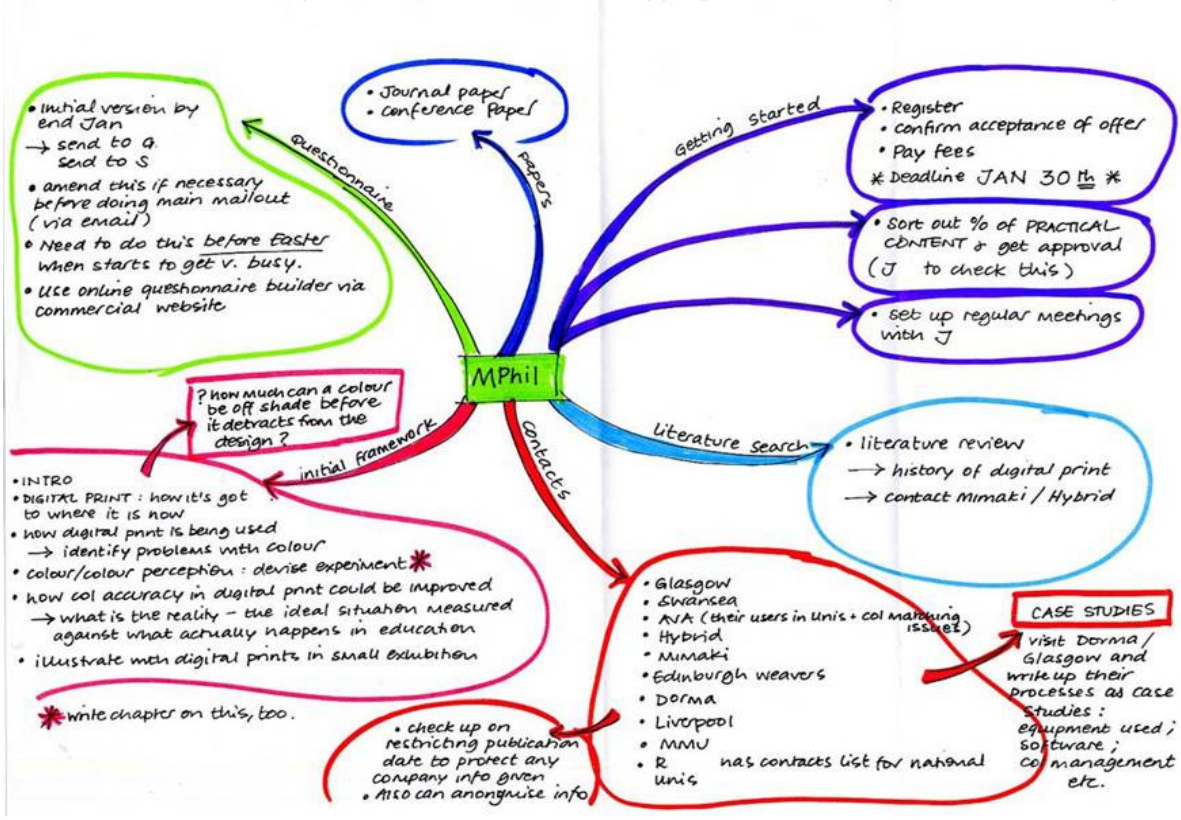


Figure 4: An example of a mind map (in this case to initiate a postgraduate research project)

The characteristics of a mind map are that:

- The starting point, namely the main idea, question, or issue which is the focus of the activity is positioned at the centre of the diagram.
- Main themes, issues or questions radiate from the focus, and are linked to it by 'branches'.
- The branches are identified by a key word or phrase, and lead to groups of related issues or questions (sometimes referred to as twigs).

Mind maps can provide a visual representation of a problem or issue and also crucially can be used to organise issues or questions into a plan of action or a flow chart. Mind maps and flow charts are universally used to communicate, understand and discuss the process of solving specific problems.

Flow charts

A flow chart is an easy to understand diagram which can be used to do the following.

- Define a process, and/or analyse it and communicate how the process works;
- Build or present a step-by-step picture of a process for discussion;
- Promote the understanding or improvement of a process.

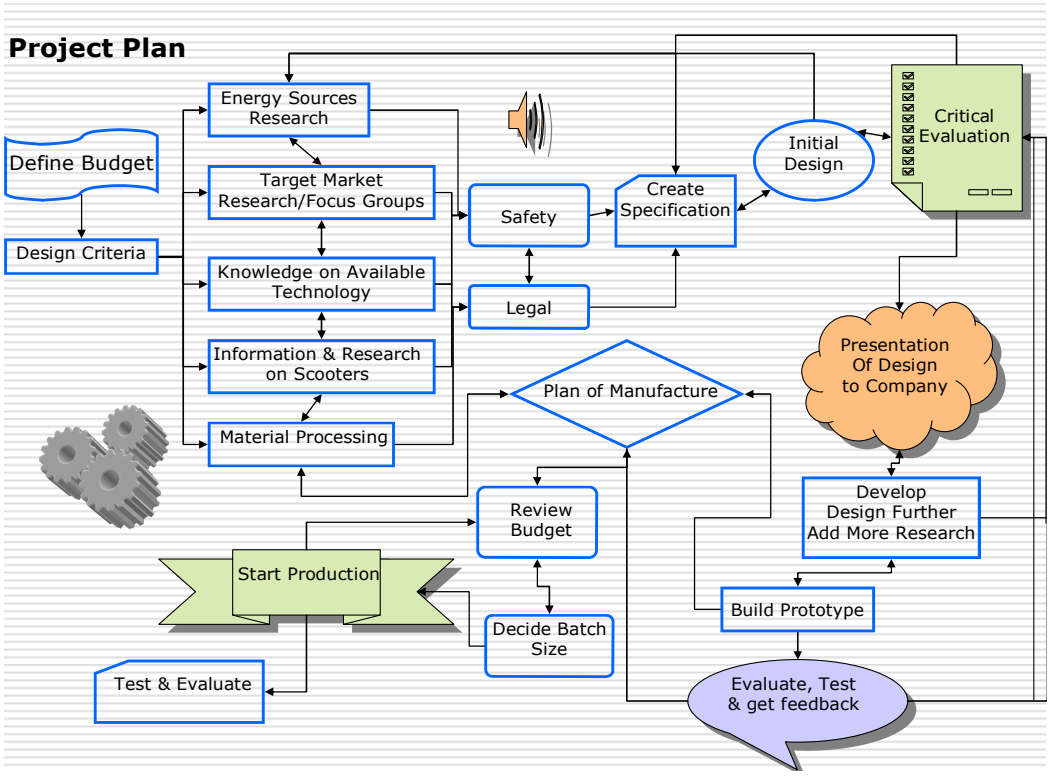


Figure 5: Example of a flowchart (Source: Student coursework 2008-09)

A flowchart, as has been said, is a tool for analysing processes, and in some cases for monitoring or evaluating progress. It enables you to break down the process into individual activities or steps and present these in a shorthand form so that the relationship between the steps can be understood. Standard symbols can be used to represent types of activity or decision points.

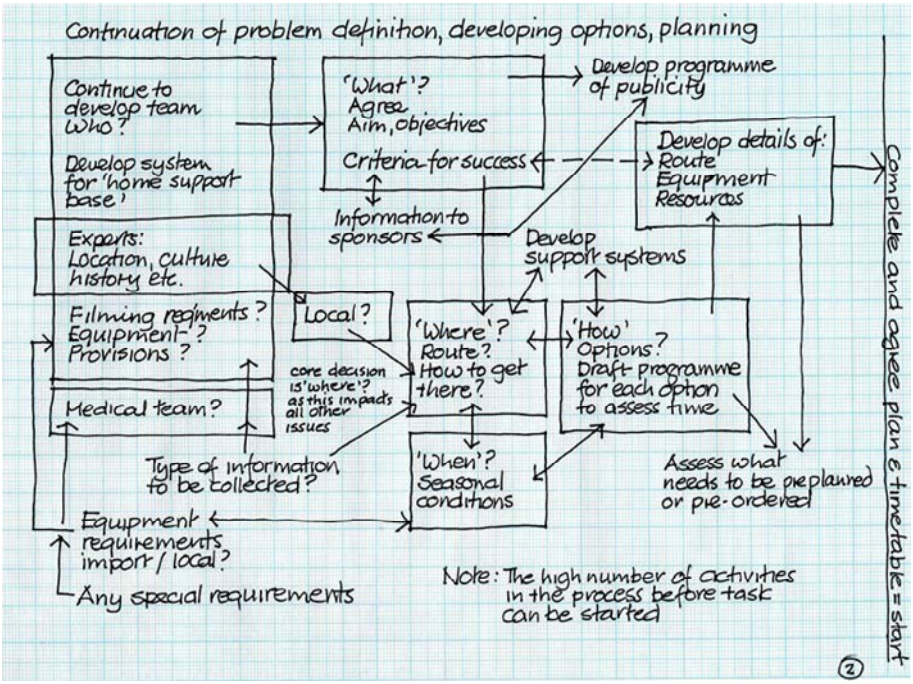


Figure 6:
Combining a flow chart (to show sequence) with a mind map (to show relationships)

It is often the case that there are one or more interim steps between a classic mind map and a flow chart (a sequence of activities set out along a time line) when a problem- solver is using elements from both techniques to identify relationships and priorities. This hybrid technique is very useful in clarifying and communicating complex questions, issues and activities, prior to devising a project plan.

A project plan is an illustration of activities and decision points, usually shown as a flow chart, which provides a schedule of the activities to be undertaken and the relative timing of these activities to achieve a set goal. The contents of the project plan will depend on the context, but will typically include major decision points, management stages, milestones, activities and resources. A project plan is generally used not only to plan activities to achieve a goal, but also as a baseline to monitor or evaluate progress.

Section 7
The creative problem-solving process

Introduction
Any activity, whether it be a work related, research related or life related task, is based on a process. The activity can be considered as a process-based response to a problem. Problems are often complex and their resolution generally has an effect on and impact upon many individuals and organisations. The quality of the process by which we arrive at a response to a problem determines the appropriateness and quality of the response or outcome. In this section creative problem-solving is discussed; however it should be noted that for many problems there is no unique solution. The aim here is to provide an overview of the issues and factors which affect the quality of the creative problem-solving process and provide a framework for improving the creative problem-solving approach.

The terminology
The terms 'creative open-ended problem-solving process' and 'design process' and are often used interchangeably. Essentially, which phrase we use to describe the process of matching a solution option to a need (or problem) will depend on which discipline we work in. Although the phrase 'creative problem-solving' is a very apt generic phrase, in other disciplines such as engineering the term 'design' is used.

The process of problem-solving is generally considered to be a creative and intellectual activity which deals with open-ended problems. There are many definitions of 'creative problem-solving' and 'design', all of which refer to similar core characteristics. To show the similarities two definitions are given, one for creative problem-solving and one for design.

Definition of 'creative problem-solving'
Creative problem-solving is a way of thinking and behaving. It is a process, method, or system for approaching a problem in an imaginative way which results in effective action. This process:

- includes creativity, namely arriving at an idea that has an element of newness, at least to the one who creates the solution, and also has value and relevancy;
- is focussed on addressing a problem and arriving at a satisfactory method of resolving it. A problem is any situation that presents a challenge, an opportunity, or is a concern.
  (Adapted from Mitchell and Kowalik, 1999)

Definition of 'design'
"Design is the application of creativity to planning the optimum solution of a given problem and the communication of that plan to others".
(Wright, 2005)

The creative problem-solving process is a flexible activity which is relevant not only to all disciplines but also in everyday life. In reality the 'activity' or process is a framework of interrelated and interdependent activities and decisions. We can think of this process as having some specific characteristics, and as encompassing some specific activities, which can be adapted in any context to respond to any open-ended problem. The process is aimed at achieving the appropriate outcome in answer to a specific need. Some of the characteristics of the process are set out below.

- For the process to commence a specific need, problem or trigger is required.
- It is a thinking process which deals with concepts, ideas and abstractions and their translation into outcomes and products.
- It is a decision-making process based on the evaluation of options within a context.
- It is a process based on insightful questioning, investigation and research.
- It is a dynamic, iterative process and not a linear process.

Visualisation is essential to develop the solution options, predict the form, performance and characteristics of any product, or system, and to communicate this information to, for example, individuals, organisations, or manufacturers.

In order to build a picture of what the process or framework is and to develop an understanding of the issues and factors involved there is a need to define the terms below.

- Creative or creativity
- Open-ended
- Problem
- Problem-solving

Creativity

The terms 'design' or 'problem-solving' and 'creative' are often thought of as being two sides of the same coin, as good design or problem-solving is considered to require creativity. How you perceive their meaning depends on many factors including the discipline you work in.

Creativity is a very complex and controversial issue and is difficult to define precisely. Creativity has often been perceived as being a mystical and mysterious attribute bestowed on only a few individuals. Many still believe that a person is either innately creative or not creative. This concept of innate creativity however is generally not supported and most agree that all individuals can be, and are, creative at many different levels, to different degrees. For individuals to develop creativity first they need to accept that everyone is and can be creative.

> "I have joined those who associate creativity with achievement. If a person is doing something that, at least in intent if not in realization, will contribute to society, he or she is being creative." (Balkin, 1990)

Creativity is also often portrayed as an inspirational 'flash of lightning'. However this also is generally not the case. 'Eureka' moments do occur but such inspiration comes from hard work and deep, prolonged, meaningful and insightful thinking.

Much work has been done both to understand the processes of creativity and to develop methods by which creative abilities can be improved. Creativity is thought to be a combination of the following.

- Skill - *skills related to the processes of questioning, investigation, analysis, evaluation etc.*
- Reasoning – *which is based on analysis and evidence*
- Different types of thinking *e.g. lateral thinking*
- In some cases intuition and inspiration – *which is often based on lateral thinking*
- A great deal of effort!

Creativity is generally perceived as providing an outcome that is imaginative, innovative, original, valuable or interesting. Many now agree that an even broader definition should be used, for example, the outcome of a problem-solving process can be considered creative if an incremental change enhances the value of an existing solution, system or product.

> "Creativity, it has been said, consists largely of re-arranging what we know in order to find out what we do not know."
> (Kneller, 1967)

Although we can recognise and generally agree that a specific product or artefact is creative, there is no one definition of creativity. Many researchers and writers have attempted to define, describe and explain creativity. In an attempt to describe the nature of creativity, some writers focus on the 'creative process', others on the 'creative person' and yet others on the 'creative product or system'.

Writers generally consider those definitions which focus on the individual's response to a creative product to be the most useful and appropriate; as the product is the result of a creative process and the thought processes of the problem-solver or designer.

From the definition below it can be concluded that something that is creative is therefore both novel and appropriate. Novelty and appropriateness are therefore seen as characteristics of creativity.

> "Bruner (1962) saw the creative process as anything that produces 'effective surprise' in the observer, in addition to a 'shock of recognition' that the product or response, while novel, is entirely appropriate."
> (Amabile, 1996).

Amabile (1996) as a result of her work arrived at the following definition of creativity.

> "A product or response will be judged as creative to the extent that (a) it is both a novel and appropriate, useful, correct or valuable response to the task at hand, and (b) the task is heuristic rather than algorithmic".

The type or nature of the task therefore is also a core factor in determining what creativity is. A task can be categorised as heuristic (open-ended) or algorithmic (tame). This categorisation is important as it will determine the process by which the task or problem is to be addressed.

An algorithmic task is one where there is a clearly defined aim and the process by which the solution is arrived at is straightforward. An example of an algorithmic task is a crossword puzzle as there is one answer arrived at by solving given clues. A heuristic task is one where there is no one clear goal or clearly defined problem and the task is open-ended. When dealing with a heuristic task the process of finding a solution option is not straightforward or linear. The designer's or problem-solver's task is first to define or discover the problem (Hilgard and Bower, 1975).

Another characteristic of creativity therefore is that problem identification and definition are core activities and the problem is open-ended. Creativity can therefore also be defined as "a novel appropriate response to a heuristic (open-ended) task" (Amabile, 1996).

A very important factor which affects our perception of whether something is creative is our knowledge and background. Our judgement of creativity therefore is affected by our prior knowledge, which determines what we consider to be novel or imaginative, and our background and culture, which determines what we consider to be appropriate.

Most writers agree with the definition put forward by Morris Stein (1953) that creativity is "that process which results in a novel work that is accepted as tenable or useful or satisfying by a group at some point in time".

The same creative open-ended problem-solving process can in the case of any specific problem produce many different solution options which differ significantly in their creativity levels. It can be argued that this is because the basic process for defining a problem is the same but each problem-solver's knowledge and understanding of the context related to each problem is different, and, each problem-solver's view of and approach to the problem will be different.

Creative individuals are considered to have a number of characteristics:

- Independence of thought or action;
- The ability for lateral and divergent thinking;
- The ability to see many viewpoints;
- The ability to tackle a problem from a different angle;
- The ability to rethink situations or problems and reassess assumptions and opinions;
- The ability to discover new meanings through analysis.

Many studies have shown that the following are also necessary for creative performance and that by developing these skills an individual's creativity can be enhanced:

- Domain-relevant skills, namely the appropriate technical knowledge;
- Creativity-relevant skills such as the appropriate working styles and thought processes;
- Task motivation, to put in the effort required.

One way of enhancing creativity is through creativity-training programmes and using specific techniques. There are a number of programmes and techniques which aim to encourage the pursuit and generation of creative ideas. Brainstorming is one of these techniques. This technique is aimed purely at generating ideas. Other techniques such as the problem-solving framework described here, or the Osborn-Parnes problem-solving model address the whole process.

Brainstorming

The technique of Brainstorming was developed by Alex Osborn in 1938, with the aim of improving group problem-solving, although it can be a useful tool for individuals. It is a method of generating creative ideas in a non-judgemental environment. Osborn (1963) sees the creative process as being made up of two stages, namely idea generation and idea evaluation. Osborn considered brainstorming to be most useful for idea generation and developed four rules for a brainstorming session.

Rule 1:There should be no criticism of suggestions
In the activity of brainstorming the most important rule is that of 'deferment of judgement'. This means that no-one, not even the individual suggesting an idea should criticise it.
Rule 2: There should be no restriction on the type of ideas
This allows for any idea, to be included, however mundane or unusual it may appear to be.
Rule 3: A large quantity of ideas should be listed
This is based on the concept that the more ideas are generated the higher the probability that some will be worth developing further.
Rule 4: Ideas listed should be built upon
This allows for ideas, which are put forward, to be used by others as a springing point for their own, with the aim of combining and improving on initial ideas.

A typical brainstorming session consists of the following stages.

Stage 1 Assemble a group of participants, preferably of equal status
Elect or appoint a Chairman <u>and</u> a recorder

Stage 2 In the team, define the subject or problem to be brainstormed

Stage 3 Start by explaining the rules of brainstorming, as set out below
(a) Include all ideas – no matter how extreme
(b) Do not judge or evaluate of ideas
(c) Record each idea, moving quickly to next,
(d) Quantity and not quality is your objective.

Stage 4 Record all ideas

Stage 5 Evaluate the ideas using an agreed system such as:
A = Important and feasible
B = Possible
C = Impossible, not worth pursuing.

In a real-life situation the idea or ideas with the highest ratings would then be developed further. The aim during the evaluation stage is to reach a consensus and therefore choose an idea or ideas that meet some of the initial requirements and criteria, and can therefore be investigated further.

The problem and problem-solving

There are different types of problems, which have different characteristics. The problem-solver needs to be aware of the problem type in order to select the appropriate approach.

What do we mean by a 'problem'?

The problem is the trigger or need that requires a response, which then leads an individual, a team or an organisation to embark on the problem-solving process. A problem can be identified by an individual or be the result of a collective need, requirement or want.

In the widest sense, a problem exists when an individual or organisation becomes aware of a significant difference between what actually is and what is desired. This would then prompt questioning about what that difference is and how to achieve a satisfactory outcome. The term 'problem' can also refer to a situation, condition, or issue that is as yet unresolved.

Open-ended problems

Open-ended or heuristic problems have three main characteristics, and these are set out below.

- **A problem where there is more than one answer**
  The problem-solving *process should lead to a range of solution options, some of which are more appropriate than others, the aim is to choose the most appropriate.*

- **A problem where there is no 'right' or unique answer**
  Due to the characteristics of open-ended problems and the many interrelated and interdependent factors, which affect them, it is not possible for there to be one correct, unique answer; generally there are several possible options, none of which fully fit the requirements.

- **A problem which requires a dynamic process and is embedded in a dynamic context**
  Open-ended problems are difficult to define, and as more knowledge is gathered about them this changes the definition of the problem or problems. In addition the external factors which impact on the problem are themselves variable and subject to change.

'Tame', 'Open-ended' and 'Wicked' Problems

Problems can be categorised as being tame, open-ended or wicked. Tame problems are those that are straightforward and can be solved through an algorithmic task (see 'Creativity' section). Tame problems can be solved using a linear process. In other words as mentioned before the problem can be easily defined and there is one correct answer.

Problem-solvers often deal with so-called 'wicked' problems, which are a type of open-ended problem (see previous section).

The term 'wicked' was coined many years ago to describe a specific and large group of very troublesome open-ended problems. In industry the most valued problem-solvers are those who are creative and can deal with such (wicked) problems.

Wicked problems have particular characteristics; which means that they cannot be easily defined or resolved. They are also considered to be dynamic and often contain within them other 'wicked' and open-ended problems. Wicked problems require the problem-solver to consider a range of interrelated and interdependent issues in a specific, often changing context and to predict the consequences of decisions.

> "(Wicked problems) are messy, devious, and *reactive*, that is they fight back when you try to "resolve" them."
> (Ritchey, 2004)

Rittel and Weber (1973) drew up a list of characteristics of wicked problems and a number of these are set out below.

1. The problem cannot be understood until a solution has been developed.
   What is meant here is that the problem cannot be fully defined because it is ill-structured, it encompasses interrelated and interdependent issues and constraints, and it is dynamic and uncertain. As in all open-ended problems the process towards an appropriate solution is not linear.

2. Wicked problems do not have a 'stopping rule'.
   What is meant here is that in theory the problem-solving process is endless, as there is no one right answer. In reality a time limit has to be applied.

3. Solutions to wicked problems cannot be described as right or wrong.
   Generally the adjectives used to describe possible solution options are, for example, 'better', 'worse', 'satisfactory', 'not good enough' or 'good enough'.

4. Each wicked problem is unique
   Each wicked problem can be thought of as a bundle of problems and interrelated factors embedded in a dynamic context, so any solution has to be custom designed.

5. The definition and solution emerges together
   To learn about the problem, solutions have to be tried out. However trying out a solution is expensive in time and resources. Also when a solution is tried it can have lasting and unintended consequences which can result in other wicked problems. Modelling and pilot studies are often used to try and overcome this.

6. There is no guarantee that a solution can be found
   There may not be any appropriate solution.

The issues that need to be dealt with in wicked problems can be a complex mixture of human, cultural, social, ethical, technical and scientific ones. This messiness means that there is no best solution to such problems, only a range of options, one of which may be more appropriate than the others.

When dealing with wicked problems the problem-solver is also required to attempt to predict the success of their response to the problem as a full evaluation of any solution option generally cannot be done until the product or service is operational.

Wicked problems are very difficult to deal with and include a high level of uncertainty and risk. There is therefore often a temptation to guess what the solution is. Having a solution provides a zone of comfort as the perception may be that the complexities and difficulties do not have to be dealt with.

Fixating on a solution by guesswork or making assumptions can lead to failure as the problem-solver has not attempted to understand all aspects of the problem; so the solution will probably not match the need. Also a 'fixed' solution can lead the problem-solver to overlook the appropriate options that are available. In addition a 'fixed solution' can impose one individual's viewpoint, which may be flawed or biased, on others.

Experienced problem-solvers use a process which includes a number of interrelated and interdependent steps to arrive at solution options from which one can be chosen. In certain situations they may also use a strategy based on putting forward several options which they then test against requirements and criteria. Such a strategy, although useful when dealing with uncomplicated problems, which you have solved before, is of little help when approaching wicked problems. The danger is that if you start with an 'assumed' solution then the problem has not been defined and therefore the solution will not match the need.

What do we mean by problem-solving?

The answer to the above question should be considered in terms of the activities that need to be undertaken when we engage in the process of problem-solving. Problem-solving involves numerous activities some of which are listed below.

- Thinking, questioning, and observing to gather knowledge
- Defining the 'problem' to find the real problem
- Engaging in critical analysis and evaluation to assess information and decisions
- Implementing effective action, for example to model a specific scenario
- Applying implicit knowledge to explicit knowledge
- Evidence-based decision-making
- Setting criteria to enable the evaluation of decisions and options

Explicit and implicit or tacit knowledge

Applying implicit (or tacit) knowledge to explicit knowledge is a core requisite of problem-solving. There are two main categories of knowledge. Knowledge can be explicit or tacit; it is important to understand the relationship between these two types of knowledge.

Explicit knowledge is data that can be easily communicated; it can be shared, arranged in a system and stored. Examples of explicit knowledge are regulations, procedures and scientific data.

Tacit knowledge is sometimes referred to as implicit knowledge. Although it is difficult to define precisely it is generally valued more highly than explicit knowledge. It refers to the wisdom and insight that is gained through experience. Tacit knowledge involves judgement and personal interpretation. Experiential knowledge is tacit knowledge. Tacit knowledge is that knowledge which allows us to apply the appropriate explicit knowledge in the appropriate way to actual situations and problems.

Although both types of knowledge are required to solve any problem or arrive at a solution, tacit knowledge is thought to be the most important and valuable. Tacit or implicit knowledge helps the problem-solver to determine what explicit knowledge is needed, where to find it and how to use it.

Success in solving problems is largely determined by how we apply our tacit knowledge to explicit knowledge, and therefore it can be said that how we develop our tacit knowledge is of paramount importance. Reflective thinking is one method of developing tacit knowledge such as critical analysis.

Reflection can be said to be the positive use of hindsight as a tool to critically review actions, decisions, experiences, observations and performance in order to improve the planning and implementation of future actions, and improve future decisions and performance. The process of reflection (thinking purposefully about an experience) is an essential part of the development of implicit knowledge such as judgement, analysis and critical evaluation which are an integral part of expertise. Experienced problem-solvers are valued for their judgement and expertise, for example, their ability to analyse and evaluate information, apply explicit knowledge and thereby find responses to complex problems.

The problem-solver

Today there are still some problem-solvers, in some discipline areas, who work on their own. This is generally a rare occurrence. Generally in today's industries and organisations, due to the complexity of projects, services and products, a team of individuals with diverse, but overlapping expertise, collaborates to carry out their design, development and implementation. These teams are brought together for a specific project or group of projects and therefore the team is a temporary alliance. It is common for one individual to be a part of more than one such team at the same time. In such a situation any personal viewpoints therefore have to be balanced and integrated with that of others, so that the many differing viewpoints are catered for. Each individual therefore works at two levels; they contribute their expertise and also collaborate with others to reach a consensus.

> "…the designer (problem-solver) must understand and study the requirements, produce … solutions, test them against some explicit or implicit criteria, and communicate the design to clients and constructors. …design (problem-solving) is a process in which problem and solution emerge together."
> (Lawson, 2006)

In organisations and in industry problem-solvers rarely address or solve problems for themselves; they address or solve problems for others. They need to be aware of and understand the client's or users' requirements; the success of any project or product depends on their response to these requirements. Every problem-solver, therefore, needs to be aware of the views and requirements of others, as the success of any product or project will depend on each user's or stakeholders' evaluation.

Although the language that different professions and individuals use to describe the creative problem-solving process can be different, the core activities are the same. Each problem-solver or team will go through a process which commences with looking at what a specific need or a problem is, considering the influence of the context, investigating the problem in a creative and critical way, generating ideas and then choosing a solution from a range of possible options. The process therefore encompasses a very wide range of activities from decision-making to the application of scientific principles through to the realization of an actual product, project or service.

For a problem-solver the most important abilities are those which enable them to find and use information and resources in a creative and appropriate way. Problem-solvers generally work as part of a team and therefore the following is required.

An understanding of goals
A consensus as to the goals, aims and objectives and a collective understanding by all parties involved of the process, and, the criteria that need to be met so an appropriate response is made.

A pool of generic information understood by all involved
Although each team member has specific expertise they also need general knowledge within the project discipline field so they can ask the appropriate questions and understand the answers of other parties involved.

The use of standard terminology, symbols, notations and annotations
Problem-solvers need to communicate in a way that is clear, avoids misconceptions, and is succinct. Words alone can only convey certain types of information and words can be easily misinterpreted.

In all professions, but especially those that deal with the creation of 3-dimensional products or structures it is important to communicate with others using diagrams, networks and sketches combined with notes and symbols. In this way we can reduce misunderstanding and reinforce the clarity of the message. We can term these annotated visual images a 'visual language'. We use all sorts of images to communicate in everyday life (e.g. the London Underground map).

Clarity of communication
See the handouts on 'Communication and teamwork' and 'The use of a visual language'.

Project Development

Before we look at the creative problem-solving process a brief look at the whole process of project development is needed. For a client the aim of any problem-solving process is a specific outcome which is an asset for that client and (hopefully) of benefit to the user.

Project development is a term which generally encompasses the life cycle of a product, project or service, from its inception to its operational stage and beyond to when it becomes redundant.

The four main phases of project development from need to completion are as follows.

1. **The problem-solving or design phase (including the feasibility stage)**
   Solution options or ideas are developed from the definition and investigation of the problem or need and one option is chosen.

   This is the first stage and most important part of project (or product) development. The decisions made during this stage have a profound affect on all other aspects of project development and implementation.

   The problem-solving process is important because as each decision (which is part of the process) is made it not only affects what options and decisions are available in the future, but also controls all other aspects, such as the quality of the outcome, the time required for its implementation and the cost. Everyday examples of the influence of a decision on potential future decisions are everywhere. If we need to travel from Helsinki to London the first decision can be the form of transport. Whether we walk, cycle or fly will determine the time taken, effort involved, fuel needed, comfort, cost and equipment needed and of course how tired we are when we arrive!

From the above we can conclude that the success or failure of any project is founded in this initial problem-solving phase. The next three main stages are listed below.

2. **Convert chosen solution option to instruction**
   At this stage the focus is on converting the chosen solution option into a workable and executable form. The option is developed in detail at the same time as the method by which it can be realised is devised. Experienced problem-solvers consider methods of realization at the same time as they are developing solution options. Any changes after this stage will result in significant delays and cost increases.
3. **Deliver project**
   The product is manufactured, the project is completed or service put in place.
4. **Final evaluation of outcome and experience**
   Although it is crucial that evaluation is embedded in every stage of the process, it is also important to carry out an evaluation of project's success or failure to inform future work.

If the correct decisions have not been made during the initial problem-solving phase then the outcome will not match the need. The cost (in terms of money, time) of correcting mistakes in the later stages is always significant. The different phases or stages of the process can sometimes overlap; this depends on the management of the process. Overlapping the stages can increase the risk of failure.

The problem-solving process

The problem solving process is the first phase of project development. The creative problem-solving process includes many strands of interrelated activities. In addition to problem-definition and decision-making it includes, for example, investigation, analysis, critical evaluation and project planning. It is this complexity which makes the process both challenging and interesting. The process requires a great depth of thought, for example, to ensure that the problem is considered in its context; as the same problem in different contexts will require different solutions.

The stages of the creative problem-solving process can be described using a range of terms, which are usually discipline specific; however the core activities are generic whatever the discipline or context in which the problem sits. Figure 7 is an illustration of the concepts involved in creative problem-solving.

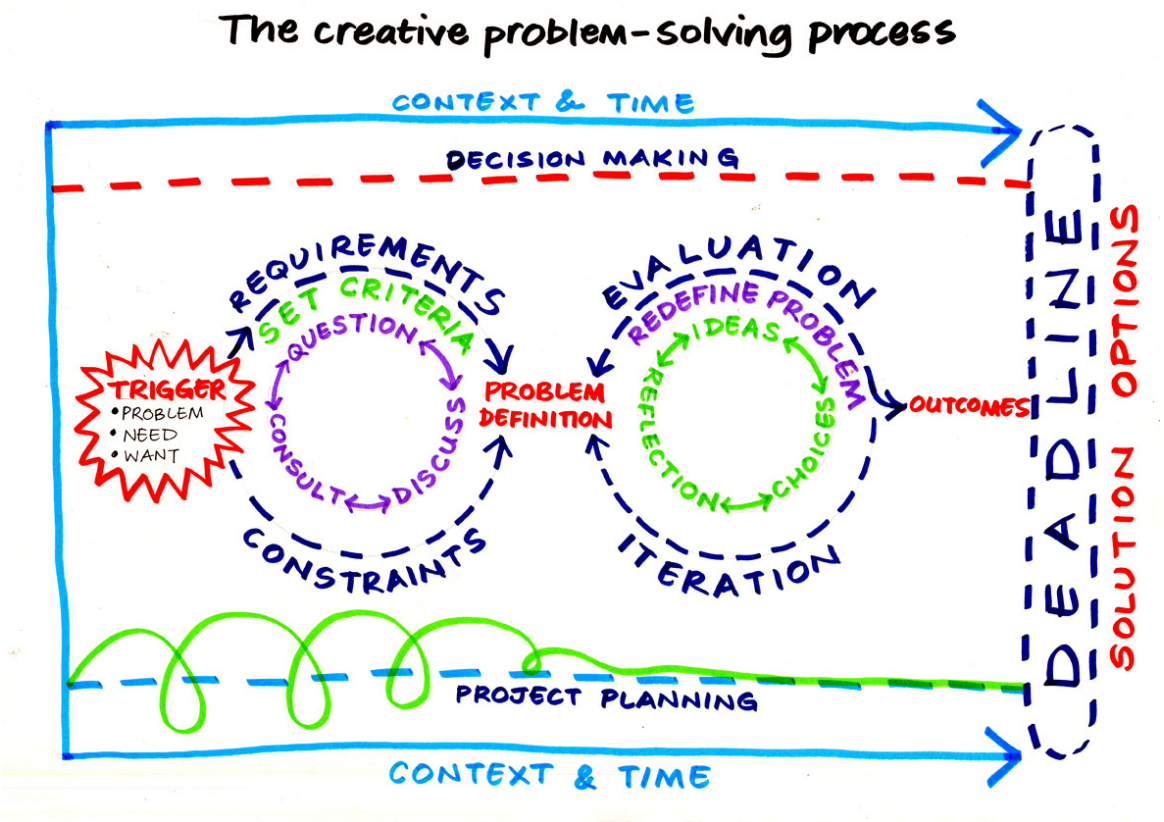


Figure 7: A conceptual map of the creative problem-solving process

Stages within the creative problem-solving process

The concept shown in Figure 5 can be broken down into a number of interrelated stages or activities. Since the process is not linear some stages (activities) can overlap, and some can be done in parallel with others. The sequence of activities depends on the characteristics of the problem. It is important to consider a number of these stages in more detail here.

- Context
- Problem Definition
- Setting requirements, constraints and criteria
- The process of iteration
- Decision-making
- Evaluation of options and outcome

Context

Each problem is embedded in a context which will have specific characteristics. The Oxford English Dictionary defines context as follows.

> "The circumstances that form the setting for an event, statement, or idea, and in terms of which it can be *fully* understood"

An understanding of the context within which a need or a problem exists is crucial. The context has a significant effect on how the need or problem can be defined. Therefore the context also has a significant effect on the options that are available and from which an appropriate solution can be chosen. The term 'context' encompasses a range of factors including social, economic, environmental, legislative and technical issues. Context determines how a problem can be approached, addressed or resolved by setting parameters and limits within which each individual or team must work. These context parameters can be grouped under five headings.

- What is acceptable in terms of people/culture/gender etc
- What is achievable in terms of technology/environment/time etc
- Who is available in terms of their experience/role/background etc
- What is available in terms of resources etc
- What is permitted in terms of legislation etc

Describing the context is part of the problem definition process. This activity includes establishing what information is known and unknown about the context and ensuring that preconceptions and assumptions are dealt with. All individuals involved in the process will have a particular world view as a result of their age, gender, background, experience and role. Problem-solvers solve problems for others and therefore always need to consider others' viewpoints and avoid assumptions and bias.

Good examples of differing contexts are the periods prior to and after the Industrial Revolution in the UK. Prior to the Industrial Revolution a rural model of society prevailed. In general, local resources were used by craftsmen to make whatever was needed and generally only small and easily transportable artefacts were traded across distances. The technological advances, which were a result of the Industrial Revolution changed the population profile, promoted the growth of the middle class, and changed the expectations of individuals. The Industrial Revolution promoted the following changes.

- A change from a rural to an urban environment.
- A change from design being mainly by the individual for the wealthy to individual or team-based design mostly for mass production.
- A growth in the fragmentation of knowledge, so most people now specialise in narrow fields.
- Production which is based on industrial (now often global) scale manufacture, with a consequent reduction in craft-based methods of manufacture.
- The development of a scientific approach which enables us, for example, to measure the properties of materials with great precision.

Figure 8 below sets out the three initial questions to ask or the three areas that should be initially investigated, namely what the real problem is, what type of problem it is and the context. It is often the case that the problem initially has only been described in terms that hide the actual need or problem.

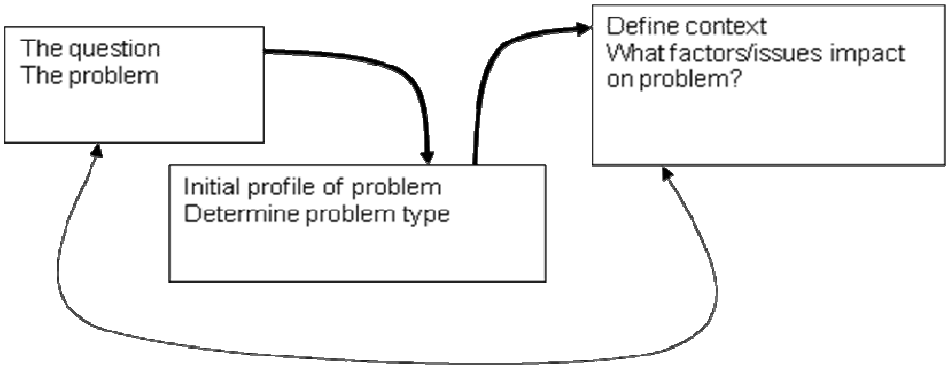


Figure 8: The first stage of the process

Problem Definition

A core activity in the design or problem-solving process is problem definition. It should **never** be assumed that a client will set out and define what the problem is that he or she wants you to address. A client will generally describe maybe the symptoms of a problem, or what he or she thinks the answer may be, or indeed what he or she perceives to be the problem. Investigation should be carried out to ensure that the actual problem is defined.

It is crucial that the problem-solver develops an understanding of both the problem and its context. Understanding promotes an appropriate approach and response, which should ultimately lead to a range of solution options. So the more you know about a problem the better able you are to arrive at an appropriate solution.

It is important to remember that the definition of any problem can change as the problem-solving process progresses. This is generally because the process is not linear and the context is dynamic and new information emerges. Therefore being open-minded and adaptable is very important.

Time is needed to undertake the problem-solving process. Since this part of project development (research, investigation and thinking) is often not highly visible, and may not result in significant tangible outcomes until the outcome is realized, time for it is often squeezed. Time allocated to this phase significantly affects the potential for success. It is crucial to remember that the quality of the outcome depends on the quality of the process leading to the outcome.

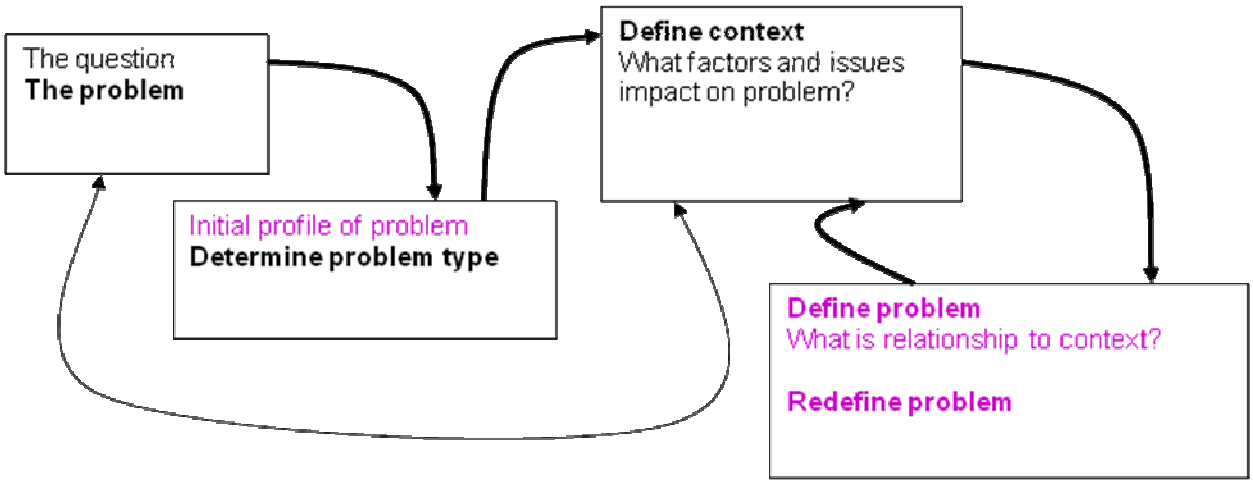


Figure 9: Redefining the problem as the investigation is progressed

A good definition of the problem will provide a platform for generating ideas and solution options and will include:

- an agreed definition of the problem actually is;
- what is known and what is unknown about the problem and context;
- the requirements and constraints relating to the problem and context;
- and criteria based on the requirements, which will provide a basis for evaluation.

Requirements, constraints and criteria

The terms requirements, constraints and criteria are often used interchangeably and although there is some overlapping of meaning it is important to be clear as to their place in the problem-solving process. The trigger for the process can be called a need or a problem. The aim of the process is to provide an outcome which successfully fulfils a function. Function is therefore a key driver and can be defined in terms of requirements, constraints and criteria.

The terms **requirements** and **constraints** can have different meanings which depend on an individual's role, responsibilities and viewpoint. Both requirements and constraints create boundaries within which the designer works to find a solution.

- A **requirement** is something that is obligatory or is demanded.

- A **constraint** is a factor which creates boundaries within which the problem must be solved. *Constraints are the boundaries within which a designer or problem-solver has to work; they determine the freedom available to come up with solution options. Constraints are also linked with the concept of feasibility, namely whether something is possible or doable. Whether or not a project is feasible can be determined by such widely varying factors as the country of manufacture or a government's economic policy. For example, high interest rates can mean that the cost of borrowing money to fund projects becomes prohibitive. When considering the feasibility of a project it is important to consider both constraints and requirements.*

The main sources of constraints can include the client (e.g. budget), the problem-solver (e.g. his or her experience), the resources available, the context (e.g. legislation) and what is technically possible. Constraints are often viewed as being negative, for example legislative requirements, such as Health and Safety. Constraints need to be evaluated to prioritize them in order of importance, and to assess their impact on the problem-solving process, project management and other issues such as manufacturing processes. In the case of many constraints e.g. those related to legislation there is a need to include time periods (often lengthy), for example to apply for consents and approvals.

A client's or user's wants are generally thought of as requirements and external factors (e.g. legislation) are thought of as constraints. Any problem has to be addressed within a specific context, namely external factors. This means that there will be a range of factors which will determine what can be done, and how it can be done.

Criteria are a combination of requirements and constraints.

Criteria are the standards by which an outcome can be judged to determine whether it is a satisfactorily response to a need or problem. Criteria form the parameters within which suitable options can be chosen. They are therefore a set of conditions or rules which must be fulfilled for the outcome to be judged successful. Criteria are not arbitrary; they are developed from requirements and constraints. It is crucial that criteria are set at the same time that the problem is defined as they should reflect the performance required of the product or system. It is also crucial to refer to them throughout the process to evaluate decisions, and to ensure that the solution options are an appropriate response to the need.

A major challenge is that all requirements and criteria cannot be fully satisfied and therefore there is a need to prioritise and compromise them. For any project there will be many requirements, constraints and criteria which in reality cannot all be fulfilled to the same level, indeed one requirement may contradict another. Requirements, constraints and criteria therefore have to be prioritised, and when appropriate a compromise has to be reached.

- **A Compromise** is an agreement that is reached by making concessions (hopefully with consensus) to overcome incompatibility.
- **Prioritisation** is determining the relative importance of factors and tasks, and can be based on whether the **criteria** are:
  - mandatory or discretionary;
  - objective or subjective;
  - complex or simple.

The process of iteration

Core to defining or building a picture of the problem is the process of iteration. The problem-solving process is iterative due to the interrelationships between factors and the fragmented nature of data sources. Identifying and defining the problem requires finding and compiling a range of appropriate information, related to a specific context, and identifying the gaps in the knowledge. Since there are so many issues and factors involved, the sources of information are fragmented and scattered. As each piece of information is added to expand the definition of the problem it will have an impact on the body of information already gathered and therefore on the definition of the problem. This process of adding knowledge and reviewing its impact is called iteration (see Figure 10 below). This activity is repeated many times throughout any problem-solving process.

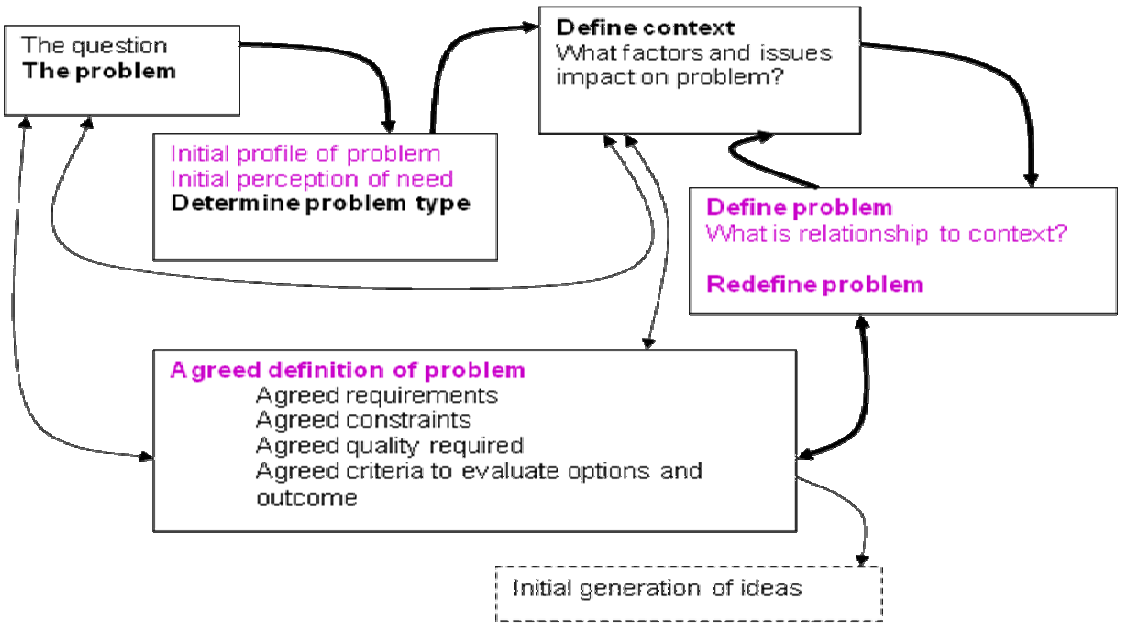


Figure 10: Arriving at a more complete picture of the problem

Iteration, or linking new knowledge to existing knowledge, is also often termed elaboration, indicating that additional detail is being added. Depending on the stage reached in the problem-solving process the result of iteration may be, for example, a deeper understanding of what the problem is, or a more detailed knowledge of a particular technical aspect.

Iteration should occur at all stages of the process as it provides another way (in addition to the evaluation of progress against criteria) of monitoring whether the decisions being made or options suggested continue to match the defined problem.

In addition new knowledge often changes the definition of the problem, or requirements related to the problem. So the process of iteration is also a checking procedure which evaluates the implications of the new knowledge that is added. Iteration is a core activity in problem definition and problem-solving.

Another way of looking at the process of iteration is to think of it as the problem-solver working at different levels of detail and knowledge at the same time. The problem or need at the beginning can be envisaged as a 'thing' with many fuzzy, indistinct areas (the unknowns) and some clear, sharp areas (what is known). Work is undertaken to improve your knowledge of the unknown areas and this information is then brought back to the 'thing' to create a clearer picture.

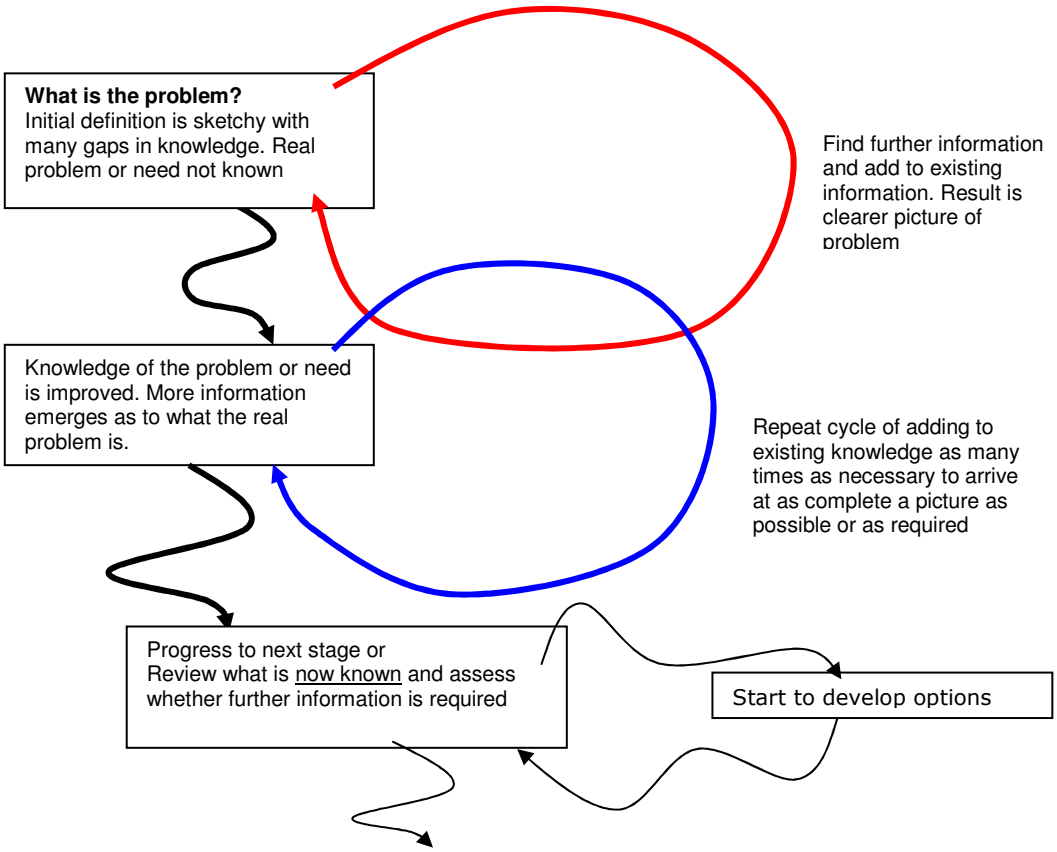


Figure 11: Diagrammatic representation of the process of iteration

Decision-making

Decisions are made throughout the problem-solving process. Each decision will have a significant effect on what future decisions and future options will be available. Decisions have to take into account the context, the criteria set for the outcome and the likely consequences of making the decision.

Decision-making involves the following activities:

- Gathering and analysing information;
- Thinking about what options we have;
  - by weighing up the advantages/disadvantages;
  - by thinking about previous similar decisions;
  - by considering, modelling or predicting what the consequences might be.
- Putting together proof or evidence which will support our decision or decisions;
  - the proof or evidence is found, for example by questioning and testing.

The client, for whom the problem is being addressed, requires assurance that the decisions being made will lead to success rather than failure. It is therefore important that decisions are supported by reasoning and evidence.

The aim of the problem-solving process is to provide an asset, which for example will form part of a client's financial portfolio. Some of the factors affecting the value of an asset are shown in Figure 12 below.

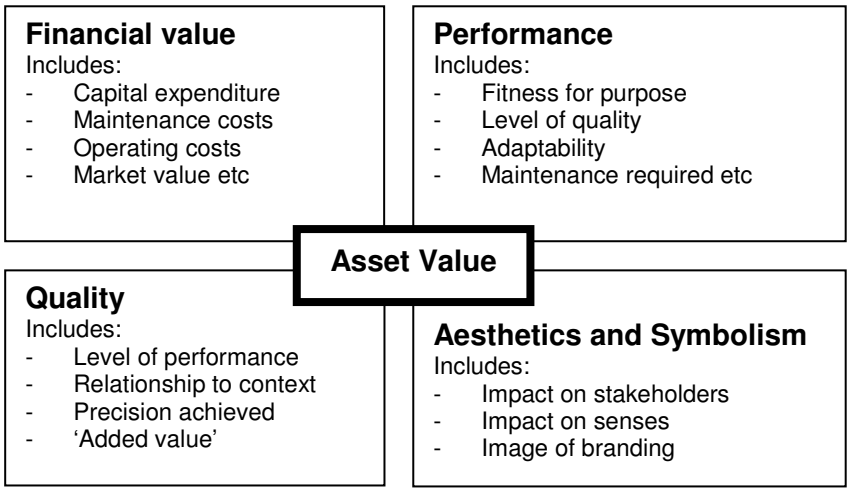


Figure 12: Asset value matrix illustrating factors which affect the asset value

Evaluation

Evaluation is an activity which can take many forms. It is often thought that this is a one-off activity which is undertaken once the project or product is in use. This approach can lead to failure.

The complexity of the problem-solving process is such that individuals involved can be diverted from the goal. Experienced problem-solvers therefore apply evaluation throughout the process to ensure that they stay 'on track'.

Evaluation requires the following:

- setting criteria;
- choosing the appropriate systems of measurement;
- the application of judgment.

Systems of measurement depend on:

- what is being measured;
- how it is being measured;
- whose viewpoint is the basis for measurement

Problems of evaluating the outcome

How success and failure is measured is a contentious issue. Many have spent decades attempting to arrive at a standard framework for evaluating an outcome or project. This has met with limited success.

The one point that all individuals, whatever their role, can agree on is that many projects can be considered to be both a success and a failure. An example of this is the Sydney Opera House; as an icon for Sydney and Australia it is a success, however it does not fully fulfill its function as a venue for opera. Many consider mobile phones to be a success story; others see them as an intrusion. Each individual's definitions of success and failure will depend on numerous factors, including the following.

- The individual's role, status and background
- The quantitative (objective) criteria applied
- The qualitative (subjective) criteria applied

Questioning and the PESTLE model

A core activity which runs through all the stages of the creative problem-solving process is critical questioning. It is crucial to ask insightful questions. Insightful questions are those that promote exploration, investigation and critical analysis and will lead to appropriate solution options. In addition the problem-solver must always remember that questioning should include investigating the viewpoints and the situation of the user, client or other individuals involved, therefore understanding their interpretation.

The following list, based on Browne and Keeley (2004) sets out a basic list of critical questions. Since each need or problem has specific characteristics any list of questions will be specific to that problem and context and therefore should be developed by the problem-solver to suit their needs.

- What are the needs, problems, issues or factors?
- What are the reasons for the requirements or views?
- How appropriate or credible are the sources of information?
- Is communication between all parties clear and unambiguous?
- Do all stakeholders agree on the goals?
- What are the value conflicts and assumptions?
- What are the rival causes or viewpoints?
- Are there any fallacies, or assumptions, or bias in the reasoning?
- What significant information is missing?
- What reasonable conclusions or solution options are possible?

It can be seen from the above list that the questions need to be wide-ranging and address the problem at different levels. Most organizations wish to ensure that the processes of problem-solving, analysis of context and decision-making are based on a exploration of the problem or need that encompasses all stakeholders and all levels (for example the microeconomic and macroeconomic level) and all factors. One method of ensuring all areas are covered is to use a tool such as PESTLE analysis.

PESTLE stands for Political, Economic, Sociological, Technological, Legal and Environmental. It provides individuals or teams with a series of headings under which they can explore, investigate, or brainstorm key factors. The model enables a simple or a complex analysis to be made by promoting questioning and research under each heading, although it should be remembered that many of these factors overlap.

1. Political factors, for example
   What is happening politically in the environment in which the organization is operating?
2. Economic factors, for example
   What is happening within the global and national economy?
3. Sociological factors, for example
   What are the cultural norms, attitudes and expectations of the population?
4. Technological, for example
   What is the impact of changing technology on products, services and employment?
5. Legal factors, for example
   How does the legal environment impact on employment and access to resources?
6. Environmental factors, for example
   What are the attitudes to ecological and environmental issues and how are they reflected in legislation?

Project evaluation, quality and risk

The amount of information and knowledge that is currently available to problem-solvers, together with the systems which facilitate the use of global resources means that the context in which problem-solving takes place provides much more choice. This situation has resulted in an increase in the numbers of activities and interfaces between activities, which in turn increases the numbers of points at which failure can occur.

The success of a product or project can be measured in a number of ways. Interestingly those involved or affected by the product, project or system will have different views of what success or failure is depending on their particular viewpoint.

As has already been stated, a project or product can be a success and a failure at the same time. It is important therefore to clearly define and agree on what the problem or need is and how it is to be evaluated and by whom. Quality also has to be agreed on at an early stage as, for example, it affects how precise, well engineered and well manufactured a product or system is, namely how much thought has gone into its design and production or implementation. Quality is generally expensive in terms of, design time, labour, and materials or resources.

All those involved in the problem-solving process have to take into consideration the balance between risk and reward. In other words what level of risk they happy to take responsibility for in relation to the potential reward that may be gained. All options for solving a problem can be defined in terms of how risky they are and how rewarding the outcome may be. In general the more innovative a project the more risky it is, however if such a project is successful there may be a high level of reward. Incremental design, namely making a slight change to an existing product or service, will generally be less risky, and the level of reward may be less, or may result in a continuing steady reward.

The summary

During the initial stages of any problem solving process the main activity is putting together a descriptive profile of the problem or need and identifying the relevant information that will support the progress of decision-making. Therefore it is difficult at this early stage either to fully describe the problem or to assess how much work or time will be needed to resolve it. The main interrelationships between stages are shown in Figure 13 below.

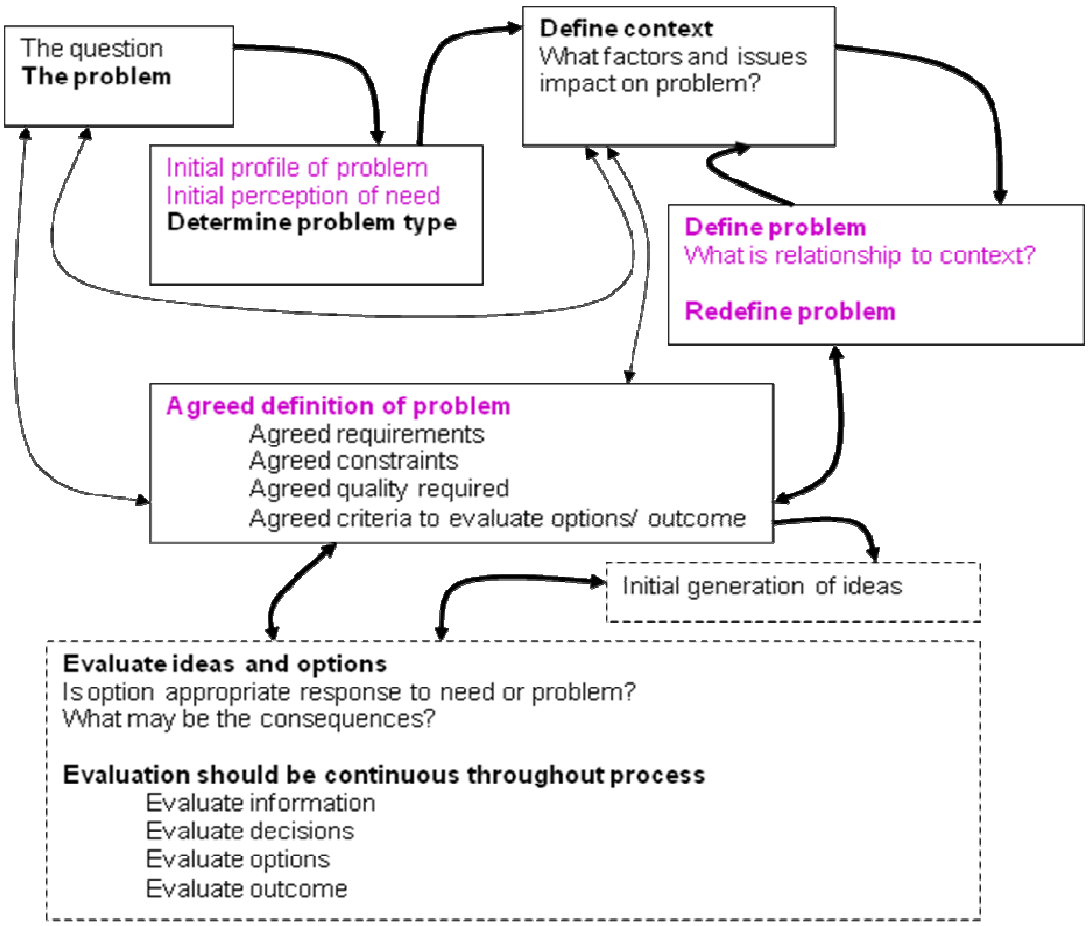


Figure 13: The process of problem-solving should include evaluation at every stage

It can be said that achieving an understanding of any problem is done through the process of solving it. In practical terms as progress is made through the process of problem solving, the outstanding work, and therefore the time required to complete the process becomes more predictable. It is however generally impractical to proceed on this basis and the time needed to solve the problem is estimated from experience.

The aim of the problem-solving process is to arrive at an appropriate outcome, through identifying and evaluating potential options, and ensuring that the problem identified and solution option chosen match.

- **Identifying and evaluating potential options**
  To identify solution options you need to set criteria against which potential options can be evaluated. These criteria will be based on the context, performance requirements and constraints. Criteria are developed during the problem-definition phase.

- **Ensuring the need or problem and solution option match**
  There is a need to continually assess the level of match between the identified problem and the chosen solution, as is indicated in Figure 14 below. Quite often evaluation is seen as an end-point activity which completes a process. This is not the case; to ensure an appropriate solution is chosen evaluation needs to be carried out regularly at all stages of the process.

Problems or projects may often appear to be similar. However each project has specific characteristics and as it is embedded in a specific context and needs to respond to specific requirements and constraints.

To summarise, the creative open-ended problem-solving involves the activities listed below.

- Defining the problem, through iteration to determine what the real problem is
- Investigating how the context affects the problem
- The activation of prior knowledge to identify useful previous knowledge
- Establishing the requirements and constraints
- Setting criteria to establish how decisions, options and the outcome will be evaluated
- The critical evaluation of information, ideas generated and options
- Decision-making to select an appropriate option
- The application of judgement at all stages

The process should lead to choosing and describing an option in detail, and providing the appropriate information, which then lead to a project's, product's or system's realization.

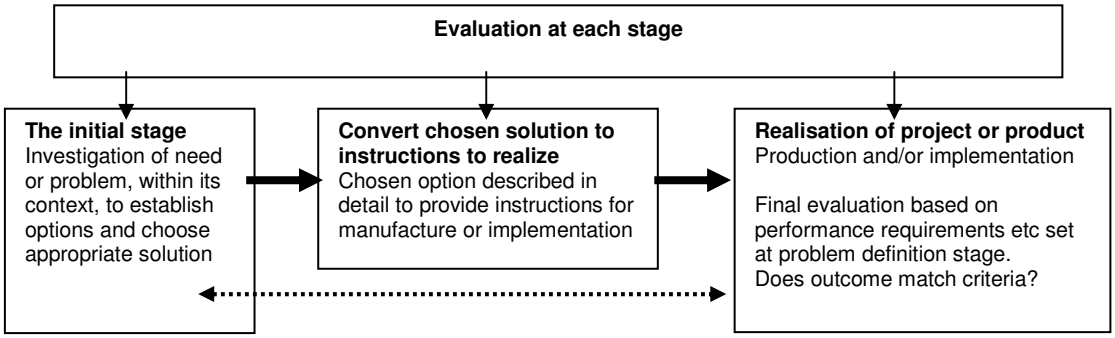


Figure 14: Evaluation to be included at each stage to ensure outcome aligns with need

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