



**From the constructs and methods of the philosophers  
to a model for improved discourse between disciplines**

By

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## **Abstract**

We have problem areas which are beyond the scope of a discipline, but we are generally educated in just a single discipline. I explored our philosophy of work to see how we became disciplinary, where the disciplines came from, what philosophy underlies our way of working, and what philosophy underpins work that is beyond the scope of a discipline. The underlying philosophy leads to the research question.

My hypothesis is that a systems engineer can create a model which networks the disciplines using constructs from philosophy, the tiers of disciplines in transdisciplinarity, and systemic and holistic thinking. This will provide a way of working on problem situations which transgress the boundary of a discipline.

Using constructs from philosophy, the methods of the philosophers, hermeneutics, systems thinking and soft systems methodology I proceeded to create a conceptual model and showed conceptual examples of how to use the model. The client for the model is the interdisciplinary researcher who is seeking a way of working to manage problem areas that transgress disciplinary boundaries. The recommendation is made for using critical, systemic and holistic thinking and a network model of disciplines to manage our approach to problem situations which are beyond the scope of a discipline.

The model is developed in the incremental sequence: disciplinary, multidisciplinary, interdisciplinary, transdisciplinary and gets as far as catering for tiers of disciplines (one aspect of the large and complex field of transdisciplinarity). Therefore, the model is suitable for interdisciplinary research, but can be developed further in future projects.

The importance of the model is that it provides a practical way of working to manage problem situations which transgress disciplinary boundaries whilst accessing the expertise of disciplined practitioners. The model can find wide applicability. It is not necessary for the user of the model to be comfortable with the abstract philosophy used to create it. Users will need the will for uncoerced mutual understanding or free communication, along with their disciplinary expertise. The reader of the dissertation however should be comfortable with abstractions such as ideas about reality and actuality, form and class, subject and object, truth and justice, truthfulness and functional fit. Future work may reduce the method to practice in the academy and extend the method to bridging silos in learning organisations in the workplace. The work was conducted independently, and an original model was created.

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Table 1: Abbreviations

CHED	Centre for Higher Education Development
EBE	Faculty of Engineering and the Built Environment
MOAD	Model of any Disciplines
SDG	Sustainable Development Goal
UCT	University of Cape Town
UN	United Nations

Table 2: Glossary

Academe	The academic community or society or academy which promotes standards in disciplines as branches of knowledge in higher education.
Authority	The power or right to give orders, make decisions and enforce obedience.
Axiom	A basic proposition taken to be self-evidently true.
Business method	A way of working.
Calculus	A method of reasoning using differentiation and integration.
Class	<ol style="list-style-type: none"> <li>1. A category of academic disciplines. In the decimal system each class has ten divisions, and each division has ten sections.</li> <li>2. A conceptual construct holding the definition of a category.</li> </ol>
Competence	The ability to do something correctly or successfully.
Conscience	An individual's judgement of the moral validity of behaviour.
Differentiate	Recognise or ascertain difference.
Dogma	Principles laid down by an authority as incontrovertibly true.
Eudaimonic	Referring to happiness in the sense of human flourishing and actualisation. Includes work and achievement which has meaning, with consequent happiness, and especially meaningfulness.
Evolution	Gradual development. For example, the evolution of the thesis.
Feasibility Study	An assessment of practicality at a conceptual level before attempting any actual implementation with people or software in the real world.
Gunning Fog Index	This index estimates the years of formal education a person needs to understand a text on the first reading. The fog index of this dissertation is 16. This is the average of measurements of 13-19 which were taken on random samples of the dissertation text submitted at the website <a href="http://www.gunning-fog-index.com">www.gunning-fog-index.com</a> .
Hedonic	Referring to happiness in the sense of pleasant sensations. Generally applied to leisure and pleasure for its own sake.
Hermeneutics	The branch of knowledge that deals with interpretation of texts.
Holarchy	A natural hierarchy of holons.
Holon	A whole that is simultaneously a part of a higher whole.

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Integrate	Combine to form a whole.
Interdisciplinary	In this dissertation interdisciplinary is used generally as pertaining to interaction between disciplines.
Model	A structural representation, on a smaller scale than reality, used as an example that can be imitated in reality.
Neoliberalism	A view condoning free markets and tolerating government interventions in the event of market failure.
Ontology	The branch of knowledge that deals with the nature of being and existence.

Philosophical Method considered in the methodology (in chronological order of appearance in history)

- Socratic method  
Cooperative dialogue, starting from a place of not knowing, and seeking understanding through the dialogue.
- Dialectic method  
Debate, without rhetoric and without subjective or emotional appeal, with different points of view, establishing truth through reasoned argument.
- Plato's directive  
'Let no one enter the academy who has no geometry.' When Plato invented the academy for higher education, he directed students to study geometry as a precursor to philosophy. Critical thinking can be applied to discover why Plato says this.
- Descartes' method  
We have enough rules if we (1) look for evidence, (2) deconstruct into parts, and (3) order from simple to complex, and finally (4) be thorough to assure completeness so we know when we are truly done.
- Hegelian Dialectic method  
Dialectic, in which a first proposition (thesis) and an apparent contradiction (antithesis) are reconciled in a third proposition (synthesis) which is at a higher level of truth and transcends the contradiction. This aligns with Einstein's comment that we cannot solve a problem with the level of thinking that created it.
- Habermas' method  
Communicate at the highest level through the rational inter-subjective exchange of uncoerced mutual understanding.
- Bhaskar's method  
Experiment in a way that activates the underlying mechanism. If it is a natural science system this is more easily done. If it is a human activity system, activating the underlying mechanism is more difficult and must consider the social structure which imposes on individual agency.
- Wilber's method  
Include all the perspectives. Include the inside/subjective view and the outside/objective view. Include individuals and collectives with their inter-subjective and inter-objective patterns. Include lines and levels of development. Include states of consciousness and types in people.

Phylum The category above class, that contains classes.

Progressive Assertiveness A mechanism for a subordinate to assume control in the event of a failure in the hierarchy, to avoid a catastrophe. The way this is achieved in practice is to make sure the differential between the

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	authority and his or her colleagues does not get so big that progressive assertiveness fails.
Reflexivity	Referring back to the subject. People may consider themselves objective but can use reflexivity to uncover their subjectivity and so understand the limits of their objectivity and their hidden biases.
Solidarity	Mutual support in a group. Unity between individuals due to common interest.
Subsidiarity	The devolution of power to the lowest appropriate level. Higher levels of power should not concern themselves with anything that can properly be dealt with at a lower level. This frees the lowest level to make local decisions and frees the highest level to focus only on the highest-level issues. It is an emancipative principle.
Systems Engineering	An interdisciplinary field of engineering and management focusing on design and management of systems. An engineered system such as a MOAD is a combination of components working to collectively perform a useful function.
Tacit	Implied but not stated (e.g. a tacit understanding is not verbalised).
Techne	Craftsmanship, art, craft, technical skill.
Telos	The ultimate end or aim. Always in front, and towards which we move. If we reach the end it is not the ultimate end. Therefore, the telos is more likely eudaimonic than hedonic.
Tenet	A basic principle of a philosophy.
Transdisciplinary	In this dissertation transdisciplinary is used generally as meaning beyond the scope of a discipline.

*Begin at the beginning and go on until you come to the end; then stop.*

*Lewis Carroll (1865)*

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## **1. INTRODUCTION**

### **1.1 Roadmap to This Chapter**

The introductory chapter covers the context and defines the purpose of the study. It provides the background in which the researcher undertook the project, and the scope.

### **1.2 Problem Statement, Purpose of the Study and Key Question**

We have problem areas which are beyond the scope of a discipline, but we are generally educated in just a single discipline.

The literature review explored our philosophy of work. What philosophy underpinned becoming educated in a discipline? Where did disciplines come from? What were the ways of thinking? For problem areas beyond the scope of a discipline, what philosophy is appropriate? How can we work together on these problem areas? These questions directed the literature review.

Given the underlying philosophy and wide range of ways of thinking uncovered in the literature review, the key research question is 'Can we create a conceptual model which networks the disciplines, using constructs from philosophy and systemic and holistic thinking?' Problem areas which are beyond the scope of a discipline can benefit from significant networking of disciplines.

The aim of the study is to make a contribution towards improved understanding of the philosophical underpinning of disciplinary discourse and propose a model for collaboration between disciplines. I build the conceptual model in the sequence: disciplinary, multidisciplinary, interdisciplinary, transdisciplinary (Max-Neef, 2005) addressing a limited part of transdisciplinarity (the tiers of disciplines), so the thesis cannot be said to be a model for transdisciplinary work at this stage of development, but it does produce a model for interdisciplinary research as a first iteration (Model 1.0). It can be developed further in future to address more aspects of transdisciplinarity.

### **1.3 Background**

#### **1.3.1 Society**

Modern society in the twentieth century emphasised differentiation and rational investigation, creating depth of knowledge in well differentiated disciplines. This was appropriate to the life conditions of the time, where people had been disoriented by the breakdown of dogmatic tradition and religious belief, the totalitarian impulses of nationalism and socialism, and two

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world wars. People created structure through discipline and a work ethic focusing deeply in their discipline. In our journey from pre-modern to modern society thinking had become critical, and work was arranged into disciplines with science and technology dominant. Since the 1970s neoliberalism has been ascendant in economics. This uses critical thinking to allow free market efficiencies but condones government intervention as a corrective mechanism in the event of market failure.

Society is now entering a phase of integration which transcends modern differentiation. The new integral era of the twenty first century has life conditions of the globalisation of problems and solutions. Integrating the disciplines will be holistic. The holistic approach is to retain the disciplines created by differentiation but take them all into account and integrate them as components (holons) of a higher order system (holarchy) suited to problems which transcend disciplines. For example, the UN sustainable development goals (UN, 2015) do not belong to any one discipline and require that professionals in disparate disciplines work in concert to achieve the goals.

### **1.3.2 The Academy**

The academic literature of transdisciplinarity shows two main thrusts (Max-Neef, 2005, Klein, 2014, Popa et al., 2015, Tejedor et al., 2018, Kirby, 2019). The first is a bridging between academia and society for socially relevant research. The second addresses global challenges that do not belong to any particular discipline, such as the sustainable development goals. Sustainable development is a not a problem to be solved, but a systemic crisis to be managed, particularly in engineering (Tejedor et al., 2018). These approaches can benefit from significant networking of disciplines. The literature recommends (Kirby, 2019) that a first step towards interdisciplinary working should be done in the academy (T1 research), before starting work in the workplace or community (T2 research). This is not mandatory.

The concept of a T-shaped person is somebody who has depth in a discipline (the vertical line of the T), as well as breadth to reach across to other disciplines (the horizontal line of the T). This type of person facilitates interdisciplinary projects (Johnston, 1978). The academy is starting to produce T-shaped researchers who may benefit from a method for performing interdisciplinary work.

### **1.3.3 The Researcher**

My undergraduate degree was in electrical engineering, and my in-depth experience is in systems engineering in process control systems, telecommunication systems, real-time

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transaction processing systems and information and communication technology systems (ICTS). I was a registered chartered engineer for twenty-five years and completed over one hundred systems projects before turning to education for the next generation. The vertical line of my 'T' is Systems Engineering. The horizontal line of my 'T' is business relationships and for several years I worked as a business analyst and product manager in ICTS. Jack Ma (2018) proposed that experienced people from industry might return to education, to contribute from their experience. I propose that a such a T-shaped person can produce a model for working on interdisciplinary projects between academic departments at the university (T1 research). The T-shaped person has specialised, but has also broadened, through experience, and in management and leadership, and so has developed beyond specialisation to a maturity and wisdom that can facilitate interdisciplinary projects.

### **1.3.4 The Disciplines**

Disciplines are branches of knowledge in higher education. The Dewey Decimal Classification System organises the knowledge base of humanity by discipline. There are ten classes, each with ten divisions (100 divisions), each with ten sections (1000 sections) which are numbered 000-999. University faculties and departments are organised by disciplines which match these Dewey disciplines. For example, the faculties of Commerce (380), Law (340), Engineering (620), Health (610), Arts (700) and Science (500), and the departments of Economics (330), Mathematics (510), Philosophy (100), Physics (530) and Political Science (320). There are six faculties at UCT and approximately fifty departments representing fifty Dewey disciplines. For information and easy access these are provided below.

#### Faculty of Commerce (380)

- Accounting (657)
- Economics (330)
- Finance (332)
- Information Systems (000)
- Management Studies (650)

#### Faculty of Law (340)

- Private and Commercial (346)
- Public (341, 342, 344)

#### Faculty of Engineering (620)

- Architecture (720)
- Chemical Engineering (660)

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Civil Engineering (624)  
Construction (690)  
Electrical Engineering (620)  
Geomatics (550)  
Mechanical Engineering (620)

Faculty of Health (610)

Anaesthetics (617.96)  
Human Biology (611)  
Medicine (610)  
Obstetrics & Gynaecology (618)  
Paediatrics (618)  
Pathology (616)  
Public Health & Family Medicine (614)  
Psychiatry (616.89)  
Surgery (617)

Faculty of Science (500)

Archaeology (560)  
Astronomy (520)  
Biology (570)  
Chemistry (540)  
Computer Science (000)  
Environmental & Geographic (550)  
Geology (551)  
Mathematics (510)  
Oceanography (551.46)  
Physics (530)  
Statistics (310)

Faculty of Humanities (100, 200, 400, 700, 800, 900)

Anthropology (301)  
Archaeology (930)  
Dance (792.8)  
Drama (822)  
Education (370)  
Fine Art (700)

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Historical Studies (900)  
Language (400)  
Library & Information Studies (020)  
Linguistics (410)  
Literature (820)  
Music (780)  
Philosophy (100)  
Political Science (320)  
Psychology (150)  
Religion (200)  
Sociology (300)

In this snapshot of 2018, it is interesting to see that the disciplinary divisions of commerce, law, engineering and health are *divisions* that have grown in stature from departments to *faculties*, whilst the disciplinary classes of philosophy, religion, language, arts, literature and history are *classes* that have shrunk down to a *single faculty* called humanities. In effect humanities is a superclass of six classes. The classification system is not a perfect structure, but it is not necessary to be perfect. What is necessary is to have some or other structure for the knowledge base of humankind. In the 1950s C.P. Snow had thought there were basically two academic cultures (humanities and sciences), but Kagan (2009) added a third culture (social sciences) and now a fourth is appropriate (technologies) so it would be convenient if the classification system had four superclasses to match the academic cultures. Nevertheless, the existing system of ten classes, each with ten divisions, each with ten sections is flexible and extensible and transcends and includes four cultures. It has been extended massively over the twentieth century, and each of the one thousand sections now has one thousand subsections, and each of those subsections has a further one thousand subsections, so this system currently has one billion subsections. We can keep going as deep as we like into our knowledge base.

### **1.3.5 Specialisation and Communication**

As the specialities deepened so the language became specialised and specific to that depth. Deepening of speciality creates stronger boundaries, in knowledge and language. Disciplines like economics, engineering, education, politics, psychology and philosophy became more so or less so inaccessible to each other, as they carved out their unique domains. If the disciplines become completely inaccessible to each other we may for example see philosophy become a profession to itself, read only by philosophers. Specialisation caters for rich knowledge within

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a domain but poor knowledge transfer between domains. Does this matter? Does it matter whether specialists can talk to each-other?

Consider the case of building a house. We need brick-layers, carpenters, plasterers, electricians, plumbers, glaziers, engineers, architects, draughtsmen, painters, cabinet makers and so on. They are all specialised. It is very efficient that they are specialised, because each can do their tasks rapidly and with high precision. However, these skilled workers, suppliers, artisans and professionals need to talk to each other so that water pipes can be run inside brick walls and electrical sockets can be located above kitchen cabinets and so on. Without communications between specialities we cannot build the house. Without management the implementation is not actualised. Without leadership the vision is not realised. The means of communication are language and plans or models. The owner leads and communicates vision, mostly down to the project manager who will be responsible for implementation. The project manager communicates further down the chain of implementation, using more detailed and technical language and plans. There is a hierarchy of communication. Language and plans at the vision level are more abstract, whereas language and plans get more technical, specialised and detailed at the lower levels. In the case of building the house the hierarchy of communication has three levels, leader, manager and implementer. This is common.

On a larger scale, if we want to build a corporation or a city or a nation, then economics, engineering, education, politics, psychology and philosophy are all parts of the picture and people will have to work together to produce such a built environment. These deep specialisations are legitimated by professional degrees in the discipline just as the artisans are legitimated by their practical implementation skills. Analogous to building the house we will need a hierarchy of communication with leadership and management in order to realise the vision and actualise the implementation.

It is interesting that at the smaller scale (building a house), where the disciplines are *subsections* of a division, then technical skill (Aristotle's *techne*) increases at this depth, whilst at the larger scale (building society), the disciplines are academic *classes* (Aristotle's *academe*) at the highest level. This shows that the craftsman zooms in to technical proficiency whilst the academic zooms out to ultimate philosophical telos.

In the twenty-first century we will need a focus on integration of disciplines because problems are complex and need multiple disciplines and coordination to resolve or manage. Academe and techne (Table 2) are necessary parts, with academe at the high level of abstraction and techne at the detailed level of proficiency. The dissertation proposes that a discipline

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addresses a certain set of questions and performs a certain set of activities. In other words, 'what questions does the discipline address?', and 'what can the discipline do for the world?'

### **1.3.6 Integrative and Holistic Thinking**

Integration puts components together to form an integrated whole. Holistic thinking considers the components as wholes in themselves as well as being parts in the integrated whole. For example, geometry and algebra are disciplines, but they are also integrated as component parts of the discipline of mathematics. A whole that is also a part of a higher whole is called a holon. On the other hand, merging of disciplines refers to reflexive dialogue between aspects of disciplines which results in something new, such as socio-economics.

For example, geometry and algebra can be networked to work on some problem that is beyond the scope of either. They can be merged to form something new. They can be integrated in the discipline of mathematics. An example of forming something new is given in Figure 9.

To highlight the difference between the concepts of integration and merging, consider atoms, molecules and cells. Atoms are holons, molecules are holons and cells are holons. Cells are made of molecules which are made of atoms. The fact that the molecules are parts of the cell does not mean they are no longer molecules. A molecule remains a whole molecule and becomes in addition a part of a cell. The integration of the atoms, molecules and cells is holistic. A cell is a hierarchy of holons. A hierarchy of holons is called a Holarchy. So, for the case of a cell, we have atoms as the first layer, molecules as the second layer, organelles (sub-structures) at the next layer, and the cell at the next layer of the Holarchy. The atoms and molecules are integrated but not merged in the cell. They retain their identity as atoms and as molecules as well as their identity as parts of the cell, however, the lower holon can only do what it is constrained to do as a part of the higher holon, so for example hydrogen behaves as constrained by water when it is part of a water molecule.

In the case of the built environment, the economics, engineering, education, politics, psychology and philosophy are parts, but they remain wholes in themselves. Leaders are concerned with what should be. Managers are concerned with ensuring that it can be and that it becomes so. Workers make it so. The leader, manager and worker are parts of the solution, but remain whole in themselves. People are holons and disciplines are holons.

With integration of disciplines we build holarchical systems of holons. The Holarchy is hierarchical, but this is not a power hierarchy, it is a competency hierarchy. The atom performs as an atom, the molecule performs as a molecule and the cell performs as a cell in the human

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organism. We don't find an atom usurping its position in the hierarchy. It has a natural place in the hierarchy. The natural hierarchy shows us that it is not hierarchy itself that is bad, but a pathological dominator hierarchy such as an ideological dictatorship is bad, and this is not a natural Hierarchy. The literature review shows how philosophers addressed hierarchy and competence, particularly Plato (1955), Habermas (1984, 1987, 1991) and Wilber (1995).

Philosophers are concerned with why the leaders have a certain vision, why the managers follow and why the workers implement? What is the nature of the world and the people, why do we behave like this, what are the reasons and the causes for the behaviour? What is the logic, what is the ethics, what is the knowledge? This is investigation of the underlying reality that explains the actuality. The result of philosophy is knowledge of the real.

### **1.3.7 Finding Meaning**

Too many people have too little meaningful work despite living under conditions where economics has reduced poverty, and where technology has reduced the effort and repetitiveness of work. Furthermore, we may soon eliminate certain forms of work altogether using computers and robots.

We may tax computers and robots to provide sufficient funds for welfare and even leisure but meaning is not typically found in leisure or play. Leisure and play are more the domains of happiness. Play is something we do for its own sake because it is enjoyable, entertaining and fulfilling. We say we play a piano, and not that we work a piano. If we are in pursuit of happiness, we might be happy with leisure and play. If we start seeking to answer whether the leisure or play is worthwhile or meaningful then we have had sufficient leisure for the time being. After enough leisure we desire something more meaningful. Aristotle (1955) says we work that we may have leisure, and here we see too, that we have leisure that we may work.

Meaning is found in love and in work. The telos is meaning rather than happiness. However, happiness is often experienced as a by-product of the meaningful work. When this happens, it is an indication that the meaningful work is experienced in the same way as play. Meaningful work can be enjoyable, entertaining and fulfilling but that is a by-product, not the end itself.

The need for meaningful work therefore persists even if we have funds and leisure. This is demonstrated by Bill Gates starting his philanthropic foundation, and Jack Ma returning to work in education.

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In studies of well-being (in experience and functioning) the focus on happiness or pleasure as the main value is called a hedonic approach (attain pleasure, avoid pain), whilst a focus on meaningfulness as the main value is called a eudaimonic approach (achieve full potential and self-actualisation). If we take a hedonic approach, then we might stay with happiness and simply play football for example. If we take a eudaimonic approach, then we seek work that will help us achieve our potential and self-actualisation and this will be meaningful.

The problem space is ontological. It is about 'being'. It is about well-being rather than surviving. It is about a eudaimonic approach to well-being. But what about the solution space? Do the mechanisms for creating meaningful work lie in ontology?

### **1.3.8 Philosophy of Work**

What philosophy will create meaningful work? Can past philosophy, psychology, politics, economics, technology, entrepreneurship and literature contribute to the synthesis of a new philosophy to help orient education and training programmes for meaningful work in a societal context of computerised and robotised jobs in the 2020's? What would this philosophy look like? How would the philosophy guide curricula and education policy? What work programmes would arise? These are complex questions sufficient for a career in research and beyond the scope of an MPhil dissertation. The first step in such a career would be the MPhil dissertation. The dissertation is thus the means-to-the-end and not the end-in-itself.

### **1.3.9 A Career in Research**

An MPhil should examine the current situation and explain it. A DPhil or PhD should synthesise new knowledge. The scope of an MPhil is inter-disciplinary but should be well bounded. The purpose of an MPhil is to create the foundation of a research career. Synthesis of new knowledge will come out of the career, not merely out of the MPhil. As the start of a research career, the MPhil will be limited to creating the conceptual model.

## **1.4 Scope for the Project**

The literature review investigates the philosophy underpinning working in disciplines, and the philosophy underpinning approaches to working beyond the scope of a discipline. After the literature review, I investigated the key question: 'Can we create a conceptual model which networks the disciplines, using constructs from philosophy and systemic and holistic thinking?'

Within the scope of the project I created a conceptual model using concepts and methods from philosophy and a process from systems engineering. It is a best practice of systems engineering to start small and progress through iterations in manageable increments. Given

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the sequence of increasing complexity: disciplinary, multidisciplinary, interdisciplinary, transdisciplinary, I produced iterations of development of the 'model of any disciplines' (MOAD) in the same order: i.e. disciplinary (existing disciplines e.g. (DDC23, 2011)), multidisciplinary (MOAD without interfaces), interdisciplinary (Open MOAD, Integral MOAD) and transdisciplinary (the four tiers of disciplines shown in a Tiered MOAD).

It is out of scope to cater for all facets of transdisciplinarity as this is a large and complex field. Only a part of transdisciplinarity (the tiers of disciplines) was catered for in this first issue of a conceptual model. The model networks disciplines and can do so optionally using the tiers of transdisciplinarity. It can be said to be suitable for interdisciplinary or T1 research. This will be called Model 1.0. It provides for improved communication and collaboration between disciplines. I selected a few disciplines to demonstrate the concept e.g. Philosophy, Social Science, Technology and Science. These disciplines are representative of all four tiers of disciplines (values, normative, pragmatic and empirical tiers).

If this approach is successful, the beneficiaries would be people working on a problem area that transgresses the boundary of a discipline in interdisciplinary research.

The scope is limited to the creation of the conceptual model. It is out of scope to implement the model as a human activity system or a network of expert systems or software components using artificial intelligence.

The limited scope of what has been done within the scope of this thesis does not preclude undertaking future work to cover further aspects of transdisciplinarity, complexity science or epistemological integration in future, which could extend the model to Model 2.0, Model 3.0 ... At UCT we are still very disciplined, and Model 1.0 is a first step to networking disciplines.

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## 1.5 Roadmap for the Dissertation

The dissertation has a linear form:

1. Introduction
2. Literature Review
3. Methodology
4. A Model of Any Disciplines (MOAD)
5. Scenarios
6. Conclusions
7. References

The literature is reviewed before defining the project objectives and methodology (chapter 3). The main objective of the dissertation is the creation of the model (chapter 4) and the secondary objective is to show how to apply it in conceptual scenarios (chapter 5). The dissertation ends with conclusions and possibilities for future work (chapter 6). In this dissertation I present the conceptual model and leave for future work the possible implementation as a human activity system or in software as a network of expert systems.

Elaborating slightly, with key references, I provide a storyline of the thesis in under 500 words:

We have goals which are beyond the scope of a discipline, but our way of working is disciplinary (chapter 1). The literature review (chapter 2) focuses on the philosophy underpinning working in disciplines, and in working on problems situations that are beyond the scope of a discipline. The review shows that our disciplinary approach is modern and uses critical thinking (Descartes, 1649), but more recent philosophy is available which caters for holistic thinking (Bhaskar, 1987, Wilber, 1995, Smuts, 1926, Koestler, 1967, Jantsch, 1980). Transdisciplinarity is seen as a project in progress, and whilst it proposes tiers of disciplines (Max-Neef, 2005) it does not provide guidelines on how academics can work across disciplines. The dissertation therefore investigates creating a model as a business method (i.e. a way of working) for academics to work on problems which transcend the boundaries of disciplines using a network of disciplines. The model is limited to interdisciplinary research, but it can optionally use tiers of disciplines of transdisciplinarity.

The interdisciplinary or transdisciplinary researcher has become known as a T-shaped person (Johnston, 1978, Hansen, 2001), who has depth in a discipline, and breadth to facilitate interdisciplinary working using systemic and holistic thinking. The classic example of the T-

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shaped person in the Harvard Business Review is the scientist who becomes a manager, having the leadership qualities to facilitate working in a network of disciplines.

The project is defined with a hypothesis, research question, project objectives and a roadmap for achieving objectives, as well as a conceptual framework (chapter 3). This is developed from first principles, using the classical philosophy of Plato (1955). I investigate the boundaries of disciplines and what the interfaces between disciplines could look like. I create a model which optionally maps the disciplines onto either the integral philosophy of Wilber (1995) or the tiers of Max-Neef (2005). The disciplines of the model are based on Plato's Forms (1955) which were shown to be rational by Locke (1964) and formalised as classes (OMG UML, 2015). The disciplines are already classified in the Dewey Decimal Classification (DDC23, 2011) so we have a set of existing disciplines to work with. With systemic thinking a network of disciplines is seen as a system, whilst with holistic thinking, disciplines are considered holons in a holarchy. The nature of holons is that they retain their identity as wholes whilst being parts, so the identity of disciplines is not lost in my model of interdisciplinary work. The model caters for knowledge generation in existing disciplines, as well as allowing for the creation of new disciplines as research develops (chapter 4).

The model caters for interdisciplinary problem solving (e.g. engineering education) and problem situation management (e.g. sustainable development). Scenarios are documented in the results (chapter 5). The study concludes (chapter 6) that the model is suitable for academics working on problems not contained within a discipline. It is sufficient, by heuristic, if 10% of the interdisciplinary team is T-shaped, and 90% contribute from their special discipline using the model which networks their disciplines.

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## 1.6 Project Plan

### 1.6.1 Timeline

Literature review, research design, supervisor interviews: June 2018 - March 2019

Presentation of research proposal: 4 March 2019

Presentation for patent or IP protection: March 2019 – April 2019

Intention to submit dissertation (PeopleSoft): by 1 May 2019

Online submission of dissertation: by 1 July 2019

Submission of a paper of publication standard: by 1 October 2019

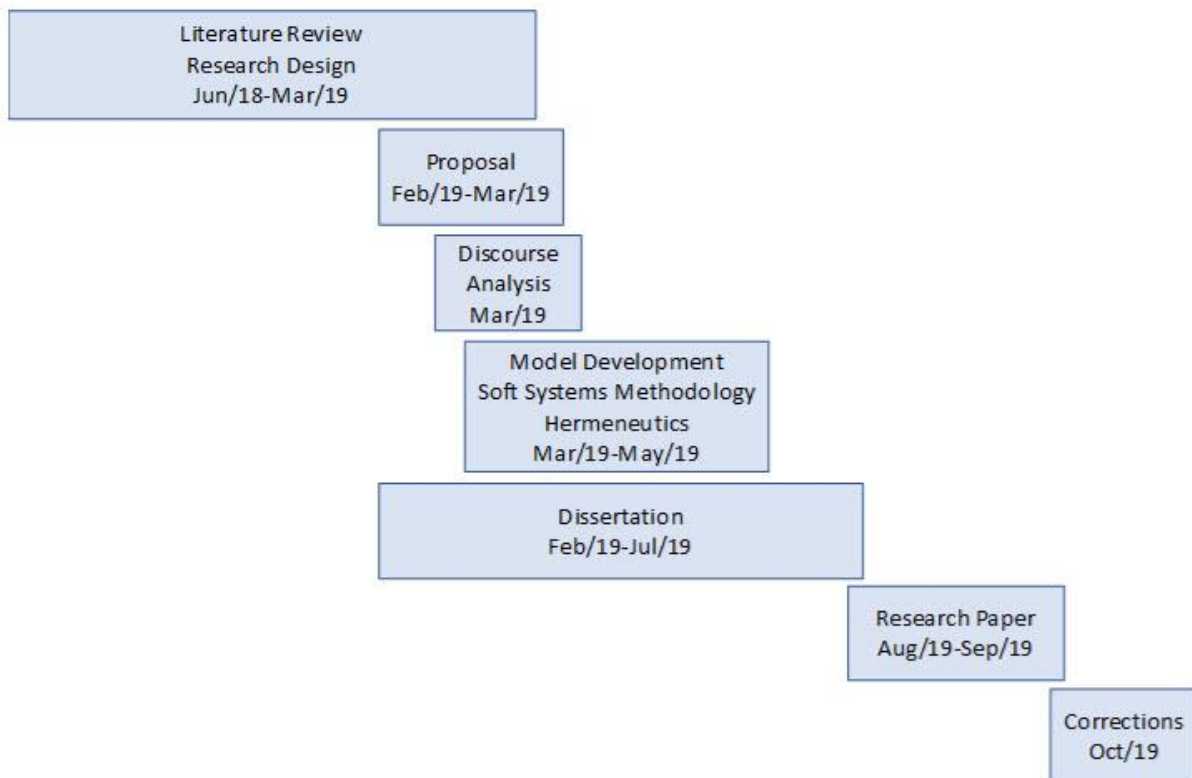
Examination process: July - September 2019

Examination outcome: by 4 October 2019

Corrections: by 21 October 2019

Graduation: December 2019

### 1.6.2 Gantt Chart



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## **2. LITERATURE REVIEW**

### **2.1 Roadmap to This Chapter**

The literature review covers the development of philosophy of work through pre-modern, modern, postmodern and integral eras leading to the definition of my project, to develop a model that transcends disciplined work and caters for working on problems that are beyond the scope of a discipline, underpinned by constructs from the philosophy.

### **2.2 Introduction**

A critical synthesis of philosophy yields a picture of the changing living conditions and ways of thinking that impacted how society has been organised and the ways we work as new philosophies have been developed. It reveals the development of our thinking from absolutistic, to idealistic, to realistic, to critical, to relativistic, to systemic, to holistic thinking. With these different ways of thinking we have progressed to focus on different disciplines, from religion, to philosophy, to science and technology, to social sciences, to information sciences.

Life conditions and societal structure in our own time have resulted in the sustainable development goals adopted by the United Nations. These goals are beyond the scope of a discipline, and the academic literature of transdisciplinarity is reviewed, which yields a picture of transdisciplinarity as a project in progress.

Whilst life conditions have produced problems that are beyond the scope of a discipline, critical realist and integral philosophies have developed to accommodate levels of reality. This is fortuitous as transdisciplinary problems require this kind of philosophy. I will use this philosophy to develop my model, which will be limited to interdisciplinary work. With systemic thinking the model can be viewed as a system of disciplines, whilst with holistic thinking, each discipline is a component holon in a holarchy of holons (Koestler, 1967).

Plato demonstrates the development of our thinking from absolutistic to idealistic thinking. Aristotle demonstrates the development of our thinking from idealistic to realistic thinking. Descartes demonstrates the development of our thinking from realistic to critical thinking. Locke shows how we have to give up revered positions in order to progress. Since his time classic liberals have been known for facilitating progress. It is through developing that the grounds for our current philosophy were laid. Habermas demonstrates the development of our thinking from critical to relativistic thinking. Bhaskar and Wilber looked at the conflicts between critical thinking and relativistic thinking and demonstrated the development of systemic and holistic thinking with philosophies that include levels of reality and the holistic inclusion of

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subjective, objective, inter-subjective and inter-objective perspectives. Bhaskar investigated what the world must be like for scientific activity to be possible (1987:6). His method then was to design experiments which will activate the underlying mechanisms of reality, whether in natural science or in social science.

## **2.3 Philosophy**

### **2.3.1 Pre-modern Philosophy**

#### ***2.3.1.1 Plato***

Plato discusses individuals and their work in the city state in his philosophical dialogue 'The Republic,' originally fourth century BC, re-published (Plato, 1955). Since individuals have differences in aptitude, but mutual need, they gather into society. The society enables them to benefit from others where they are weak, and contribute to others where they are strong, so society is mutually beneficial to citizens. Productive quantity as well as quality are highest when a man specialises in an occupation for which he is naturally fitted. The community will grow to accommodate the specialists, as people will not be doing everything themselves. Furthermore, a state cannot always produce everything itself, and needs to import goods, so the community also needs people in the import-export business such as ship owners. These ships will need to export goods on the outward journey and import goods on the return journey. From these considerations Plato sees the need for producers, merchants, sailors, retailers and labourers, but also a defence force.

Plato had experienced war and oppression of people. A good leader who acted in the interest of the people might be defeated and the victors act in self-interest and use their strength to oppress the people. In addition, a problem with democracy is that simple people with a vote lacked the proper knowledge to vote wisely and might simply vote for the strongest. A state which was a power hierarchy with the strongest dominators in charge was often oppressive of anyone not in power, so it was only good for a few at the top.

He used dialogue or conversation, typically starring Socrates, to set out the philosophical ideas. Socrates claimed ignorance and sought to get knowledge through the method of questions and answers and questioning the answers in order to get better answers. The idea is that the wisest man assumes he doesn't know the answer and therefore seeks it out, and this is how he becomes so wise. He is humble and learns from others. Plato founded the first university in Europe, the Academy, and the first curriculum, in order for philosophers to learn to rule or for rulers to learn to be philosophers, so that the government would be rational and for the greater good. Such a state would have a wise ruling tier, a second tier of protectors of the peace, police, soldiers and civil servants, and then a third tier of people in skilled work,

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providing food and material goods for everyone in the state. So, Plato's tiers of work were administration, security and production (guardians, auxiliaries and businessmen minding their own business). The wise at the top, the strong in the middle, and the skilled and productive at the bottom, with the auxiliaries like watchdogs and the rulers like shepherds. Justice in such a system was defined as minding your own business or dedicating yourself to your role and not interfering with others' roles. Plato's scheme of a hierarchy of occupations can be recognised in the hierarchy (tiers) of disciplines in transdisciplinarity (Max-Neef, 2005).

A prime factor in the education and training of individuals in Plato's scheme would be the training of character. The trained character of a man would ensure that he was not corrupted by power. Plato was idealistic in asserting that strength of character could be trained to overcome a base human nature. But in Plato's ideal state everybody had meaningful work and knew their place in such a state. All the people had an admirable and honourable identity as a wise administrator, a strong enforcer, or a productive and skilled professional. Plato thought it would be a good idea if everybody minded their own business. Just because this might never happen does not mean it is not a good idea.

'The state founded on natural principles is wise as a whole in virtue of the knowledge inherent in its smallest constituent part or class which exercises authority over the rest.' (Plato, 1955:132).

In addressing the functions of the state, the occupations of individuals, the university curriculum, the mind, the spirit and the body Plato dealt with politics, law, commerce, economics, technology, art, literature and education and he set the agenda for philosophy in this context. Philosophy would cover the ontology, epistemology, ethics and logic for this reality. Western philosophy has followed this agenda so closely down the ages to the current time that it has been called 'footnotes to Plato.'

Plato considered the form of things as a higher and deeper reality than the things themselves. For example, all dogs conform to the idea of Dog. The form of Dog is the unseen reality of the actual instance of the particular dog that is seen. There can also be forms of forms, for example forms of political systems (such as oligarchy, democracy and tyranny) conform to the form of Political System. A particular instance of a political system such as the democracy of Athens, conforms to the form of Democracy, which conforms to the form of Political System. All actual instances are imperfect, and for Plato the form was the perfect, and so the unseen reality of the form was higher and better than the imperfect actuality. This concept of the Form has formed the basis of the concept of a Class as a template for objects which are instantiated

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from the class later in the dissertation (section 3.11.4). The form or class is the 'one' perfect form or idea or type from which the 'many' actual instances are created.

### ***2.3.1.2 Aristotle***

Aristotle wrote lecture notes which have been preserved and later published as books. His works on natural science are about 'what is' whereas his work on ethics, the 'Nicomachean Ethics' (fourth century BC) is about 'what we should do' (Aristotle, 1955). Nicomachus was Aristotle's son, and the Nichomachean Ethics is Aristotle's advice to his son. Whilst Plato pointed upwards to unification, uniformity and unity, moving from the many to the one (from the actual to the underlying reality), Aristotle pointed downwards to the many and studied the actual (the many actual instances rather than the one conceptual class or form). This dichotomy of the one rational ideal world and the many empirical actual pragmatic worlds endures.

The idealistic asserts that by learning self-mastery reason can rule over the spirit and appetites, whereas the realistic asserts that it usually does not, and we have to deal with the actual unreasonable spirit and appetites that actually rule. He postulated the doctrine of the mean, which became known as the golden mean, which is not too much and not too little. This appears nowadays in 'Doughnut Economics' (Raworth, 2017) where the hole in the doughnut is too little (e.g. poverty), and the space beyond and outside the doughnut is too much (e.g. pollution), and the doughnut itself is the golden mean at which we aim. The classical 'golden rule' is to treat others as you would like to be treated yourself. Nowadays we have enhanced this and created the 'platinum rule' to treat others as they would like to be treated themselves. These are different in nature to Plato's 'mind your own business.' For Aristotle we ought to become good people, and aim at the best, happiness, and the mean. The best is the middle. The middle way avoids the extremes of too little and too much.

We can draw from Aristotle a one-dimensional line showing too little at the left, too much at the right, and the golden mean in the middle. For example, the auxiliary would need a golden mean of courage. Too little courage would make him a coward, but too much courage would make him reckless and both of these extremes should be avoided. Aristotle moves us away from the Platonic perfection of forms to the shades of grey of all actual instances, and the best will be the mean in the middle between black and white. This freed people from the unattainable ideal of perfection toward which one might aim but never achieve. Instead we should aim at the best. The best is not the ideal, but the middle way between extremes. Like

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all great philosophers he aimed at the liberation of actual people. Plato liberated us from the shadows of our perceptions and Aristotle liberated us from ideals.

For Aristotle the real was the actual world, peopled by actual instances of people. For Plato the real was the underlying reality that we cannot see because all we actually see is our imperfect perceptions of our imperfect world. For Plato if we want to 'get real' we improve ourselves in self-actualisation, moving away from the actual towards what is better, the ideal. For Aristotle if we want to 'get real' we deal with the actual and avoid unattainable ideals, becoming our best selves somewhere in the middle between too bad and too good.

Aristotle claimed, 'we occupy ourselves so that we may have leisure, just as we make war in order that we may be at peace' (Aristotle, 1955:329). In eastern philosophy we have yin that we may have yang (Max-Neef, 2005, Lao Tzu, 1995). We move from work to leisure and back, from war to peace and back, from yin to yang and back again. We move from too much into too little, and then grow towards too much, and then fall back into too little. This is illustrated in the Chinese yin-yang symbol.



We occupy ourselves so that we may have leisure. We have leisure so that we may occupy ourselves.

For Aristotle, the difference between the leisure and the occupation is that what we do in leisure we do for its own sake. It gives us peace or joy or happiness or contentment. What we do in occupation is not done for itself alone, but as a means to an end, such as provision of necessities to live, or what we call earning a living. Whereas in noble leisure, such as the contemplation of the wise philosopher we are self-sufficient, and contemplate for its own sake, because nothing is gained from it apart from doing it. Alan Watts (2002) called this play, and that we are advised to find work that would be as enjoyable as play, so that we would do it for its own sake. We play the piano. We do not work the piano. So, Alan Watts chose philosophy as his work, and as a professor of philosophy entertained scads of youngsters with his engaging lectures, which he gave for the pleasure of doing it, in the 1960s.

## **2.3.2 Modern Philosophy**

### ***2.3.2.1 Descartes***

The one-dimensional golden mean between too little and too much is fine when we are examining only one dimension, but in real situations there may be two or three or more factors, that may vary between low and high values. These may be coordinated with each other on a

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two-dimensional grid or a three-dimensional cube. On a two-dimensional grid we can see how  $y$  varies with  $x$ . A two-dimensional grid gives us four quadrants. The quadrants differentiate high and low values of the  $x$  and  $y$  factors. For example, high or positive  $x$  and  $y$  are in the upper right quadrant, whilst low or negative  $x$  and  $y$  are in the lower left quadrant. Plato had said 'let no man enter the academy who has no geometry.' Descartes went into geometry and extended it to analytic geometry which every scholar now learns in school.

When thinking about how to go about philosophy, and approaching his invention of analytic geometry, Rene Descartes had this to say in the Discourse in Method (Descartes, 1649):

"I ought to seek some other Method, which comprehending the advantages of these, they might be exempt from their defects. And as the multitude of Laws often furnisheth excuses for vice; so, a State is fair better polic'd, when having but a few, they are very strictly observ'd therein: So, instead of the great many precepts whereof Logick is compos'd, I thought these four following would be sufficient for me, if I took but a firm and constant resolution not once to fail in the observation of them.

The first was, never to receive any thing for true, but what I evidently knew to be so; that's to say, Carefully, to avoid Precipitation and Prevention, and to admit nothing more into my judgment, but what should so clearly and distinctly present itself to my minde, that I could have no reason to doubt of it.

The second, to divide every One of these difficulties, which I was to examine into as many parcels as could be, and, as was requisite the better to resolve them.

The third, to lead my thoughts in order, beginning by the most simple objects, and the easiest to be known; to rise by little and little, as by steps, even to the knowledg of the most mixt; and even supposing an Order among those which naturally do not precede one the other.

And the last, to make everywhere such exact calculations, and such generall reviews, That I might be confident to have omitted Nothing."

In summary we have enough rules if we (1) look for evidence, (2) deconstruct into parts, and (3) order from simple to complex, and finally (4) be thorough to assure completeness so we know when we are truly done.

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Furthermore, to live as well as possible, Descartes formed a provisional moral code for himself, (1) Obey the law, and customs, and religion of my culture, in proper moderation, avoiding extremes. 'I would not simply believe but know what I believed.' (2) Be decisive in action after choosing an opinion, as if I was certain of the opinion (act as if). (3) Choose self-mastery rather than luck, developing good habits. (4) Review the occupations and choose the best. 'My methods give me complete satisfaction. Every day my method led me to discover truths that seemed to me to be quite important and not widely known. For nine years I was a spectator rather than an actor, concentrating, uprooting errors, to reach certainty.' He put aside his perceptions, the arguments of others, his beliefs and ideas and anything he might doubt, and found a basic truth he could not doubt 'I am thinking therefore I exist.'

### **2.3.2.2 Locke**

Plato had started out with a general dissatisfaction with the limitations of democracy and with its power to execute the wisest man he knew, Socrates. Locke too was dissatisfied, but this time with the limitations of contemporary philosophy in the 17<sup>th</sup> century. He wanted to clear it up. He wanted to investigate knowledge versus opinion. In 1690 he investigated what we understand in his 'Essay Concerning Human Understanding' (Locke, 1964). He started with Plato and Aristotle (classical philosophy) and created something new (modern philosophy).

Locke challenges Plato's theory of forms being innate. He sees them rather as a product of reason, in the following way (Locke, 1964). This is a key move from pre-modern to modern philosophy. Suppose we see a horse, we would directly have the idea of horse (the thing we see), and we can think of that image and know what we think without a word for it. Having perception and the idea are the same thing. We can give the idea the word 'horse' to stand for the idea. Later when we hear the word, we understand the meaning, and the meaning is the idea, and the idea is what we previously saw. We can say ideas are the meaning of words, but this is a second-hand idea created from the word, whereas the first-hand idea was when we saw the horse the first time (the perception). Since we can understand the meaning of the idea without the word, we do have knowledge without words. We know what we have seen. We haven't articulated it yet. When we use words, we understand the words as meaning the idea, and so then have knowledge from the meaning of the words. Locke says the new idea is the meaning of the words. This would be the second-hand idea. Locke says we don't have innate ideas (such as horse), we either see it or hear about it and then we have the idea. If we have the second-hand idea, somebody else's description, we take it on trust. If we have the experience then we have the idea first hand, and the first-hand idea takes precedence in our degree of certainty. The idea is the object of the understanding. Words are the sensible signs

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of ideas. The general and universal are not the actual, the word horse is an invention of the understanding, made for the use of the understanding, and is only a sign. Locke uses the word real but means actual, since horse is a real concept. The shape of a horse will be imperfectly imprinted on the mind by words. 'The sight of the animals doth it a thousand times better.' A picture paints a thousand words. The form or class is the 'one' perfect form or idea or type which is inferred from the 'many' actual instances.

Suppose a great philosopher like Aristotle had said 'what is, is' and 'it is impossible for the same thing to be and not to be.' We might think these reasonable ideas as they seem to be true. Furthermore, a great thinker has asserted them, so their truth is never called into question. But these ideas are not innate. We might never have these ideas ourselves. The fact that Aristotle's reason produced them does not make them innate, it makes them a product of reason. Locke says it is not that reason discovers the idea that was innate, but reason produces the idea. If we go back to geometry and our discovery of Pi then, it is not that the idea of Pi is innate, but it is produced by reason. Thus, Locke brings us into the modern world of reason, called the age of reason.

Aristotle called the basic proposition a maxim. It is the solid ground on which we build. Aristotle's maxim is called the principle of the excluded middle, because something is either one or the other and never something in-between. Locke calls maxims revered propositions. Locke turned out to be correct because in modern physics we found wave/particle duality where it seems we cannot say what is, is and we cannot say that it is impossible for it to be and not to be because the wave/particle turns out to be both. If we look for it as a wave, we find a wave. If we look for it as a particle, we find a particle. We cannot say what it is unless we look and then we only find what we are looking for. Transdisciplinarity takes this into account by having the principle of the included middle. We had to give up the revered proposition of the excluded middle (with apologies to Aristotle). The experience of the experiments on wave/particle duality gave us proof. Thus, all ideas come from sensation or reflection. Aristotle's classical idea of the excluded middle came from reflection (reason) and the modern idea of the included middle came from sensation (experience). Locke called these ideas the material of reason and knowledge. The material of reason can be wrong. We do the experiment to find out actual knowledge. We only get actual knowledge from experience. This is how we differentiate knowledge and opinion. When we dream our thinking is for the most part frivolous and irrational, which means that the soul owes the perfection of rational thinking to the body. That is to say the awake state with senses operational promotes our reflective thought. Consciousness is the perception of what passes.

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The qualities that affect our senses are in the things themselves united but our ideas of them via the senses are simple (perceptions). That is if something is warm and soft, we perceive warmth and softness separately and not united like in the soft warm thing itself. However, the understanding can unite the simple ideas and make something complex. Nevertheless, the understanding cannot make up a simple idea (perception). We are limited to our senses for these simple perceptions. We get the idea of solidity from touch. The impenetrability of solidity is perceived by touch. When we use more than one sense, we perceive space, extension, figure, rest and motion (sight and touch). These are primary qualities of the object perceived. Secondary qualities are qualities that we perceive but do not belong to the object, such as colour which depends on our eyes.

The simple ideas of reflection are perception and volition. We make complex ideas by combining simple ideas. We can also relate ideas without combining them. We can separate ideas from each other by abstraction. Creating the class of all dogs is to abstract the idea of dog from actual dogs. The abstraction is the 'general' idea.

Book 4 of the essay 'Of Knowledge and Opinion' says that knowledge is the perception of the agreement or disagreement of two ideas, and the agreement is fourfold (Locke, 1964:320). (1) Identity or diversity (the intuitive agreement or disagreement). (2) Relation (the relative nature of the ideas). (3) Co-existence (always occurs with them). (4) Real existence without the mind (not imaginary). We have intuitive knowledge which is direct perception of ideas immediately by themselves, as the eyes see light, without proof. All the certainty and evidence of all our knowledge depends on intuition. If perception is not immediate, we can use reasoning to demonstrate knowledge through proofs. Each step of demonstration, if understood, become intuitive knowledge i.e. the step is directly perceived intuitively. The demonstration makes each step clear to immediate perception. Knowledge cannot extend further than ideas. Knowledge is perceived. Perception can be by intuition (immediately present), reasoning (present but not immediately grasped, takes thought) or sensation (present to senses).

### ***2.3.2.3 Kant***

Kant, writing in the 1790s, produced critical philosophy for the age of enlightenment (Kant, 2008). The Categorical Imperative is the moral law proposed by Kant, to act towards others as you would want others to act towards all people, as if it was a universal law. We do not want to be treated as means-to-an-end, but as an end-in-itself. So, we can see that Kant's Categorical Imperative has a direct impact on any organization working with people, such as churches, corporations and governments. 'Act in such a way that you always treat humanity,

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whether in your own person or in the person of any other, never simply as a means, but always at the same time as an end.'

Pre-modern societies assumed social norms were valid, but modernity introduced critique, questioned the validity of norms, and reasoned about whether they were right, just, or true. Kant showed through critique that the norm (treat people as resources) was not valid because people are ends in themselves rather than means to an end. Thus, Kant identified a 'kingdom of ends.'

Kant proposed that we behave 'as if' there was a moral law to behave the way we would like people to behave. This was a liberating notion for people because when we doubt there is a morality and are uncertain of what to do, we can proceed 'as if' there is a moral law, and this gives us clear direction of what to do.

#### ***2.3.2.4 Hegel***

You can assert a thesis, but equally you can propose an opposing antithesis, and this contradiction can be resolved through synthesis, which is at a higher level. Einstein thought in a similar way, proposing that problems cannot be solved at the level of thinking that created them, but can be solved at a higher level (synthesis). The proposal of a thesis and antithesis is dialectical (takes multiple perspectives). The solution in synthesis is another perspective, and because it takes into account other perspectives is itself therefore a higher-level perspective. Thus, whilst all perspectives have validity, they are not all equal. Hegel leads from personal rights to the family and the state and sees that to the extent the family and the state are integral to us, we are thereby oriented to doing our duty as self-interest, but this makes us ethical citizens and members of family and society, not simply self-interested individuals.

### **2.3.3 Postmodern Philosophy**

#### ***2.3.3.1 Habermas***

Writing in 1962 Habermas discusses the shift from the literary public sphere to the bourgeois public sphere of Marx, followed by the integration of the public sphere into the welfare state, which he referred to as the 'Structural Transformation of the Public Sphere' (Habermas, 1991). However, it is more rational to solve problems and resolve issues through discourse than through the power and conflict of the state with the private sphere. Rationalism doesn't have to be limited to strategic conflict or Darwinian competition of survival of the fittest. Reasoning is thinking in language. The discourse will not be limited to stating facts, but will include dialogue and argument, so as to have communicative action and coordination. The modern

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approach had been 'I'm right, you're wrong,' whereas the postmodern pluralist approach was 'We're all partially right (and partially wrong) in our different perspectives.' Science (the focus of modernity) had looked for the purely right or wrong, but social science (the focus of postmodernity) has to live with the partial validity of multiple perspectives, so science is on an empirical level, but social science is more pragmatic and normative. In spiral dynamics terms (Beck and Cowan, 1996) postmodernity was pluralistic in its thinking (the green value meme).

Habermas described the existing situation as the system. So, the conflict of capitalism and labour would be the system. In contradistinction to the system, the capitalist and the labourer each have their own lifeworld or worldview, and conflict can be resolved by taking into account the different worldviews or perspectives through discourse. This would be similar to Hegel's dialectical thinking, taking into account thesis and antithesis and then seeking resolution through synthesis.

Habermas discussed the interpretation of texts (hermeneutics) as a way we further communication. We read books and form interpretations of what is being said. We talk about what the books mean. This allows us to take things forward. This is what we have been doing since Plato, and which gives western philosophy the reputation as 'footnotes to Plato.' Like all good philosophers, Habermas was working for liberation of people, for love of wisdom, for progress. Modernity had been given a bad name because nationalism and socialism and the associated wars had arisen in modernity. This should be balanced against the good in modernity, such as progress in science, medicine, psychology and so on. We shouldn't have any systematic distortion in our reading and interpreting texts and only see one side and condemn it accordingly. This counters postmodernism which was an attempt at systematic distortion of modernism in order to break it down. It is important to have an engaged public sphere and to provide balancing discussion and counter-viewpoints so that we don't get systematic distortion or oppression from one side.

It is a problem when the public sphere and the state become entwined because critical debate is quashed, for example left wing democrats in the majority in the public sphere and government might no longer allow the free speech of the right wing and so we get a systematic distortion toward the left, or *vice versa*. Listening to the left and the right provides a more balanced center. Habermas indicated that the exclusion of any particular group would be destructive of the public sphere.

Typically, the ruling ideas in a society would be the ideas of the ruling class and might exclude certain groups. Groups such as the poor or women or migrants, which may not be in the ruling

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class, need voices (rather than representatives) in the public sphere. Habermas was writing in the 1960s. We need to ensure we keep a public sphere between the private sphere and the state. When it comes to getting undistorted communications and a full understanding of what is communicated, we will need certain conditions. For example, everyone should get a chance to speak and to be listened to, to ask questions and to get answers. So, we don't always have one side commanding and one side obeying commands, such as you get in pathological dominator hierarchies, which are systematic distortions. Dialogue means both ways, rather than one-way monologue. When communication is open and undistorted by power relations you can convince me with your argument, but you can't force me by command. Thus, Habermas was bringing back the rational solution of conflict through discourse in the aftermath of the violent solutions of World War, as Plato had done in his time. Habermas' method for obtaining intersubjective mutuality through shared knowledge, trust and mutual accord was stated eloquently by Wilber (1995) as follows: 'the height of communication is the rational intersubjective exchange of uncoerced mutual understanding.'

Habermas had this to say in the Theory of Communicative Action (Habermas, 1987:212):

'Locke lays claim to a practical reason that forbids us to follow only imperatives of purposive rationality in rationally pursuing our own interests. He already conceives of the state of nature from the perspective of the intersubjective validity of a natural right to a rational pursuit of one's own interests. The right of each to behave in this way is limited by the fact that from the start everyone else also has the same right. It includes the recognition that all men are equal and independent and that they have a reciprocal obligation to recognise each other's rights and thus take upon themselves sacrifices of their own immediate interests.'

We can see that it is rational to pursue self-interests and to limit pursuit of self-interests to the extent that all others have the same right. If they didn't have the right, neither would we ourselves have that right.

Historically social action has been an idealist approach whilst social system has been a positivist approach (Habermas, 1987:201). Social action focuses on meaning and social systems focus on consequences. Habermas integrated them by describing society as a stabilised system of the actions of integrated groups, needing action theory and systems theory. This integrative approach leads us to the systemic and holistic thinking of the integral era.

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## 2.3.4 Integral Philosophy

### 2.3.4.1 Bhaskar

Metaphysics has two branches, ontology and epistemology. Ontology is the study of the nature of being or existing. Epistemology is the study of the nature of knowing or knowledge. The existence of something and our knowing about it are differentiated.

Philosophers study the nature of reality and debate whether reality is what exists or what we know or both or neither. If we say reality is what exists, then it is ontological. If we say reality is what we know then it is epistemological. What we know is ideas, and if everything is about ideas, we have types of idealism. Any 'ism' is the extreme case, so idealism is the extreme or unrealistic attachment to ideas (alone). For example, we say a person is idealistic when seeking the perfect rather than the adequate. The realist says perfection is not something that exists, but just an idea, and that seeking that ideal is unrealistic. If we say that ideas of forms are real, and not the objects themselves, we have a type of idealism. Realism is the extreme case of being realistic to the extent that all ideas are eliminated and only the object itself is real and not the ideas about it. This is reductionistic. Just as Descartes was reductionistic in creating his method. We reduce everything to objects. If we have realism at one end of a spectrum (only objects exist) and idealism at the other end (only ideas exist) then there is a range of cases between these two ends that are more or less realistic or idealistic. In modern use realistic means accepting what exists and dealing with it. Idealistic means not simply accepting what exists as the only possibility but working towards something better by changing what exists because it is not good enough. Realists think idealists are unrealistically optimistic aiming for the unachievable. Idealists think realists are unrealistically pessimistic accepting what is and not working for improvement.

Empirical observation, actual existence and underlying mechanisms of reality are three layers in the philosophy of critical realism. In the empirical domain there is the experience. In the actual domain there is the event and possibly the experience of it. In the real domain there is the mechanism that makes the event and experience possible. Thus, the causative mechanism is in the real domain rather than the actual domain. You don't see the mechanism, you only see the actual result of the mechanism. The mechanisms actualise the outcome. This is what happens in an experiment for example. Mechanisms must be activated to realise actual outcomes, but if they are not activated it does not mean they do not exist. The experiment will need to create the conditions to activate the mechanism to actualise the outcome to demonstrate the mechanism. Bhaskar added a fourth layer called structure (1987). Structure provides for the society or structure of the collective who have community, which is

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differentiated from the individual who has agency. The individual scientist with agency executes empirical observations and gains knowledge but this is not automatically accepted in the community. There are structural obstacles. The structure of society imposes constraints. Through agency and communion, we can get the ideas accepted into the community. Agency can produce transformative practice. Thus, agents such as scientists and engineers do not have to accept a lesser role than causing transformation in society. Mechanisms in social science will be different to mechanisms in science. If we activate mechanisms in social science, we actualise social events. The constructs (soft, non-linear concepts) in social science are more complex than the variables (hard, linear concepts) in science and the outcomes are far less predictable.

Roy Bhaskar's vision behind creating the philosophy of critical realism was to have an adequate realist philosophy of science, social science and critique. He took positivism (an empirical realism) and constructivism (a transcendental idealism) as being the two extreme ends and created critical realism as a golden mean between them, as a reaction to the deconstruction project of postmodernism. Crucial constructs in critical realism are difference, change and layering. Thinking about change and ethics moves us into dialectical critical realism.

If we apply critical realism to a social science like economics or education, the idea will be to find and explain the mechanisms (the causal reality layer in social ontology) that underlie the observed events (the actual) in the economy or in the classroom.

Science and philosophy have their own domains. 'For just as there can be no discourse on method in abstraction from the sciences, so there can be no science in abstraction from the possibility of a critical discussion of its method' (Bhaskar, 1987:19). You won't be able to scientifically investigate such a possibility, but you can do so philosophically. It is a critical part of the model that the disciplines are required. Something is lost if science is dropped, and something else is lost if philosophy is dropped.

#### ***2.3.4.2 Wilber***

Intuition is immediate perception (not reasoned, and not yet articulated). Holism is going to take into account both rational and intuitive approaches because holism allows all dimensions. Rationalism allows only the rational and denies both the pre-rational and the trans-rational, so it is not holistic. First tier approaches like rationalism and pluralism tend to adopt only their

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own worldview and think that other worldviews are wrong. Second tier approaches assume everybody is right, everybody has a valid contribution, and that these must be partial, so it is valid to allow all of them to get a fuller, more complete picture. Resolving the contradictions between the first-tier world views will simply be a matter of a higher level, second tier synthesis. In the course of development during an individual lifetime a person might, as a child, believe in Father Christmas, and as a teenager, not believe in Father Christmas, and as an adult, become Father Christmas for his children, and finally in old age, look like Father Christmas, with a long white beard. Father Christmas must be, in some sense, true, through belief, or through acting out belief, it becomes part of life. Pre-rational, rational and trans-rational worldviews come into being through development, in societies through history, and even in a single person in a lifetime. It is no use lamenting pre-modern societies that coexist with modern societies and saying that they are invalid or unacceptable in a modern world. It is no use saying that the childish view of a child is invalid. We have to live with them, acknowledge them, and even embrace them in a holistic embrace. Everybody starts at square one and develops through life (or stops developing at any point), and even if we somehow got all adults to a high level of development, new children are born every day at square one and so we always have to cater for all levels (Wilber, 1995). But at the same time as we embrace lower pre-rational levels, we embrace the higher levels of development, the rational modern, pluralistic postmodern and the transrational integral worldviews, we do not deny them for the benefit of the pre-rational pre-modern. In the reverse direction children often enhance the lives of adults by contributing joie de vivre or wonderful curiosity or innocence of expression.

At present, because it is the first time in history that all these levels are coexisting, we have pre-modern cultures complaining about the abuse they received in the past from modern cultures which they call supreme and imperial, and we have the postmoderns apologising for the moderns of the past saying they are not superior and that everybody is equal in a multicultural society. Now we have the integral culture arising which sees that you never get modern before pre-modern, or postmodern before modern, or integral before postmodern. This means that there is a development sequence. If there is development, then there are levels of development, and higher levels are indeed higher than lower levels. So, whilst we might regret the bad, we also celebrate the good at every level of development. We don't say they are all equal, but that each level has its shadow, as well as its bright side. It is no use wishing there was no shadow or dark side. The integral worldview accepts the dark side and the bright side of all the levels for the simple reason that they are there, and we have to take them into account in any kind of comprehensive worldview. Modernity may have brought evils like nationalist socialist regimes, but it also brought effective medicines and efficient transport.

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Postmodernity may have brought goods like universal care, but it also brought a shadow side of political correctness and intrusive monitoring and evaluation in social media.

In examining what it is that includes everything we know, integral philosophy sees quadrants, lines, levels, states and types. These five factors cover what we know in the integral worldview.

The quadrants in the integral worldview cater for objective, subjective, inter-objective and inter-subjective factors. In history we emphasized one or other quadrant at particular times. In the pre-modern era, we emphasized a subjective worldview, and in the modern era an objective worldview, and in the post-modern era an inter-subjective worldview, and in the integral era all the quadrants including inter-objective systems theory (the fourth quadrant). Systems thinking in the fourth quadrant is integral. Systems thinking is the fifth discipline in Peter Senge's learning organization (1990). We see systems theory and chaos theory appearing in the integrative worldview of the yellow value meme in spiral dynamics (Beck and Cowan, 1996).

The lines cover factors that can develop, such as morality and cognition. The levels cater for stages of development, for example in moral development we have egocentric selfishness (care for ourselves), ethnocentric care (for our group), and world-centric care (for all-of-us), and in cognitive development we have sensorimotor, pre-operational, concrete operational and formal operational levels. Wilber (1995) points out that Carol Gilligan documented these levels of moral development in her work on feminism, to show that caring is not female, but human, and is developmental, whilst Jean Piaget documented the levels of cognitive development in his study of child development.

The states cover the fact that we have different states of consciousness, and that these do not develop. We all enjoy states of waking, sleeping and dreaming for example, even as infants.

Finally, the types cover all the different types that we need to take into account, such as personality types, genders and so on. Types are typically fixed for the life of an individual. We don't develop into different personality types or develop from male to female for example. We live with the type that we are (or we rail against it).

Looking back at the history of philosophy we see beauty, truth and goodness was already present in the philosophy of Plato and Aristotle in the pre-modern era. These map to the subjective, objective and inter-subjective quadrants respectively. The fourth inter-objective

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quadrant received serious study in the twentieth century with systems theory and technological networks. The lines and levels of development and states of consciousness were thoroughly studied in the twentieth century, mostly in psychology, neuro-science and philosophy.

#### ***2.3.4.2.1 Validity Claims***

The validity claims of the four quadrants (Habermas, 1984, Wilber, 1995) are

- **truth** by empirical correspondence (in the first quadrant / third person / it / objective)
- **truthfulness** (in the second quadrant / first person singular / I / subjective)
- **justice** (in the third quadrant / first person plural / we / inter-subjective)
- **functional fit** (fourth quadrant / third person plural / 'its' or they / inter-objective)

In other words when we want to check out the validity of phenomena

- we validate whether 'It' is objectively true (or false)
- we validate whether 'I' am truthful (or lying)
- we validate whether 'We' are just (or unjust)
- we validate whether 'Its' have functional fit ('does this work?')

Integral philosophy holds a holistic worldview, which is in the turquoise value meme in spiral dynamics (Beck and Cowan, 1996). Whilst Plato thought reality was made of ideas, and Aristotle thought reality was made of things, holism says that reality is not made of processes or things, nor is it a whole composed of parts. Holism asserts that reality is composed of holons. Atoms, cells, people, symbols, ideas, disciplines are all holons. Holons are wholes in themselves, as well as parts of other holons. Atoms are parts of molecules, which are parts of cells, which are parts of people, but atoms are at all times atoms as wholes in themselves. The discipline of mathematics is at all times mathematics, though it can be part of science which can be part of the whole knowledge base.

#### ***2.3.4.2.2 Tenets of Holistic Philosophy***

I will end my review of philosophy with the tenets of holistic philosophy, summarised from (Smuts, 1926:132-147), (Koestler, 1967:45-70), (Wilber, 1995:17-21, 35-78), (Jantsch, 1980:75). Holism transcends idealism and realism and includes them as parts, so a holistic worldview is higher than an idealistic or realistic worldview and describes it through holons. Higher developments always come after lower developments. You never get a high development appearing first. This is how we decide whether it is higher. You never get holism before idealism. Holism is never part of idealism. Holism is not just different to idealism. Holism includes and transcends idealism. The tenets are as follows.

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1. Reality is composed of holons (wholes which are also parts).
  2. Holons have the capacities of
    - a. Self-preservation (they remain individuals in any context, they have agency)
    - b. Self-adaptation (they accommodate themselves; they have communion)
    - c. Self-transcendence (they become part of a greater holon)
    - d. Self-dissolution (holons breakdown in the reverse sequence of building up)
  3. Holons emerge (e.g. quarks, atoms, molecules, cells ...). Emergence produces layers.
  4. Holons emerge holarchically (as a hierarchy of component holons). Hierarchy is a natural emergence, not a socially constructed concept.
  5. Holons transcend and include predecessors (e.g. molecules include atoms).
  6. The lower sets the possibilities of the higher; the higher sets the probabilities of the lower. (the higher is only possible through the lower parts; the lower can only do what it is constrained to do as a part, so for example hydrogen behaves as constrained by water when it is part of a water molecule even though it is hydrogen).
  7. Depth is the number of levels in a holon (for example a cell is made of atoms (at say level 1), molecules (level 2), organelles (level 3) etc. Whereas 'span' is the number of holons at a level.
  8. Each level has greater depth but lower span than the previous level (e.g. there are always more atoms than molecules, because the atoms in molecules still count as atoms, they don't disintegrate when becoming part of molecules).
  9. When a holon is destroyed, all holons above it are destroyed, but no holon below it is destroyed (e.g. if you break apart molecules you destroy cells, but not atoms).
  10. Holarchies coevolve (holons do not evolve alone, and never exist alone).
  11. The micro and the macro relate at all levels (for example people made of matter, life and mind relate physically, biologically and psychologically).
  12. Evolution has directionality (things get more complex with levels of development e.g. atoms to molecules to cells). See for example, 'The Self-Organising Universe' (Jantsch, 1980:75) 'the evolution of the universe is the history of an unfolding of differentiated order or complexity.' This tenet is not about Darwin's theory.

From this we can see that the twenty-first century holistic turquoise endeavour can only proceed because it contains postmodern green pluralism, modern orange rationalism and pre-modern blue traditionalism, and we cannot simply get rid of the traditional or the rational and still be holistic. In fact if we get rid of blue, we destroy orange and green and yellow and turquoise, as described explicitly by tenet 9, and implied by tenet 5. So being holistic does not mean we are no longer rational. It means we are rational and trans-rational and pre-rational and must take them all into account. The colours refer to the value memes of Spiral Dynamics

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which are based on Clare Graves model of bio-psycho-social development, as presented by management consultants (Beck and Cowan, 1996).

If we deconstruct a holon into its parts, and order from simple to complex we can construct a Holarchy from Holons. For evidence we look for examples. For completeness we go all the way down, and all the way up, seeing holons as parts at every level. These are the four rules of Descartes method.

### **2.3.5 Constructs taken from the Philosophy for use in the Model**

I now examine the above review of philosophy, and highlight how the existing disciplinary view was created, and the constructs that will be useful to a way of working on problems that are beyond the scope of a discipline.

From Plato:

1. The creation of the academy for the purpose of educating wise leaders.
2. The university disciplines: politics, law, commerce, economics, technology, art, literature and education.
3. The Platonic Form (the basis of the concept of a Class as a template for any form of object (section 3.11.4)).
4. The functions of the state.
5. The occupations of individuals.
6. The agenda for philosophy, in ontology, epistemology, ethics and logic (so called 'footnotes to Plato').

From Aristotle:

1. The doctrine of the mean, which became known as the 'golden mean,' which is not too much and not too little.
2. The classical 'golden rule' to treat others as you would like to be treated yourself. Nowadays we have enhanced this and created the 'platinum rule' to treat others as they would like to be treated themselves. These are different in nature to Plato's 'mind your own business.' For Aristotle we ought to become good people, and aim at the best, happiness, and the mean. The best is the middle. The middle way avoids the extremes of too little and too much.
3. The reality of the actual world peopled by actual instances of people (rather than the Platonic underlying unseen form of reality).

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From Descartes:

1. The reductionist approach and the scientific method. We have enough rules if we (1) look for evidence, (2) deconstruct into parts, and (3) order from simple to complex, and finally (4) be thorough to assure completeness so we know when we are truly done.
2. A provisional moral code, (1) Obey the law, and customs, and religion of my culture, in proper moderation, avoiding extremes. 'I would not simply believe but know what I believed.' (2) Be decisive in action after choosing an opinion, as if I was certain of the opinion (act as if). (3) Choose self-mastery rather than luck, developing good habits. (4) Review the occupations and choose the best.
3. The 'Cartesian grid' and analytic geometry.

From Locke we get the modern critique.

1. A critique of Plato. Locke realized that ideas are not innate. He rationalised Platonic Forms as products of reason. This is a key move from pre-modern to modern philosophy.
2. A critique of Aristotle. Aristotle called the basic proposition a maxim. It is the solid ground on which we build. Aristotle's maxim is called the principle of the excluded middle, because something is either one thing or the other and never something in-between. Locke calls maxims revered propositions. Locke turned out to be correct because in modern physics we found wave/particle duality where it seems we cannot say what is, is and we cannot say that it is impossible for it to be and not to be because the wave/particle turns out to be both. If we look for it as a wave, we find a wave. If we look for it as a particle, we find a particle. We cannot say what it is unless we look and then we only find what we are looking for. Transdisciplinarity takes this into account by having the principle of the included middle. We had to give up the revered proposition of the excluded middle (with apologies to Aristotle). The experience of the experiments on wave/particle duality gave us proof.
3. All ideas come from sensation or reflection.
4. Ideas are the material of reason and knowledge. The material of reason can be wrong. We do the experiment to find out actual knowledge. We only get actual knowledge from experience. This is how we differentiate knowledge and opinion.
5. Consciousness is the perception of what passes.
6. The simple ideas of reflection are perception and volition. We make complex ideas by combining simple ideas.
7. We can also relate ideas without combining them.
8. We can separate ideas from each other by abstraction.

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9. Knowledge is the perception of the agreement or disagreement of two ideas, and the agreement is fourfold (Locke, 1964:320). (1) Identity or diversity (the intuitive agreement or disagreement). (2) Relation (the relative nature of the ideas). (3) Co-existence (always occurs with them). (4) Real existence without the mind (not imaginary). We have intuitive knowledge which is direct perception of ideas immediately by themselves, as the eyes see light, without proof. All the certainty and evidence of all our knowledge depends on intuition.
  10. If perception is not immediate, we can use reasoning to demonstrate knowledge through proofs. Each step of demonstration, if understood, become intuitive knowledge i.e. the step is directly perceived intuitively. The demonstration makes each step clear to immediate perception.
  11. Knowledge cannot extend further than ideas.
  12. Knowledge is perceived.
  13. Perception can be by
    - a. intuition (immediately present),
    - b. reasoning (present but not immediately grasped, takes thought) or
    - c. sensation (present to senses).

From Kant:

1. A modern ethics. Kant's Categorical Imperative has a direct impact on any organization working with people, such as churches, corporations and governments. Corporations which wish to treat people as human resources, and governments which wish to treat people as a workforce and a tax base have an orientation towards treating humanity as a means, and this is unenlightened or pre-modern.
2. Pre-modern societies assumed social norms were valid, but modernity introduced critique, questioned the validity of norms, and reasoned about whether they were right, just, or true. Kant showed through critique that the norm (treat people as resources) was not valid because people are ends in themselves rather than means to an end. Thus, Kant identified a 'kingdom of ends.'
3. These concepts of objective resources (things) and subjective resources (resourcefulness, intellect, understanding) taken from Kant are used in the model.

From Habermas:

1. The height of communication is the rational inter-subjective exchange of uncoerced mutual understanding. This premise is a fundamental requirement of the participants in interdisciplinary research using the model.
2. The Validity Claims (Habermas, 1984).

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3. We can see that it is rational to pursue self-interests and to limit pursuit of self-interests to the extent that all others have the same right. If they didn't have the right, neither would we ourselves have that right.

From Bhaskar:

1. There are layers of reality.
  - a. Empirical observation.
  - b. Actual existence.
  - c. Underlying mechanisms of reality.
2. Structure provides for society or the collective, who have community, which is differentiated from the individual who has agency, and which imposes on individuals.
3. Mechanisms must be activated to realise actual outcomes, but if they are not activated it does not mean they do not exist. The experiment will need to create the conditions to activate the mechanism to actualise the outcome to demonstrate the mechanism.
4. The individual scientist with agency executes empirical observations and gains knowledge but this is not automatically accepted in the community. There are structural obstacles. The structure of society imposes constraints. Through agency and communion, we can get the ideas accepted into the community.
5. Agency can produce transformative practice. Thus, agents such as scientists and engineers do not have to accept a lesser role than causing transformation in society.
6. Mechanisms in social science will be different to mechanisms in science. If we activate mechanisms in social science, we actualise social events. The constructs (soft, non-linear concepts) in social science are more complex than the variables (hard, linear concepts) in science and the outcomes are far less predictable.
7. Bhaskar provides a vision of an adequate realist philosophy of science, social science and critique. He took positivism (an empirical realism) and constructivism (a transcendental idealism) as being the two extreme ends and created critical realism as a golden mean between them, as a reaction to the deconstruction project of postmodernism.
8. If we apply critical realism to a social science like economics or education, the idea will be to find and explain the mechanisms (the causal reality layer in social ontology) that underlie the observed events (the actual) in the economy or in the classroom.
9. If we apply critical realism to creating work, the idea will be to find and explain the mechanisms (the causal reality layer in social ontology) that underlie the observed situation of too few jobs, no growth, and loss of existing jobs. The mechanisms currently at work seem to be aimed at reducing work rather than creating it. Why would this be? It may be that work is considered as a negative, as a cost, and something to

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be reduced. Work may be on the negative side of the balance sheet in business. What about in education? The phenomenon of faculty falling to the administration may be the implementation of a business philosophy in the academy, as discussed by Habermas.

10. Science and philosophy have their own domains. It is a critical part of the model that disciplines are required. Something is lost if science is dropped, and something else is lost if philosophy is dropped. And by implication, the other disciplines. Furthermore, to go beyond a discipline in any way (multidisciplinary, interdisciplinary, transdisciplinary), requires the disciplines.

If in any society there are adults at all levels of development and we have a sustainable development goal where we want to have work for all men and women, we will need work for all levels of development. Our orientation cannot be simply catering for the fourth industrial revolution, in information technology, biotechnology, nanotechnology, internet-of-things, robotics, quantum computing and so on. We also need pluralistic caring, rationalistic business management, physical mining, agriculture and traditional horticulture. The integral worldview is holistic, taking into account everything we know.

From Wilber we take:

1. Quadrants, lines, levels, states and types. These five factors cover what we know in the integral worldview. The model uses quadrants, levels and lines but doesn't place any emphasis on states and types (which are non-developmental).
2. The quadrants in the integral worldview cater for objective, subjective, inter-objective and inter-subjective factors. In history we emphasized one or other quadrant at particular times. In the pre-modern era, we emphasized a subjective worldview, and in the modern era an objective worldview, and in the post-modern era an inter-subjective worldview, and in the integral era all the quadrants including inter-objective systems theory (the fourth quadrant). Systems thinking in the fourth quadrant is integral. Systems thinking is the fifth discipline in Peter Senge's learning organization (1990). We see systems theory and chaos theory appearing in the integrative worldview of the yellow value meme in spiral dynamics.
3. The lines cover factors that can develop, such as morality and cognition. The levels cater for stages of development, for example in moral development we have egocentric selfishness (care for ourselves), ethnocentric care (for our group), and world-centric care (for all-of-us), and in cognitive development we have sensorimotor, pre-operational, concrete operational and formal operational levels. Carol Gilligan documented these levels of moral development in her work on feminism, to show that

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caring is not female, but human, and is developmental. Jean Piaget documented the levels of cognitive development in his study of child development.

4. The states cover the fact that we have different states of consciousness, and that these do not develop. We all enjoy states of waking, sleeping and dreaming for example, even as infants.
5. The types cover all the different types that we need to take into account, such as personality types, genders and so on. Types are typically fixed for the life of an individual. We don't develop into different personality types or develop from male to female for example. We live with the type that we are (or we rail against it).
6. The validity claims and the tenets of holistic philosophy.
7. Beauty, truth and goodness (three types central to Plato) map to the subjective, objective and inter-subjective quadrants respectively. The fourth inter-objective quadrant received serious study in the twentieth century with systems theory and technological networks. The lines and levels of development and states of consciousness were thoroughly studied in the twentieth century, mostly in psychology, neuro-science and philosophy.

If we deconstruct a holon into its parts, and order from simple to complex we can construct a Holarchy from Holons. For evidence we look for examples. For completeness we go all the way down, and all the way up, seeing holons as parts at every level. These are the four rules of Descartes method.

We expect to see Habermas and Wilber feature in the next generation, which will take equal communications and multiple perspectives as normal, and so a model of disciplines which communicate different perspectives into solving problems beyond the scope of a discipline might elicit the perception, in the coming generation 'Of course, wasn't it always like this?'

In modern engineering we put together ideas and things, so we don't promote idealism (only ideas) or realism (only things). Engineers design and build structures. The idea is to create something new and useful. Engineers want to create something that is reliable and durable. Creating something new could be idealistic as it is a change that is hopefully for the better. Creating something reliable and durable is being realistic. We deal with the maths and physics so that the structure will stand up in reality and not fall down. So, a practical art like engineering deals with ideas and objects. A civil engineer may consider the structure as more real than the maths. The maths is used to create the real structure. A software engineer may consider the software as more real than the algorithms. The algorithms are used to create the real software. But the maths and the algorithms are also known to be real because they work in

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producing the object. If the maths and algorithms did not exist, then the structure may fall down, and the software may not work. It is clear to engineers that ontology and epistemology are both parts of reality. We need the ideas and we need the objects we make with them. With ideas and physical parts, we make telephones. With ideas and physical parts, we make our built environment. With ideas and physical parts, we make our world. Parts of this world are constructed. We have cars and houses. We also have social constructions like norms of polite behaviour. If we have the idea of polite behaviour but do not implement it, we are rude. The rude reality is not the constructed reality. Thus, as an engineer, I will put together the philosophy and the systems engineering to create the model.

## **2.4 Transdisciplinarity**

I looked for the underlying philosophy of working beyond the scope of a discipline. I extracted constructs such as the sequence or continuum of development 'disciplinary, multidisciplinary, interdisciplinary, transdisciplinary,' and the 'tiers' of disciplines (Max-Neef, 2005). Since the tiers are only a part of transdisciplinarity, it means my model only partially implements transdisciplinarity, but it does cater for interdisciplinary research.

### **2.4.1 Discovering the Material**

A method is required for obtaining knowledge from outside one's expertise i.e. discovering the material from other disciplines. How can a practitioner in one discipline obtain the knowledge of another discipline? I went to the UCT library to see what I could find on transdisciplinarity. I found that the library card catalogue has been moved to the museum, but it has not been replaced with any online catalogue. There is a paper copy of the Dewey Classification System (DDC23, 2011) but this is locked away, and the professor of library education allows access for teaching purposes only. It is not available for library user access. The assistant librarian said she had never heard of anyone ask for a library catalogue before and took me to a librarian's office. The librarian tried to find transdisciplinarity for me by googling Dewey, but he ended up saying it was probably not in the Dewey system yet. I asked about interdisciplinarity, and he found this filed under code 001 Knowledge.

I went on the internet and found there are papers, but they are not accessible. They can be purchased or rented for 24 hours. However, if you log in with a UCT student number you can get access because students are affiliated with an academic institution. The academic literature is effectively closed to ordinary library users, but accessible to the academic community. The fundamental problem here is that the user must know what he is looking for before he starts. He must know the keyword for the search, e.g. 'transdisciplinarity.' This transgresses Socrates' advice to start with not knowing, and then seeking to understand. I

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found that a person can get a subscription to the web Dewey system DDC23 via the Online Computer Library Centre (OCLC) at [www.oclc.org/dewey](http://www.oclc.org/dewey) at a cost between \$200 and \$600 but UCT has not done this. The librarian gave me a print of the summary DDC22 (dated 2003) which is the previous version. The summary has the thousand sections, for example 001 Knowledge, 002 The Book, and 003 Systems. This is enough to start with.

When we investigate the class 000 Information Systems, we find that section 001 Knowledge contains Interdisciplinarity (Frodeman et al., 2010) and that there is fruitful discussion in the academic discourse on transdisciplinarity. This can be accessed through Primo search tool available at <http://www.lib.uct.ac.za> or through an internet search. The literature is reviewed below.

The importance of relating this episode is to highlight the Socratic method so necessary for independent researchers. The Socratic method would be enabled by a library catalogue, which enables researchers to access material across disciplines without having knowledge of the subject keywords in advance. Therefore, UCT might consider an online catalogue subscription.

Further disciplines brought up in the literature in transdisciplinarity below are quantum physics, eastern philosophy and complexity. From this I bring Schrodinger (1944) into the conceptual framework developed in chapter 3. The philosophical underpinning of transdisciplinarity is investigated below.

#### **2.4.2 Foundations of Transdisciplinarity**

Transdisciplinarity has three pillars (Nicolescu, 1998)

1. Levels of reality
2. The axiom of the included middle
3. Complexity

The first pillar accords with post-postmodern philosophy such as that of Bhaskar and of Wilber. The second pillar denies Aristotle's classical logic and affirms instead what scientists have discovered in wave/particle duality in quantum physics. The third pillar affirms that nature is systemic, not mechanistic. This means it is wise to consider systems theory and unexpected connections.

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Max-Neef proposes a hierarchy of disciplines, from empirical to pragmatic to normative to values disciplines. Empirical disciplines address what exists. Pragmatic disciplines address what we can do. Normative disciplines address what we want to do. Finally, values disciplines address what we should do, or how we should do what we want to do. The lower levels inform the higher levels. The higher levels coordinate the lower levels. (Max-Neef, 2005). The disciplines at the empirical level are coordinated from the pragmatic level. For example, pragmatic medicine coordinates empirical biology and pharmacology, pragmatic engineering coordinates empirical maths and physics. Disciplines at the normative level coordinate the pragmatic level. For example, normative politics coordinates business, education and engineering. Disciplines at the value level coordinate the normative level. For example, value level ethics coordinates politics. Ethics gives the purpose to Politics.

Max-Neef points out that the hierarchy of disciplines is not necessarily used, even when addressing transdisciplinary problems. For example, a sustainable development goal to eradicate poverty is transdisciplinary but approaches to it are usually only mechanisms to stimulate economic activity and exclude mechanisms to determine ethical principles and official policy (Max-Neef, 2005). However, in a market economy, market forces are not oriented to eradicating poverty, but towards creating efficiency (Max-Neef, 2005). A transdisciplinary approach would bring in values disciplines and normative disciplines. Max-Neef goes into the limitations of the Newtonian worldview (the mechanistic universe). We will need to include quantum physics, which seems to operate on a different level of reality to classical physics. We will also need systemic thinking and intuition, and these are not constrained by the ordinary logic of classical philosophy and Newtonian physics.

Three laws of transdisciplinarity are proposed (Max-Neef, 2005)

1. The laws of a given level of reality are not self-sufficient to describe the totality of phenomena occurring at that same level
2. Every theory at a given level of reality, is a transitory theory, since it inevitably leads to the discovery of new contradictions situated in new levels of reality
3. Because of what is not there, it is possible that there is what is there; and because of what is there it is possible that there is not what is not there.

The first law accords with Bhaskar's philosophy of critical realism, Wilber's tenets of integral philosophy, and Einstein's notion that problems cannot be solved at the level of thinking that created them. The second law accords with the experience of scientists, who make provisional theories which hold until they are superceded by new theories. The third law accords with the

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Taoist philosophy of Lao Tzu. For example, a cup works because it contains empty space which can be filled by tea, and because it has the shape of a container which can hold the tea in that place (Lao Tzu, 1995). It is clear it works because of what is there (the cup), but it is not immediately clear, until it is pointed out, that it works because of what is not there (the empty space). Systemic and holistic thinking enable transdisciplinary thinking, so we can create new disciplines like ecological economics, and instances in this new field like 'Doughnut Economics' (Raworth, 2017) which address the harm we are doing to global ecosystems (transgressing the boundaries of sustainable resources).

The following sequence or continuum (Max-Neef, 2005) is proposed: disciplinary, multidisciplinary, interdisciplinary, transdisciplinary.

**Disciplinary:** Concerning or enforcing discipline (subject to the discipline).

**Multidisciplinary:** Concerning knowledge from several empirical disciplines (branches of knowledge) arranged side by side without any integrative synthesis.

**Interdisciplinary:** Concerning disciplines that are coordinated from one higher level. The disciplines at the empirical level are coordinated from the pragmatic level. For example, pragmatic medicine coordinates empirical biology and pharmacology, pragmatic engineering coordinates empirical maths and physics. Disciplines at the normative level coordinate the pragmatic level. For example, normative politics coordinates business, education and engineering. Disciplines at the value level coordinate the normative level. For example, value level ethics coordinates politics. Ethics gives the purpose to Politics.

**Transdisciplinary:** relating to problematques that are beyond the disciplines and requiring coordination amongst the disciplines and concerning all levels of disciplines. Empirical level: What exists? E.g. iron. Chemistry. Pragmatic level: What can we do with what exists? E.g. build a bridge. Engineering. Normative level: What do we want to do? E.g. perform an impact assessment. Politics. Value level: What should we do, or how should we do what we want to do? E.g. create an economy as if people matter. Ethics, Philosophy. Disciplines below the value level are value-free and might consider that values distort their natural value-free behaviour. Disciplines at the value level wish to create precisely such changes, in the service of values.

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### **2.4.3 Knowledge Production**

Gibbons et al (1994) proposed two modes of knowledge production. Mode 1 knowledge production was hierarchical, homogeneous and disciplinary. Mode 1 is the standard operating model for universities. This is the traditional form of knowledge production.

Mode 2 knowledge production includes complexity, non-linearity, heterogeneity and transdisciplinarity. This requires systemic thinking and a multi-perspectival worldview. Mode 2 extends into the contextualisation of problems, which is perspectival and socially robust rather than scientifically reliable. Transdisciplinarity (mode 2) was further divided into T1 research (within the academy) and T2 research (between the academy and society). The way that transdisciplinary dialogue between natural and social sciences has been developed is through case studies (Klein et al, 2001).

On the level of practical projects in research in urban areas such as green gentrification and urban food production, the projects can use transdisciplinarity both within the academy (T1 research) and between the academy and society (T2 research). T2 includes people with local knowledge and people who are impacted in their communities (Kirby, 2019). A key insight of case studies is that science, social science and public policy should not become entangled when dealing with the messy contextual politics of sustainability (Kirby, 2019). T1 research can address the big questions and choose the right tools, and this can be followed by T2 research for the application where detailed contextual knowledge of the specific urban area is valuable.

### **2.4.4 Academic Discourse**

The academic discourse of transdisciplinarity takes one of three forms: problem solving, transgression, and transcendence (Klein, 2014).

The problem-solving form appeared in the 1970s in the works of Eric Jantsch (1972) and Jean Piaget (1972), but in 2019, sustainability is like a chronic disease than a problem that can be solved, and so problem-solving has become condition-management (Tejedor et al, 2014). Knowledge outside of scientific expertise can enable decision making for management of the situation rather than resolution of the problem.

The transgression form appeared as socio-political critique in a context of post-normal science and wicked problems where reductionist and mechanistic approaches don't apply. In the transgression form, transdisciplinarity interrogates the structure and logic of the university and its role in society (Klein, 2014). The Mapungubwe Institute for Strategic Reflection (MISTRA)

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launched in 2011 fosters transformative work in post-colonial African universities, in sustainable energy and in social justice.

The transcendent form of discourse appeared after postmodernity had caused catastrophic fragmentation of thinking, creating a need for unified holistic unity thinking. The transcendent form was a bid towards transcendent unity (order from chaos). This was a view taken in Max-Neef (2005). At present, emphasis is shifting back from epistemology to problem solving because of pressing concerns in sustainability. The discourse analysis of Klein (2014) indicates a shift towards problem solving within contextuality rather than in universality, and in subjectivity rather than in objectivity.

Universities addressing sustainable development will not only interconnect disciplines but may play a bridging role in society. The structure of a university need not change, but transdisciplinarity can be included in courses on complex systems theory and engineering for sustainability (Tejedor et al, 2018).

The transgression discourse in transdisciplinarity addresses post-normal science, where science is just one voice amongst many in a complex contextualized process including humanities and environmental fields, gender, native cultural communications, and urban studies. The layers of hierarchy of discipline (Max-Neef, 2005) do not privilege science, but include science as an empirical discipline which informs pragmatic disciplines.

Julie Klein (2014) notes traits in attitude of a transdisciplinary individual such as acceptance of levels of reality, openness to multiple perspectives, risk taking, willingness to transgress boundaries, will to learn and ability to think creatively. This leads to the need for reflexivity when considering transdisciplinary work.

#### **2.4.5 Reflexivity**

Science has been considered value-free but transformative action is never value-free (Popa, 2014). Transdisciplinarity always has some goal other than pure science. Reflexivity is therefore required so that the underlying values and normative orientations of participants are clarified, whether they are scientists or not. Complex systems theorists are scientists and they tend to be reductionist and study inter-objective systems without due consideration of inter-subjective factors. The science may be reliable but perhaps it doesn't address relevance and social legitimacy. Extra-scientific expertise is needed so that we also consider the collective

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processes of social learning and social experimentation. Thirdly participation is required to ensure relevance to those affected by the intervention. Neither the instrumental rationality of scientists, nor the social legitimacy of the extra-scientific experts is enough by itself for any transformative action to be sustainable. Instead, values may be transformed during the process. Sustainable transformative action may require an incremental, iterative process of adjustment of values, which can only be seen through reflexivity.

The foundations of transdisciplinarity include empirical, pragmatic, normative and values disciplines and assumes that the values disciplines direct the process (Max-Neef, 2005). However, Popa et al (2014) point out that a pragmatic approach is required because values may need to change during the process, for the sake of sustainability, and neither the community nor the institutions nor the dominant power structures may emerge with their values unchanged. We need reflexivity to expose biases and agendas through critical analysis. We also need reflexivity to facilitate convergence of values to manage conflict. Thirdly we need reflexivity as a regulator or guide to help us through the significant psychological and reputational impacts of cognitive and attitudinal changes during the transformative process. It is noted that the 'Discursive Democracy' of Habermas and the 'Critical Realism' of Bhaskar is mentioned so the paper includes postmodern and integral philosophers. It is not limited to the critical thinking of modernity but includes relational and holistic thinking.

#### **2.4.6 Summary**

There is an informal usage of transdisciplinarity as a research mechanism in projects between academia and society. This is perhaps best approached in two steps. Firstly, the big picture can be addressed through interdisciplinary research within the university, between the disciplines. Secondly, academics can enter the community, and flesh out proposals with contextual detail obtained from people with local knowledge, for the specific application. The discourse can be constructive problem solving as well as an interrogation of the role of the university in society. This work is called transdisciplinary because of the involvement of people from the impacted community, who may have no discipline at all. The thinking might not be critical, and emotional intelligence is important. Such a transdisciplinary researcher will have an acceptance of levels of reality, openness to multiple perspectives, risk taking, willingness to transgress boundaries, will to learn and ability to think creatively. Science will not have a privileged position, and solutions will be successful if they are socially robust rather than scientifically correct. This work emphasises contextuality.

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A more formal usage of transdisciplinarity is in areas of systemic complexity like the ecological impacts of climate change. This requires systemic and holistic thinking and deep involvement in inter-objective disciplines like systems theory and ecological economics. Another area of discourse for formal transdisciplinarity is transcendent and may involve the interplay of quantum physics and mysticism. Intellectual activity at this level is likely to be outside the university. This work emphasises universality.

## **2.5 Discussion leading to the Project**

The literature review yields a picture of society organized along the lines of Plato's philosophy, but with varying disciplinary focus and varying ways of thinking through the ages. Whilst holistic thinking has arisen with integral philosophy from the 1990s, it has not resulted in adaptations in social structure, nor has it produced a network model for interdisciplinary research. The need for social adaptations, and the need for a model are two possible candidates for projects. The thinking is shown in the mind map below.

### **2.5.1 Mind Map of the Literature Review**

From the review of the philosophy literature, our philosophy of work is suggested to stand on five pillars as shown in Figure 1. In other words, our philosophy of work emerged because of natural constraints due to life conditions, ways of thinking, social constraints from societal structure, academic discourse from the knowledge base of disciplines, and from the original philosophy of individuals. From the philosophy through the ages (pre-modern, modern, postmodern and integral) we see characteristic forms of thinking in each era (Figure 1). When we think in these different ways we tend to focus on different disciplines in an era (Figure 1). With absolutistic thinking we focused on religion. With idealistic & realistic thinking we focused on classical philosophy. With the critical thinking of Descartes & Locke, we focused on science & technology. With relativistic thinking we focused on social science & language. Finally, in the present integral era, with systemic and holistic thinking we are focusing on information systems and history. The complexity we see in the world is not that one world view or one way of thinking is more complex than another, but rather that they coexist. We have integral, postmodern, modern and pre-modern people existing all at the same time. This is more complex than having just one of them. We have realistic, critical and relativistic thinking at the same time in different people, as well as at different times in a single person, even during the course of a single day.

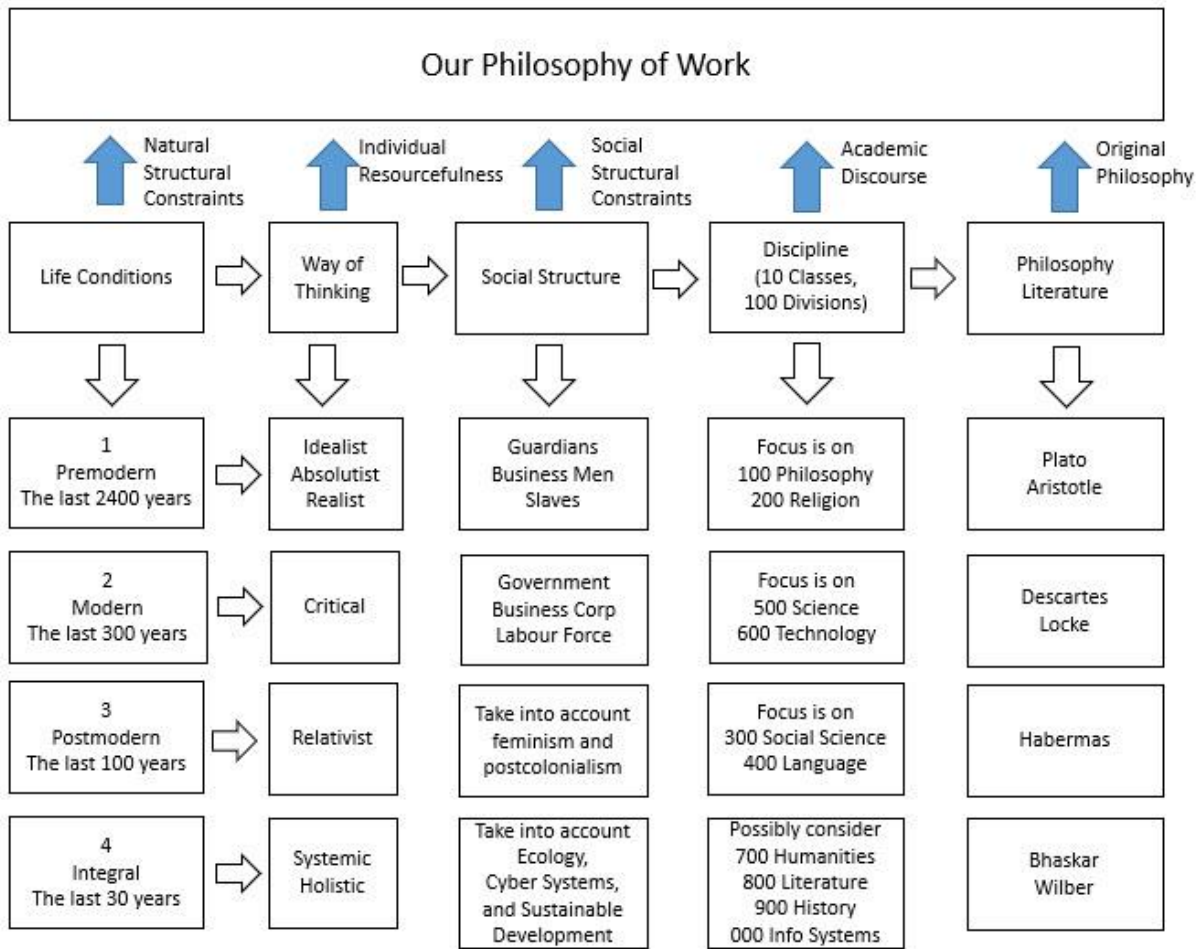


Figure 1: Mind Map Literature Review

I expect that the fourth revolution in thinking, of systemic and holistic thinking, will be adopted by the humanities and there may be a fifth era of thinking or of intuition in future which may focus on the final two classes of the decimal classification system, literature and fine arts (humanities).

### 2.5.2 The Growing Knowledge Base

Traditionally a need identified from the literature review is called a gap that can be filled (just as traditionally people looked for the missing link). The idea of a gap or missing link can be misleading because ongoing evolution and emergence is creating new space for work all the time, to make the knowledge base taller. The figure below shows how the knowledge base grows with the various ways of thinking from each era.

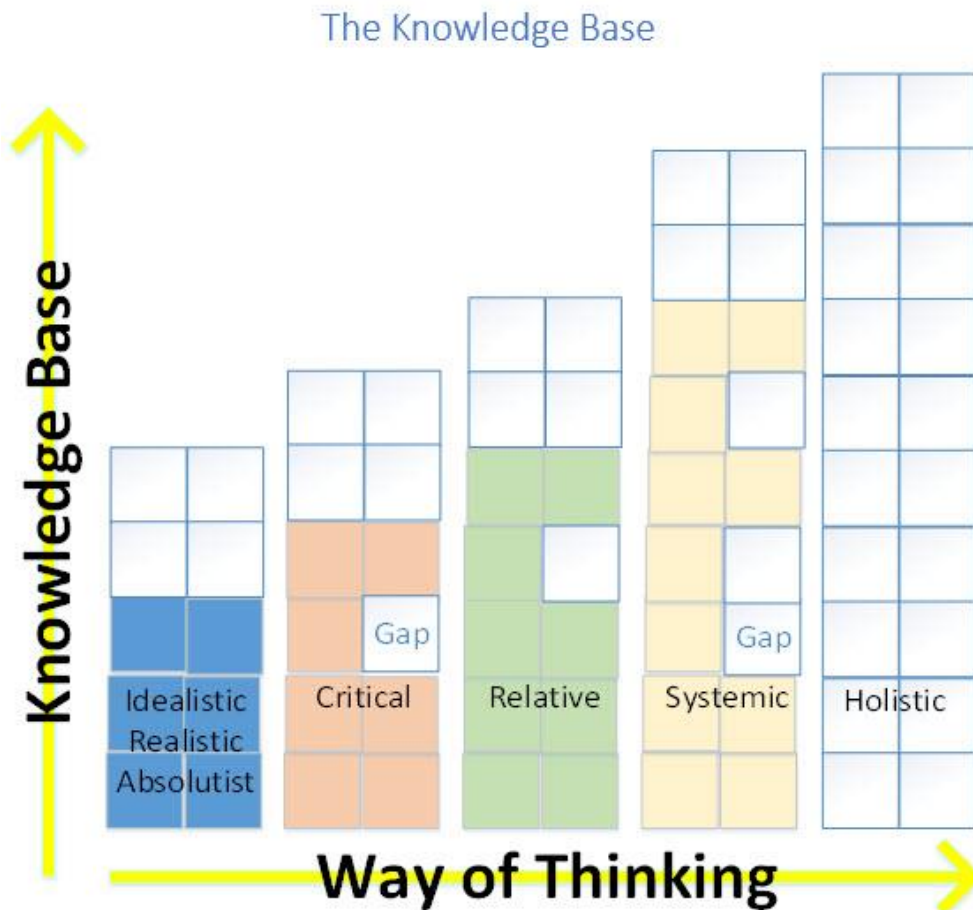


Figure 2: Growing the Knowledge Base with Various Ways of Thinking

As we progress from era to era, gaps may appear, where what was formerly assumed known is latterly assumed unknown with new ways of thinking. For example, theorems that were assumed or proved true may be found to be false when examined in new ways of thinking using new proofs. This is the second law of transdisciplinarity (section 2.4.2).

At the same time, the columns get taller as we move from premodern (blue) to modern (orange) to postmodern (green) to integral (yellow) eras because we are continually adding new knowledge.

The need for social adaptations, and the need for a model for working on problems are beyond the scope of a discipline were identified as two possible candidates for projects. The need for social adaptation is a gap because what was formerly assumed adequate is now inadequate. The need arises because new problems transcend disciplinary boundaries. These two

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candidate projects are discussed below. In both I consider using a functionalist approach in preference to a radical structuralist approach.

### **2.5.3 Project Option: The need for social adaptations**

We have seen that new ways of thinking have not changed the social structure. If we want to achieve sustainable development goals like reducing inequality, we might consider social adaptations that change the social structure. The research paradigm fitting a philosophy of radical change has been called radical structuralist (Burrell and Morgan, 1979). If we take a radical structuralist approach like Marx, we may destroy the social structure, whereas we were actually trying to destroy the power (and wealth) disparities. In history Marxist regimes produced worse power disparities because Marxist leaders did not tolerate any opposition and the regimes became totalitarian. Marx was modern and used critical thinking, but his critique was of the social structure and not of his own philosophy. He failed to think critically about how his ideas could lead to totalitarianism. The thinking of the dictators who implemented the ideas is not critical but absolutist. Absolutist thinking produces God as absolute or else an absolute dictator and absolute laws. This is called colloquially 'my way or the highway' and still exists in individuals and institutions and certain forms of government and religion. Plato and Aristotle introduced idealist and realist thinking as an antidote to absolutist thinking. They didn't want an absolutist dictator who only ruled because he was the strongest or had the most powerful army (Plato, 1955). The social structure they created survives. A social structure that has lasted for thousands of years has lasted because it is inherently a stable structure. Descartes added his moral guide (section 2.3.2.1) to transcend absolutist thinking (Descartes, 1649).

In the sociology book 'The New Realities,' Drucker (1989:12-15) talks of the belief in salvation by faith (premodern), followed by the belief in salvation by society (postmodern) which ended because of party politics where truth becomes whatever is likely to keep the party in power. 'The end of the belief in salvation by society spells the death of the most pervasive delusion of the last 200 years: the mystique of the revolution,' Drucker (1989).

If the notion of revolution and changing the social structure has no future, how should we achieve the social adaptations necessary to reduce power and wealth disparities? How do we achieve the goal of reducing inequality (SDG 10) without creating an unstable structure? We will need critical thinking rather than absolutist thinking. We can reduce inequality safely through simple adaptations such as in boards of directors where we ensure that the power differential and competence differential between members of the board is not too great. Another example is flying an aeroplane. If the copilot in an aeroplane is very junior to the pilot

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then he will be reluctant to point out errors the pilot makes, because of his deference to the pilot's seniority, and this has led to catastrophes and passenger deaths. The pilot does not even have to declare 'my way or the highway' but the junior imagines 'his way must be the right way because he is so senior.' When the power disparity is smaller, the copilot points out mistakes on the part of the pilot, and if there is an insufficient response he simply takes over, because he is not in awe of the power differential and so refuses to accept the mistakes being made, and thus accidents are avoided. These small changes to improve a stable system succeed in maintaining the stability and adding the improvement of lowering power differentials and inequality. This safe approach is called 'progressive assertiveness' and is a functionalist approach (Burrell and Morgan, 1979). Such a project lies in the domain of sociology and requires persuading radicals to not be radical. It can be done but it takes a long time. It takes development. It takes development from absolutistic thinking to idealistic thinking. From there we can also develop to realistic, critical, systemic and holistic thinking. Encouragement to development is available in education and training and from friends (low differential in power disparity). This is the sustainable approach for the population: Salvation by the development of the individual. If few individuals develop, we have progress, but inequality grows. If all individuals develop, we retain progress whilst reducing inequalities. Thus, we have the United Nations encouraging the development of nations, perhaps biased towards developing nations, to close the gap with developed nations.

This project is conceptually quite simple, the social adaptation of reducing inequality between colleagues (on the board, or in government, or piloting a plane) promotes progressive assertiveness, and thus subordinates are empowered to correct mistakes. This means we are likely to achieve the golden mean of not too little and not too much. This project is more like a social programme of personal development than a research project, so I will not pursue this option for my MPhil programme.

#### **2.5.4 Project Option: A model for networking the disciplines**

Instead of the radical structuralist approach which I consider dangerous, my approach to the research will be functionalist (Burrell and Morgan, 1979) and developmental. Therefore, I retain disciplines and experts and consider how these can be used, in preference to throwing out the stable base and replacing it with postmodern interdisciplines. As an experienced system engineer my approach is to use the best practice of incremental and iterative development in order to avoid the 'second system effect' (Brooks, 1975) where the stable base is lost through over-zealous or reckless redesign or restructuring. The functionalist approach is more aligned with the golden mean of not too much change and not too little change, but

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sufficient change that development is sustainable. I will pursue this project option and define the project accordingly in the next chapter.

The best engineering practice of incremental and iterative development is used. Each iteration in developing the model produces an increment of value. The sequence of development will be: disciplinary, multidisciplinary, interdisciplinary, transdisciplinary. In this sequence of increasing complexity (disciplinary, multidisciplinary, interdisciplinary, transdisciplinary), I get as far as the tiers of disciplines in transdisciplinarity (Max-Neef, 2005), which is a limited part of transdisciplinarity. We call this Model 1.0.

It will be useful for academics who want to break out of their discipline silo and work with others in interdisciplinary research (T1). Further work could be done in future through further iterative increments to Model 2.0 which could include further aspects of transdisciplinarity. The current project is limited as per the scope section (1.4).

I will create a model known as a 'model of any disciplines' (MOAD), which is a new concept, original with this dissertation, using the concepts of forms (Plato, 1955); holism (Smuts, 1926, Koestler, 1967, Wilber, 1995, Jantsch, 1980); integral philosophy (Wilber, 1995); the sequence of development: disciplinary, multidisciplinary, interdisciplinary, transdisciplinary (Max-Neef, 2005); the tiers of disciplines in transdisciplinarity (Max-Neef, 2005); the activation of underlying mechanism (Bhaskar, 1987); the rational inter-subjective exchange of uncoerced mutual understanding (Habermas, 1987); the validity claims (Habermas, 1984); the 'high cohesion – low coupling' design pattern (Gamma et al., 1995); and soft systems methodology (Checkland, 1990).

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### **3. METHODOLOGY**

#### **3.1 Roadmap to This Chapter**

A hypothesis is proposed, and research questions and objectives are defined. A roadmap is provided to achieve these objectives using the methodologies discussed. Critical thinking is used to examine Plato's directive, and this leads me to develop a conceptual framework from first principles and independent thought.

#### **3.2 Hypothesis**

My hypothesis is that a systems engineer can create a model which networks the disciplines using constructs from philosophy, the tiers of disciplines in transdisciplinarity, and systemic and holistic thinking. This will provide a way of working on problem situations which transgress the boundary of a discipline.

#### **3.3 Research Question**

Can we create a conceptual model which networks the disciplines, using constructs from philosophy and systemic and holistic thinking? If so, the recommendation can be made for using holistic thinking and a network model of disciplines to improve communication and collaboration between the different disciplines in addressing societal challenges that have become increasingly complex.

#### **3.4 Research Objectives**

The primary objective is to create a model which networks the disciplines.

The secondary objective is to show how to use the model, in some conceptual cases of use in problem situations that transgress the boundary of a discipline.

A third objective is to examine our philosophy of work in 2018 in order to show the limitations of the status quo. This may attract systemic and holistic thinkers to a new model of working.

#### **3.5 Roadmap to Achieve the Objectives**

1. Achieve the first objective (build the model) using the constructs taken from the philosophy as follows.
  - a. Start with the Socratic Method, knowing that I do not know, and therefore seeking to understand, apply critical thinking to Plato's directive that academics ought to 'have some geometry' (section 3.10).

- b. Develop a conceptual framework with knowers and knowledge base of disciplines based on classes derived from Plato's Forms (section 3.11).
  - c. Develop the model of any disciplines using the constructs philosophy, the tiers of transdisciplinarity and systemic and holistic thinking (chapter 4).
2. Achieve the second objective (show how to use the model) as follows.
    - a. Soft Systems Methodology (section 3.6) will be performed in several iterations addressing selected scenarios. The content of the model will be obtained through hermeneutics (section 3.7) of disciplinary texts in the library and online knowledge bases i.e. the questions these disciplines address and the things they do. Document the results of scenarios of use (chapter 5).
  3. Achieve the third objective as follows.
    - a. Perform a discourse analysis (section 3.8) on our philosophy of work in 2018 (section 5.9).

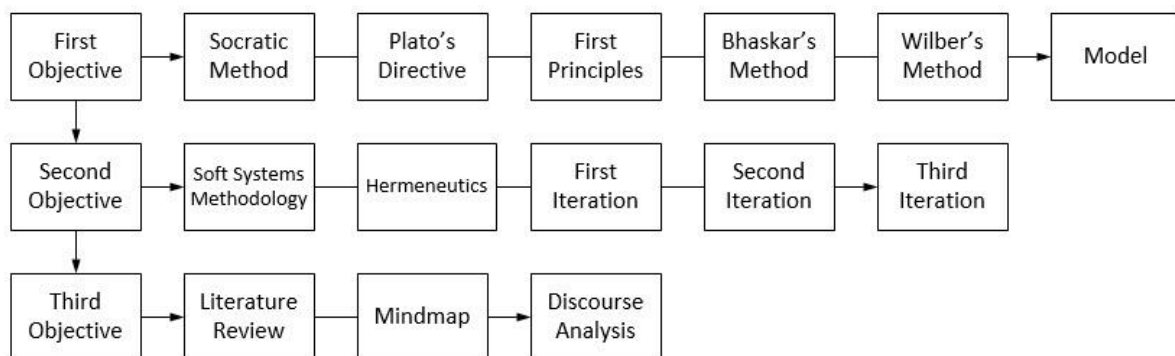


Figure 3: Roadmap to Achieve Objectives

The various techniques (soft systems methodology, hermeneutics and discourse analysis) required for this research methodology are described below. Soft systems methodology gives me a process based on systems thinking, hermeneutics gives me content for the model, and discourse analysis gives me a means of uncovering socio-psychological characteristics for a philosophy of work.

The project will be considered complete when

- We have created a conceptual model which networks the disciplines, using constructs from philosophy and the tiers of transdisciplinarity using systemic and holistic thinking.
- The model is shown to provide a way of working on problem areas that transgress the boundary of a discipline.

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### **3.6 Soft Systems Methodology**

Soft systems methodology (Checkland, 1999) uses the process 'decide, take action, monitor and take control action.' The approach I have usually taken in my systems engineering work in industry is the similar process 'DANCE,' i.e. 'Decide, Act, Notice, Change Easily.' We decide what to do, act, notice what is working and what is not working, and when it is not working, change the approach or take control action. We don't simply stick with the decision if it is continually not working. Rather, we make a new decision, and take progressive action until we notice it is working. This methodology gives me a process for deciding scenarios and working through them as thought experiments.

Soft systems methodology applies to four types of systems: natural, designed physical, designed abstract, and human activity systems (Checkland, 1993). Natural and designed physical systems will be in the lower right interobjective quadrant (Wilber, 1995) and these cannot be other than what they are. Human activity systems will be in the lower left intersubjective quadrant (Wilber, 1995) and this is crucially different, because they are manifest as perceptions to human actors who are free to attribute meaning to their perceptions. There can thus never be a single testable account of a human activity system (Checkland, 1993:14).

The conceptual model can be implemented as a network of human practitioners which would make it a human activity system (Figure 15). In this case there would never be a single testable account, as the account would vary with the specific actors in the specific scenario. The scenario could be repeated if every transaction is logged (say in a UML use case realisation or sequence diagram), but if new actors are free to attribute meaning to their perceptions their account may be different.

Alternatively, the conceptual model can be implemented in software which would make it a designed physical system (Figure 16). This would be testable with repeatable results given a fixed version of software which has implemented a fixed knowledge base in a database. As a consequence, it would lack the flexibility of a human activity system.

### **3.7 Hermeneutics**

I use hermeneutics on disciplinary texts as a way to further communication through interpretations of what is being said and what the books mean. This allows us to synthesise queries, commands and notifications to populate the interfaces to the disciplines. Disciplinary texts are obtained from the library which is classified under the Dewey Decimal Classification. For example, we find Economics texts under code 330, Engineering under code 620 and

Education under code 370. These codes form the boundaries of the disciplines for the model. By using the Dewey Classification System to define the disciplines and their boundaries we can use the library as a source for defining the interfaces on the model.

Disciplines, like software components, are built on the pattern ‘high cohesion, low coupling’ (each discipline is some unique functionality with limited interfaces). We notice that commands on inter-disciplinary interfaces ‘*Do Something*’ and therefore have active agency whereas queries ‘*Tell Me Something*’ which is passive communion, so the interdisciplinary interfaces allow for the agency and communion of the disciplines. Agency and communion are attributes of holons as per holistic philosophy (section 2.3.4.2.2). The model we are creating is holistic, built of holons.

Table 3: Interface to a Discipline

<b>Researcher</b>	<b>Discipline (e.g. Dewey Division 330 Economics)</b>
What questions does this discipline address? (What information or knowledge does this discipline provide?)	Provides a list of queries that can be requested. This can be done through a hermeneutical analysis of library texts defined under the Dewey Division.
What commands does the discipline accept? (What does this discipline do for us?)	Provides a list of commands that can be executed. This can be done through a hermeneutical analysis of library texts defined under the Dewey Division.
Query: Please give me X.	Response is X. This is done by extracting the answer from the disciplinary text.
Command: Please do Y.	Response is success or failure. This is done by executing the command. For example, calculating the result of an economics equation.
What notifications do you supply? (What signals will you give me?)	Provides a list of notifications. For example, economics might provide a red flag for stagflation (indicating the situation that inflation is high, growth is dropping, and unemployment is steady and high).

We expect that empirical disciplines will be quantitative (what exists), pragmatic disciplines will have practical outcomes (what can we do), normative disciplines will set standards and priorities (what do we want to do), and values disciplines will prescribe goals (how should we

do what we want to do), so we expect that their interfaces will have this flavour. If so, this validates the Max-Neef model of tiers of disciplines in transdisciplinarity.

Example

Table 4: Engineering Science Communications

<b>Engineering</b>	<b>Science</b>
What can I ask?	How strong is it? How big is it?
What can you do for me?	Compute X Make material X
What notifications do you provide?	New computations for first year physics.

Look for the following sort of material so as to elaborate interfacing of disciplines.

1. First consider some classes e.g. Social Science (300), Natural Science (500) and Humanities (700). This may give a flavour covering all divisions of a class.
2. Secondly, consider some divisions e.g. Economics (330) & Education (370) in Social Science (300).
3. Look for coordinating activities between disciplines.
4. Look for informing activities between disciplines.
5. Is the discipline empirical/ pragmatic/ normative/ values? Empirical disciplines are quantitative (what exists?), pragmatic disciplines have practical outcomes (what can we do? will this work?), normative disciplines set standards and priorities (what do we want to do?), and values disciplines prescribe goals (how should we do what we want to do?).
6. Contextualisation
  - a. Consider the queries and commands for the context e.g. goal of decent work
7. Specialisation
  - a. Is the discipline high/low in epistemic relations (object knowledge)?
  - b. Is the discipline high/low in social relations (way of knowing subject)?
8. Semantics
  - a. Is the discipline high/low in semantic gravity (context dependence)?
  - b. Is the discipline high/low in semantic density (complexity)?
9. Autonomy
  - a. Is the discipline high/low in positional autonomy (freedom from control)?
  - b. Is the discipline high/low in relational autonomy (independence of other values)?

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## 10. Density

- a. Is the discipline high/low in material density (coherence of content)?
- b. Is the discipline high/low in moral density (coherence of values)?

### **3.8 Discourse Analysis**

Discourse analysis uncovers socio-psychological characteristics. The status quo is investigated using discourse analysis to show that our current philosophy of work is modern, 'objective' and disciplinary. Discourse analysis reveals that the objective, reductionist approach of modernity has resulted in the loss of the subjective. This is exemplified by changes like 'personnel departments' being renamed 'human resource departments.' The status quo philosophy of work creates socio-psychological issues that can be addressed with a new philosophy. Introducing integral and holistic philosophy and a model of interdisciplinary working is a way forward.

### **3.9 Language**

We use different language in the different academic cultures of the humanities, social sciences, technologies and natural sciences. We can show examples of the way the same words are used differently and why, in order to facilitate inter-disciplinary communications. We demonstrate that humanities use 'I' language because of the subjective nature of philosophy, literature and the arts. Social sciences use 'We' language because of the inter-subjective nature of sociology, education, economics, social work, commerce and political science. Technologies use 'Its' language because of the inter-objective nature of engineering, construction and business management. Science uses 'It' language because of the objective nature of mathematics, physics, chemistry and geology. I generally use 'We' language in the project because of my orientation to including 'all of us' in the interdisciplinary research.

### **3.10 Rationale for Critical Thinking**

Plato advised 'Let nobody enter the academy who has no geometry'.

If we simply say well, I did geometry at school, so I am fine, we might miss what Plato is pointing towards. To think critically is to investigate who is saying it, what he is saying, and why he is saying it. In this way we can think independently and evaluate the advice.

Who is saying it? We understand Plato to be a great philosopher and founder of the academy in which the love of wisdom is pursued. Since we love wisdom, we will want to listen to such a man, but in the beginning, we have little wisdom, so we don't actually understand what he is saying or why. We want to get this wisdom, so we decide to listen to the man and study

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geometry. A good rule in life is to assume that the person speaking knows something that you do not know.

What is he talking about when he says geometry? People who have found out the nature of things before us may have captured that knowledge in some form of a knowledge base. We turn to a knowledge base like a dictionary or library (with a decimal classification system) to find a definition.

Why is Plato saying it? We can speculate. We may be far from the mark. It might be better to do as he advises and investigate geometry, and so it may become apparent why he advises 'having' geometry. If we search the knowledge base, such as a library or a portal for the history of philosophy, we may find out how it came about that we need geometry. Alternatively, we may find out why by doing the exercise and seeing if we are enlightened by the experience. Study geometry and find out from the experience why it has been deemed necessary. Then to be complete we can cross check our experience with the history and see if there is a correlation between what we found ourselves, and what others have found before us. If the correlation is complete, we have verified the historical account. If the correlation is partially complete, we have more to learn. If the correlation is more than complete, then we have potentially extended the field of geometry. If the apparent extension is correct, then it is a true extension. If the apparent extension is incorrect then it is an error or fallacy due to mistaken arguments.

### **3.10.1 Geometry**

Geometry is the study of shapes, the parts of shapes, and their relationships. Shapes are the contours or outline or external form. Geometry is concerned with the points, lines, surfaces and solids that provide the shape.

### **3.10.2 First Principles**

To do some research is to find out for ourselves. If I want to write a book, I research the geography and history of the setting, and the psychology of the characters, and the nature of stories, and the techniques of story-telling, and the flowers of rhetoric, and so on.

In the case of researching geometry from first principles I look at my pencil and I see it is long and straight, and the business end has a point. When I touch it to the paper it makes a point that is proportional to its sharpening. When blunt the point is rather less sharp, a dot, or more like a smudge than a clean point. The smudge has some extension. When the pencil is sharp the point is sharp.

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I make a point by touching the paper. I notice that the point is small, and the pencil is sharp. This small point has very little extension. If I idealise it, I can consider it small enough as to have no extension. But if it actually had no extension it would disappear from sight. No matter, I imagine the invisible point to be the centre of the visible approximate point drawn on the paper. Already I see that what is on the paper is an approximation. It is a visible representation of an invisible concept. Make a note of this. The visible point on the paper is actual, which is to say it exists. Is this the real point? Is this the ideal point? Is this the actual point? If we deviate into an investigation of the real and the ideal and the actual, we are moving from geometry into philosophy. Plato says do geometry first. So, we turn our attention back to lines on the paper.

If I place my cup on the paper and draw partially around it, I get an arc or approximately a semi-circle in the case where I draw half-way around the base of the cup. If I use a second pencil as a ruler, I can draw an approximate straight line between the two ends of the arc. The arc is as approximately part of a circle as the cup is circular, and the straight line is as approximately straight as the pencil that has been used as a ruler.

If I invert the pencil and place it at one end of the straight line, I see that the width of the pencil measures off part of the length of the line. Placing a second inverted pencil against the first pencil I can measure off the second portion of the length of the line. By moving the first pencil to the other side of the second pencil I advance to a third pencil width. By alternately moving the pencils I can measure the whole line by counting the number of widths of pencils. I measure the straight line to be approximately ten pencil widths. Repeating the exercise for the arc I might measure off approximately fifteen pencil widths. So, I see that the straight line is only about two-thirds of the distance of the curved line.

Now I experiment a little and draw some other lines connecting the two ends of the arc. These new lines can be any sequence of straight lines or arcs not overlapping the existing arc and straight line. When I measure them, I find that these lines are all longer than the original straight line.

Apparently, the shortest distance between two points is a straight line between them. Why might this be the case? Any other line starts off pointing in a different direction than the straight line between the points. So, we have to correct by changing the direction more towards where we want to get to. The sooner we correct the direction, the shorter the distance to our destination. The urge is therefore to get back to philosophy, but Plato says do the geometry first. Could it be that diversion into geometry may be the shortest route to our destination?

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Maybe Plato is saying that geometry will shorten our investigations in philosophy, and that without geometry we may be going in the wrong direction in our philosophy. We have already seen that geometry points out the actual. As long as we are not going directly towards our destination, we are taking a longer route (in distance), but it might be a quicker route to take the longer route, like walking up a mountain slope in a zig-zag manner, rather than climbing directly using ropes.

I presume I need to get a little more precise in my study of geometry. The width of my pencil is approximately one cm, so I get a ruler marked in cm so that I can make quicker measurements than the manual method of counting out pencil widths. To measure my original straight line with a ruler I don't need to count but only to read the mark that has been prepared on the ruler around the ten cm mark. I might want to make sure the ruler is approximately correct by using the pencil counting method on the ruler itself. After verifying the tool, I can then rely on the tool.

What we are documenting here is called first principles. We are starting from scratch, as if we have no knowledge and no laid down principles. We are starting with a single point on a piece of paper and discovering the first principles of geometry for ourselves. This differs markedly from simply accepting or affirming the principles laid down by an authority as incontrovertibly true in 'the book' or 'the literature'. Plato doesn't lay down the principles of geometry for us. Instead he says have a look for yourself. Have some geometry, rather than know some geometry. This will prepare you for philosophy.

We differentiate authority and competence. An authority has the power or right to prescribe and enforce, whereas competence is required for it to be right or successful. If we have authority and not competence, we have the power to prescribe something that is wrong or doesn't work. An incompetent authority can merely claim that it is his right to make such a prescription. He gets this right from positional authority (elected or appointed). It often happens that a competent person who defies positional authority is punished, not for being right, but for insubordination to 'rightful authority.' Descartes catered for this in his provisional moral code (section 2.3.2.1).

I now take up my pencil and draw ten points (more precisely, dots as approximate points) next to one another. I see that addition of approximate points gives me an approximate line. The point is zero dimensions, and the line is one dimension. So, addition gives us extension in one dimension. If I copy the line of ten dots ten times, then I have a surface of two dimensions made up of 100 dots. If I copy the page ten times, I now have ten surfaces giving a 'solid' wad

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of paper in three dimensions containing 1000 dots. The copying and pasting process in each instance leads to a further dimension.

Ten dots make a rather small line '.....' and a dot is hard to see or to work with practically, so it will be convenient to work with one cm squares instead of dots. Each 1 cm square will represent the dot which represents the point. We do this for convenience of easy viewing on the page.

I take the ruler and draw a square of length 1cm as our first point. I repeat this, ten times, to get a row of ten squares. The row of squares is the first dimension. I copy the row to get a grid of ten rows. This is a two-dimensional grid on the surface of the paper. The sides of the grid are ten cm long, so the outline of the grid is itself a square of ten by ten. I now draw a circle with centre coincident with the centre of the square grid. The circle is the outline of a disc and the disc has an area on the surface of the paper within the square grid.

We saw from the dictionary that geometry is the study of shapes, and parts of shapes and their relationships. We can see that the small 1 cm squares are parts of the large 10 cm square. The squares at the outline of the grid share some common sides with the grid. The areas of the small squares are all shared with the area of the grid. The sum of the areas of the small squares is exactly the area of the whole grid. The circle touches only four points of the grid, at top and bottom and sides, or North, South, East and West. However, the surface area of the circle shares many of the squares of the grid, and partially shares some more of the squares, but completely excludes other squares.

By counting the squares of the grid, we see the grid contains 100 squares of 1 cm<sup>2</sup> each so the area of the square grid is 100 cm<sup>2</sup>. By counting the squares inside the circle, we see the circle contains 60 whole squares and 28 partial squares of 1 cm<sup>2</sup> each so the area of the circle is approximately 78 cm<sup>2</sup>. The ratio of the circle area to the square grid area is therefore approximately 0.78. The area of the square being 100 is the sum of all its parts which is 10x10 or 2x5x2x5 squares where 5 is the radius of the circle. The area of the square grid is thus 4r<sup>2</sup> where r is the radius of the circle. The area of the circle is a proportion X of the area of the square grid. Thus, the area of circle = X\*4r<sup>2</sup> = Yr<sup>2</sup> and Y=4X. We don't know what X or Y are, so we assign the variable names X and Y to stand for what it is that we do not know. In our case the proportion X is approximately 0.78 and so Y = 4x0.78 = 3.12. We see that when we use a 1 cm square as an approximate point, we get Y=3.12.

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If we now make our small square smaller, say 5 mm instead of 1 cm we can get a more accurate value of  $Y$  because we can count the squares contained in the area of the circle more closely and have lower error in estimation of the area of partial squares. By counting the 5 mm squares within the circle we may get an area of approximately  $78.5 \text{ cm}^2$ . Now we have  $X=0.785$  and  $Y=3.14$ . If we measure the circumference of the circle, we get 31.4 cm and we notice that this is  $Y \cdot 2r$ . If we repeat the measurement of area with squares of say 1 mm, we may get  $X=0.7854$  and  $Y=3.141$ . We see that by making the squares closer to dots and so implicitly closer to points we get better and better approximations of  $Y$ . We never get to the point of the dot being an invisible point, but the value of  $Y$  gets more and more precise. The initial decimal places remain constant and additional decimal places are added with the greater degree of accuracy. The number  $Y$  is therefore a constant, and not a variable. We now give the constant a constant name 'Pi' rather than the variable name  $Y$  because  $Y$  turned out to be a constant. We saw empirically that the area of the circle is  $Y \cdot r^2$  and the circumference is  $Y \cdot 2r$  and so  $Y$  or the constant Pi is the ratio of the circumference to the diameter ( $\text{circumference}/2r$ ), and it is also the 4 times the ratio of the area of the circle to the area of the square grid enclosing the circle.

Geometry has now led us to the discovery of a natural constant we called Pi. This natural constant is nowhere to be seen in the empirical investigations with our senses. What we see empirically is the circumference of the circle and the surface area of the disc measured in cm and  $\text{cm}^2$ . But what we discover rationally by the means of drawing squares and circles and counting or taking the short cut of multiplication, is something invisible, a natural constant called Pi. Now we have something we might call real rather than actual. In the empirical investigation we have an actual circle (outline) and disc (surface area), and the underlying reality is a constant called Pi. Here we have three layers in that which is the case, we have empirical observation, actual geometry and underlying reality. Through geometry we have seen that the underlying reality was there to be discovered. It was not postulated as a theory or imagined to be true but discovered in an invisible underlying layer.

We must clarify the terms, and we can use common dictionaries for these definitions. Actual means existing for empirical observation and real means not imaginary. The circle is actual because we see it. We don't call Pi actual because we don't empirically see it. However, the empirical investigation of the actual has revealed Pi as real. Pi keeps turning up in investigations without us ever imagining that it existed. Nowadays we can see Pi in the literature. If its value appears different it is only that it is being enumerated further and further to a greater precision. It seems to have no end of elaboration, but whatever value (whatever depth of decimal place) of Pi we work with, it is a real constant, and its values are

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approximations of the real (i.e. 3.14 or 3.141 etc.). Actual experiments will always use approximations. Our investigation of geometry has already yielded two invisible concepts. The 'point' was an imagined zero-dimensional point of which the dot or sharp point of a pencil is an actual representation, and the constant 'Pi' was a discovered constant with actual representations of 3.14 and 3.141 and so on.

We induce the area of any circle is  $\pi r^2$  and the circumference is  $2\pi r$  and so we no longer have to draw it and count the squares or measure with the ruler but can compute them for any circle.

We can see now why Plato may have pointed us to geometry. We have to differentiate the observation and the actual and the real. In this case we are into philosophy.

The actual is what we see by empirical investigation. Geometry shows us that what we see is actual but approximate. Approximations are actual. The real is not imaginary. The real might be invisible. We can imagine the invisible, but that doesn't mean it is imaginary. Imaginary means existing only in the imagination, and not in reality. The imagined could be imaginary, but instead it might be real. There is an investigation at UCT at the moment to 're-imagine mining to improve people's lives.' Previously we imagined mining to be purely about extraction of resources, and now we imagine it to be also about improving lives. This highlights what imagination is. It is a capacity to envisage. We can envisage the real.

There is a philosophy called critical realism which works with empirical observation, the actual and the real. So, first principles in geometry indicate that critical realism could be worth attention.

The first principles that I notice in my investigation in geometry, in approximately the order I see them arise, are

- Draw
- Write down
- The drawing and the writing are data capturing
- Observe
- Notice
- Think
- Imagine
- Question

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- Experiment
  - Measure
  - Use tools
  - Count
  - Add
  - Multiply
  - Compute
  - Estimate
  - Postulate
  - Use placeholders or variables (X, Y) to represent unknowns
  - Reasoning
  - Infer (draw conclusion from evidence and reasoning)
  - Induction (infer laws from instances)
  - Deduction (infer instances from laws)

When we say work from first principles, these are the things we do.

### **3.10.3 History of Geometry**

We needn't go deeper into geometry, for example into Euclidean geometry or Analytic geometry or Riemannian geometry, to see why Plato pointed us here, but we may have to go deeper in geometry in order to properly understand Plato's philosophy. So, at this point we put down our pencil and ruler and have a cursory look into the history of geometry. These facts are generally available and widely known, with Euclidian and Cartesian analytic geometry being taught at school, including linear algebra, cylindrical surfaces and conical sections, and Riemannian geometry being taught at universities.

Euclid was the first to create a system based on axioms, and the first to provide proofs based on axioms. His geometry is synthetic or axiomatic, that is, synthesised from his axioms. If we want a more complete synthetic geometry, we will need more logically complete and consistent axioms. Euclid's axioms were intuitive and just appeared to be simply so or obviously the case, without formal logic. His geometry was the only geometry in use up until Descartes, as it had fulfilled all needs until that point.

Descartes and Fermat invented analytic geometry. This specified the coordinates of points. The two-dimensional grid that we drew in the thought experiment above is now called a Cartesian (after Descartes) grid with x and y perpendicular axes giving (x, y) coordinates. Z is the third coordinate, orthogonal to them (the copy of the x-y grid on multiple pages in the third

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or z dimension). In this geometry the points on a line are defined as the set of points that satisfy a linear equation. In other words, the definition of the straight (linear) line is an equation defining the x and y coordinates of all points on the line. The equation therefore has x and y as variables which have particular values for each point on the line. The domain of study of the linear equation is algebra. For example, the algebraic equation  $ax + by + c = 0$  defines straight lines on the Cartesian grid. Two specific points  $(x_1, y_1)$  and  $(x_2, y_2)$  will be on one and only one straight line. The definition of the invisible point as the coordinate  $(x_1, y_1)$  is the ingenious insight. The fact now is that you can go directly to the invisible point and mark it with the point of a pencil. We have moved geometry from the synthetic (synthesised, imagined, invisible point) to the analytic (true point from the meaning the x-y coordinate defining the point).

We can find the values of a, b and c for these points using the equations  $ax_1+by_1+c=0$  and  $ax_2+by_2+c=0$ . We can also draw the line between the two points and see what other x and y points it passes through on the Cartesian grid. If we look at the equation  $ax + by + cz + d = 0$  we are defining a plane instead of a line (by including the z dimension). All points on the plane are defined by the equation. These equations are all linear (straight) as seen in the fact that x, y and z are all first degree. Second degree equations will have the power of 2 e.g.  $x^2$ . A section through a cone for example is a curved arc (not a straight line) and is defined by  $ax^2+bx+cy^2+dy+ex+f=0$  which is a second-degree equation. The first degree or linear or straight-line equations apply in 'linear algebra'. Euclidian geometry applies because it is the geometry of flat space. Trigonometry, the geometry between three points covers the angles between the points, the lengths of the associated lines between the points, and their associated relationships such as sine, cosine and tangent.

If we are working on a curved surface such as the surface of a cylinder, then a straight line between two points will curve around the cylinder. The shortest curve between two points on the curved surface is called a minimal geodesic. On a globe you can draw many lines between two points (such as the north and south pole) that are all minimal geodesics. This is not possible on a flat surface, where there is only one line that is the minimal distance between the two points. Curved surfaces are studied in Riemannian geometry.

Einstein's general relativity showed that physical space-time is not actually Euclidian, but that Euclidian geometry is an approximation over short distances and where space is flat. We have seen in the section on first principles above that all the geometry we did with pencil and paper was approximate, not through axioms, but through tools (pencil, compass and ruler). The clumsy nature of the tools makes the investigation approximate. Now we see Euclid's intuitive

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axioms are also approximations, and this is because they are intuited and lack modern logic which refines the approximations. But Euclid's geometry has been suitable to the scale of reality we deal with as people on earth where space is fairly flat because earth is fairly small. Near massive objects like stars the space is curved by the gravity of the star, and space is no longer flat, so using Euclidian geometry will produce a degree of error depending on how curved space is at that place, which depends on how heavy the star is. If as McKenna says, history is a 25 000-year dash from the trees to the star-ships, at some point in interstellar space, people will need post-Euclidian geometry because actual physical space is not Euclidian. The Hubble telescope has discovered points in space with more than one minimal geodesic between the points and the telescope which shows that space is curved. The curvature is called gravitational lensing. Riemannian geometry can be used to estimate the mass of stars or black holes causing the curvature.

#### **3.10.4 Extent of Geometry in the Analytical Instrument**

This document is concerned with a structure of disciplines in the context of a philosophy of work. Whilst an empirical investigation of first principles and a study of Euclidean geometry may be as much as Plato had in mind before starting philosophy, our current perspective is that we will need Analytic geometry, although probably not Riemannian geometry. The Cartesian grid has become part of the collective psyche and is used in legitimation code theory (LCT) which is an analytical instrument for research (Maton and Howard, 2018). LCT maps out variables on a two- dimensional grid. Another term that has become part of the collective psyche is quadrant. The quadrants are the four (quad) sections of the Cartesian grid that have been created by the intersection of the x and y axes. We often refer to quadrants in order to categorise the objects of investigation. We speak of something as belonging to the upper right quadrant, or the lower left quadrant for example, and this allows us to associate the object with the attributes of the quadrant. The basic attributes of the quadrants are that they have higher or lower values the further away you move from the origin (intersection of the axes). This relative valuing (high or low) is a useful approximation or orienting generalisation that has implicit value because the explicit value of the precise position on the grid is often too detailed for us to quickly grasp its meaning. If we say the value is 23.456 this may be a true detail, but what does it mean? If we say this is a high value, then it has a meaning to us. If all the values are positive this means they are all in the positive quadrant of the Cartesian grid (upper right). To differentiate a group of data that is all in the upper right one can draw a horizontal line at a certain y value, and a vertical line at a certain x value. This creates four new quadrants that are all in the positive quadrant of the Cartesian grid. These four quadrants are given names called codes. The codes are a way of naming the four quadrants that are more or less than the value pair (x, y).

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### 3.10.5 From Geometry to Complexity

We have progressed from the shapes of geometry to the equations of algebra to the algorithms of software running on computer systems, with increasing complexity. Something might be simple or complicated or complex. Linear algebra is simple (quite easily grasped) whereas equations for curved surfaces are complicated (less easily grasped). The complex is of a different order. It can hardly be grasped, and no predictions can be made. Non-linear equations do not proceed smoothly as linear equations do, so calculus does not apply. We cannot integrate or differentiate non-linear equations. They go beyond the Newtonian understanding of the universe. The complex has many different and related parts. Non-linear equations jump from part to part. Algorithms include sequence, condition and loops. Having conditions and feedback loops creates non-linear complexity. For example, the concept 'I am a strange loop' is recognition of the feedback loop of reflexivity, consciousness of consciousness, or self-consciousness. Geometry does not have many different parts, so geometry is not complex. So, Plato is saying start with the simple and proceed towards the complex from first principles. This is a reason for Plato to say, 'let no one enter the academy who has no geometry.'

A complex number is a combination of real and imaginary parts. The imaginary part is the square root of the negative number one which we call 'i'. This doesn't sound like many different parts but the combination of real and imaginary makes it complex. Other complex areas are domains of human endeavour such as social science. These are complex through being constrained by the influences of many disciplines. For example, educating is complex when you take into account biology, economics, history and politics in the classroom. If educating merely involved the science of learning and the science of teaching, it would be much less complex. Holism teaches us to remember that the disciplines are holons. So, although biology, economics, history and politics may be brought into the classroom, education itself retains its identity as a holon and is not merged with the biology, economics, history and politics. If the individual merges history, politics and education in his understanding then his understanding is not holistic, but a merged heap. With a holistic understanding he will be able to untangle the heap and put together a holistic whole with separate parts of biology, economics, history, politics and education. Here we have moved from critical thinking to holistic thinking, but we have not dropped critical thinking, we retained it as a part, and transcended it, in holistic thinking. We must have Plato in order to have Descartes, and we must have Descartes in order to have Bhaskar, philosophically speaking.

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### **3.10.6 The Lesson**

Critical thinking encourages us to examine who is saying it, what are they saying, and why are they saying it. Using the example of Plato 'let no one enter the academy who has no geometry' we have learned to investigate from first principles, and so proceed from the simple to the complicated to the complex, by doing it, not by knowing it. We do not learn this from his authority (by rote learning his teachings by heart), but from the experience of doing what he says, and learning for ourselves. From our perspective in 2018, proceeding from first principles, thinking critically, we can differentiate the empirical, the actual, and the real. We discover Pi is real, if not actual or empirical. These are layers of reality in the philosophy of our era (Bhaskar, 1987).

### **3.11 Conceptual Framework for the Project**

Here we look at constructs gathered from the philosophy and create a conceptual framework.

#### **3.11.1 The Individual**

We have assumed that we have a tacit philosophy of work. Is this a valid assumption? Our behaviour in the world and in society demonstrates that we have underlying concepts of what is, what should be, what we know and how we know. The study of what is, what should be, what we know and how we know is called philosophy, and these domains are named ontology, ethics, epistemology and logic. We may not have articulated the philosophy. We may not have studied ontology, ethics, epistemology and logic, but we do act in the world, performing work in society, so our behaviour demonstrates that we have a tacit philosophy of work.

A prime constituent of individual agency is that we can always work from first principles to discover for ourselves. This may generate new knowledge or be an independent confirmation of existing knowledge, rediscovered through individual effort.

#### **3.11.2 The Collective or Group**

Now we come to society. There are structural constraints in society. We have collectives and individuals. Collectives include parties, corporations and civil society. We also have the constraints of the power relations of individuals and factions within the party or corporation or civil society.

Power historically has been political. People group into hierarchies and the levels of the hierarchy are levels of power to dictate. In the government we have political parties and in business we have corporations. The president or CEO, or the party in power, or the management, dictates what will happen. Opposition is seen not as a balancing force for the

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good of the collective (party, corporation or people), but as an enemy to be defeated. Opposition is suppressed within a dominator hierarchy, and this can be pathological. The experience of the suppressed is to feel oppression or repression. If conscience is denied or repressed it can create depression, anxiety or other maladies. As one politician in the ruling party said recently 'Don't come to me with a conscience, if you have a conscience you shouldn't join the party, you should have thought of that before you joined the party, but now you are in the party you have to subordinate yourself to the party. Conscience may have primacy in a church, but that primacy is not appropriate in a political party.' Clearly a person with a conscience should not join this party. We see here that the retention of power is given a higher value than integrity. This denies the principle of subsidiarity (Table 2) and the primacy of individual conscience. So, the hierarchy here is of power (in a political party) and not of values (as in a church) or competency (as in an academy). The comment of one social activist is graphic 'it is time to get up on your hind legs and howl.' The way the dean of Henley business school put it in a recent live podcast from Henley is: 'Progressive assertiveness is a mechanism for a subordinate to assume control in the event of a failure in the hierarchy, to avoid a catastrophe. The way this is achieved in practice is to make sure the differential between the leader and colleagues does not get so big that progressive assertiveness fails. We therefore have boards and committees with appropriate mixes of skills and sufficiently close levels of power between the individual directors or members.' In opposition to these collective mechanisms of corrective action will be powerful individuals wishing to dominate and retain power. If the collective fails individuals may become tyrants and eliminate both individual and collective opposition.

A prime constituent of community is collective responsibility to promote individuals who are contributing to the greater good and demote individuals who are detracting from the greater good (Plato, 1955). In this way we promote healthy hierarchies of competence and correct unhealthy hierarchies of power (pathological dominator hierarchies). The collective has no agency or will apart from its individual members and it is the duty of the members to contribute their individual conscience, reason and passion for the greater good. It is always incumbent on members to apply their minds to situations, without which the collective would lose its power to correct dominator hierarchies.

The collective stores and preserves knowledge from individuals for the greater good of the community from generation to generation, long after the passing of the contributing individuals. This knowledge base can be consulted by individuals wishing to learn or to extend knowledge.

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### 3.11.3 The Form of the Class

Many concepts arise in a philosophy of work. These concepts come from the investigation, from the literature review, discussions, brain-storms and so on. High level abstract concepts are called constructs and low-level concrete concepts are called variables. Two especially important useful constructs are the 'class' and the 'object.' The disciplines are modelled as classes based on Plato's Forms (1955) which were shown to be rational (based on reason) by Locke (1964). After Locke we would say that the class is produced by induction from our experience of the objects: the form or class is the 'one' perfect form or idea or type which is inferred from the 'many' actual instances.

A class is an abstraction that defines a type, and an object is a particular instance of the type. For example, 'Book' is a class defining books, and the telephone directory on my kitchen counter is a particular instance or an object of that type. Technically the instances are objects that are instantiated or made actual, so they exist in actuality. Whereas the class is not instantiated but remains an abstract concept in reality, not in actuality. 'Person' is a class and 'John' and 'Jane' are instances that walk around in actuality. Classes have attributes which belong to the class, for example the attribute 'height' in the Class 'Person.' Attributes in classes do not have values. Attributes are given values for particular instances. For example, 'Person' has 'height' and 'John' has height value '1.78m.'

In the investigation of the philosophy of work above all the concepts have been abstract constructs and can be classified as classes or attributes in a conceptual framework. We will denote them with the prefix Class and Attribute. Classes include individuals, collectives and disciplines as constructs or abstract concepts. Plato used the term Forms, which are abstract conceptions towards which we aim. The actual situation is not ideal and may be painful, so we bear in mind the Form, and try to make it actual in order to reduce pain. In other words, we improve the actual individual and actual society. The concept of the Class or Form is not simply to define the better or the ideal, but it is meant to be used practically to create a better life, by bettering actual instances.

1. Class: Collective or Group or Organisation (an organised group with hierarchy)
  - a. Class: Union
  - b. Class: Church
  - c. Class: Corporation
  - d. Class: Party
  - e. Class: Civil Group
  - f. Class: National government
  - g. Class: Provincial government
  - h. Class: Local government

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2. Class: IndividualRole (the role of an individual in society)
    - a. Class: Educator
    - b. Class: Employer
    - c. Class: Employee
    - d. Class: Entrepreneur
    - e. Class: Activist
    - f. Class: Intellectual
    - g. Class: Leader
    - h. Class: Follower
    - i. Class: Policy maker
    - j. Class: Public servant
  3. Class: IndividualOccupation (the role of an individual in the workplace)
  4. Class: CollectiveActivity (before work, work, and after work)
    - a. Policy Making
    - b. Regulation
    - c. Education and Training
    - d. Work
    - e. Recreation
  5. Class: Personality (the personal characteristics of an individual)
    - a. Class: Type
    - b. Class: Level
    - c. Class: Desire
    - d. Class: Fear
    - e. Class: Attitude
    - f. Class: Behaviour
    - g. Class: Worldview
    - h. Class: Life condition
  6. Class: Hierarchy
    - a. Class: PowerHierarchy
    - b. Class: CompetencyHierarchy
  7. Class: Telos (end, goal, reason for work)
    - a. Attribute: Quality (level)
      - i. Survival.
      - ii. Hedonic. Happiness.
      - iii. Eudaimonic. Actualisation.
    - b. Attribute: Quantity (number/amount)
      - i. Increase profit
      - ii. Increase revenue
      - iii. Increase production (knowledge, services, goods)
      - iv. Increase income
      - v. Save time
      - vi. Reduce costs
  8. Class: Education
  9. Class: Training
  10. Class: Knowledge
  11. Class: Discipline
  12. Class: Process
    - a. Specialisation
    - b. Generalisation
    - c. Differentiation
    - d. Integration

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13. Class: LC Plane (quadrants of legitimation codes for intellectual fields of practice)
    - a. Class: Specialisation (knowledge/knower structures in intellectual fields of practice)
      - i. Epistemic relations (legitimate knowledge)
      - ii. Social relations (legitimate knowers)
    - b. Class: Semantics (meaning, that can change, rise and fall in fields of practice)
      - i. Semantic gravity (context dependency of meanings)
      - ii. Semantic density (complexity, degrees of meaning)
    - c. Class: Autonomy (in an intellectual field of practice)
      - i. Positional autonomy (degree of being controlled)
      - ii. Relational autonomy (degree of interconnectedness)
    - d. Class: Density
      - i. Material density (coherence)
      - ii. Moral density (homogeneity)

#### **3.11.4 From Reality to Actuality through Classes to Objects**

We can structure the concepts arising from the discussion as a conceptual model shown in the figure below. The subject-object boundary appears when the dualistic world drops out of the non-dual underlying reality, in other words when we are conscious of the subject as seer and the object as seen. This is something we experience by sitting quietly and noticing that it is the case. Subject object duality is an immediate experience. All sorts of objects appear to perception. Classes of objects are abstractions denoting the type of object. These classes can be further subdivided into subclasses which are classes themselves as they are also abstractions denoting their type. For example, corporations are subclasses of groups or collectives, leaders are subclasses of individuals and education and commerce are subclasses of the discipline of social science.

Instances of classes are actual objects, for example Vodacom is an actual corporation, an object which is an instance of the conceptual class called Corporation. This corporation has actuality as Vodacom and is in reality a Corporation. If we want to create a new corporation, we instantiate an actual corporation. The new corporation will have the underlying reality of the definition of what a corporation is. It will inherit the attributes, methods and rules and regulations of a corporation as defined by the class called Corporation.

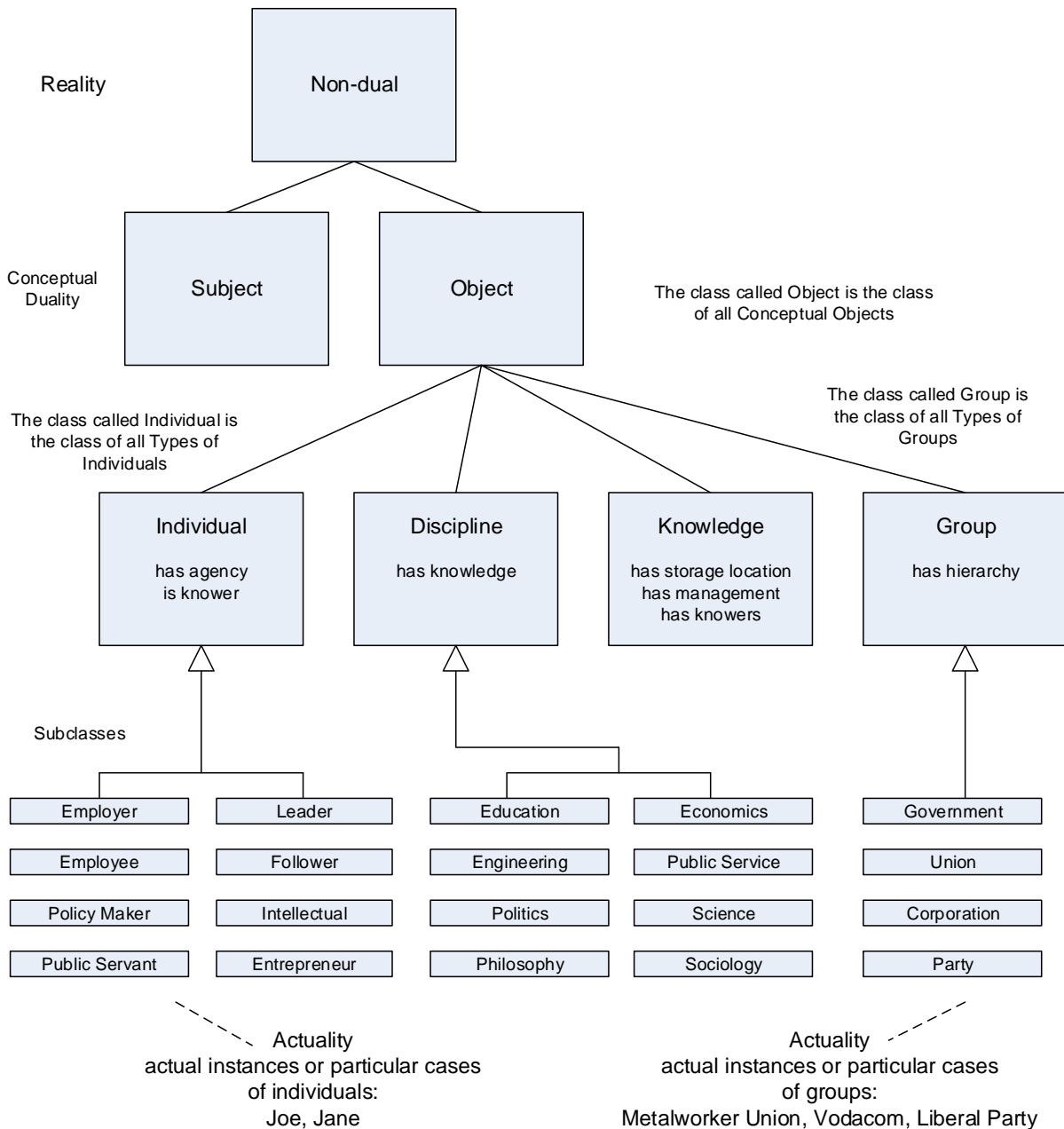


Figure 4: Conceptual Framework

Classes of individuals such as leaders and intellectuals would have instances such as Jane and Joe and these are objects in actuality. If we speak of the subjectivity of these people, we are in the dualistic domain. We bring the subject into the discussion. Jane and Joe may offer subjective opinions. Such opinions may be from their perspective as leaders or intellectuals, or perhaps from other roles they may also play such as mothers, fathers, sisters, brothers, taxpayers, consumers and so on. Multiple opinions can come from the same individual from the perspective of different roles simultaneously held.

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'Consciousness is a singular, the plural of which is unknown' (Schrodinger, 1944). All that appears to us is in the spaciousness of that consciousness. The contents that appear may be social or physical or biological or technological or psychological, but these do not determine consciousness, rather consciousness perceives them. What we are focusing on becomes the object of consciousness, the content of consciousness. If we are asleep there is no object of consciousness. If we are dreaming, the objects of consciousness are fantastic. If we are awake, the objects of consciousness are perceptions of social or physical or biological or technological or psychological objects. When we look for the subject, we can't find her or him because the subject is identified with the consciousness that is doing the seeking. Looking for the subject is like going for a walk to find your feet. The looker doing the looking is what the looker is looking for. People in inter-subjective communication expressing their role perspectives are creating the content of consciousness rather than being the consciousness. The U process of Scharmer caters for making a space in which to become consciousness again so as to consciously participate in the conversation and not be caught up in a perspective. The conceptual framework has the subject object divide and the multiplicity of objects, and no multiplicity of the singular that is consciousness.

Objects include physical and biological objects but also knowledge objects. Knowledge is considered, using the axiom of the included middle, both that which is known by the knower (i.e. existing in the mind), and also (more loosely) that which is stored in the knowledge base of humanity (books and electronically stored files). I recognise that the knowledge stored in the knowledge base is actually only symbols on pages (representing letters, words, sentences, paragraphs, chapters) or bytes, in turn representing ASCII symbols in electronic files, in turn representing letters, words, sentences, paragraphs, chapters, and that the words only really become knowledge in the mind of the knower, however, it is common practice to call the representations (words and bytes) 'knowledge' and stored 'knowledge' a 'knowledge base.' We use this common practice because the important thing about the store is that when it is accessed by the knower it is knowledge. The knowledge base is differentiated from a library of fiction or story base, because when accessed by the knower fiction does not provide knowledge, but stories. Therefore, in some sense the knowledge base contains knowledge.

Although consciousness is a singular, we see and understand things differently from each other so what is going on here? The differences we have with others are in the contents, and it is the contents that develop (e.g. becoming an expert in a discipline, developing an understanding of the material). Consciousness doesn't develop but has states, waking, dreaming and sleeping, which do not develop, and which are present even in babies and infants (Wilber, 1995). But the contents of consciousness such as the understanding in the

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adult have developed and are not the contents of the consciousness of the infant. Knowledge develops, people develop, dogs and horses develop, and these are all on the object side of the divide. Cognition develops from perception to symbol to concept to concrete operation to formal operation to vision-logic. Consciousness is singular, does not develop, and is the space in which objects arise (e.g. concepts arise, formal operations arise).

Consciousness is no thing. It is not an object. The third law of transdisciplinarity (Max-Neef, 2005) states that 'Because of what is not there, it is possible that there is what is there; and because of what is there it is possible that there is not what is not there.' Because of consciousness there are objects in consciousness. Because of objects we are distracted from consciousness and get wrapped up in the objects of consciousness. The no thing we have in common is consciousness. Now it is also true that objects exist that are not in consciousness (this is called realism). The rocks and trees are still there even when we are not conscious of them. But without consciousness the rocks and trees are just what they are in non-duality. There is no consciousness that considers them as rocks and trees, and so no concepts of rocks and trees. In the same way, the words in the books in the knowledge base are just what they are in non-duality. There is no consciousness that considers them as words. Therefore, we see that in non-duality there are not differentiated objects, but there is what is, and this is because it is in consciousness that we differentiate them as objects, and this occurs only with the subject object divide.

The conceptual framework shown in Figure 4 has all the elements of the unstructured problem situation. It shows example individuals and groups and their roles and disciplines, or fields of academic study, and the knowledge produced by the disciplines, as seen from the dualistic standpoint of the subject object divide. We have the concepts in a conceptual structure, but no articulated problem situation. We can move from the unstructured problem situation to an expressed problem situation by defining a problem situation. In soft systems methodology, the next step would be to gather definitions to construct a conceptual model using systems thinking. Constructing such a model is the subject for the next chapter.

### **3.11.5 Best Practice Iterative and Incremental Approach**

Best practise in engineering is to take an iterative and incremental approach in model building. Each iteration adds some incremental value. The first iteration would be a model that provides a way of working in a network of disciplines through collaborative interactions between disciplines. A further iteration would show that the model could take into account the quadrants of integral philosophy. A further iteration would show that the model can be represented on the tiers of disciplines of transdisciplinarity.

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## **4. A MODEL OF ANY DISCIPLINES (MOAD)**

### **4.1 Roadmap to This Chapter**

The chapter describes a new model, which is the primary objective of the dissertation. It includes the philosophical constructs on which it is founded, the model definition, the form of representation, configuration, and an example configuration of a problem area beyond the scope of a discipline. A case is supplied to demonstrate the applicability of the new model to the bio-psycho-social developmental model. A case of misuse of the model is supplied to show how outside influences can corrupt the outcome, and how such influences can be re-modelled to obtain a valid understanding, through reconfiguration. The chapter contains the complete model definition so that it can stand alone as a separate document.

### **4.2 The concept of a Phylum of Disciplines**

We are used to working with 'Classes' of disciplines and 'Divisions' of disciplines in University 'Faculties' and 'Departments.' We generally do not think about a 'Phylum' of disciplines which contains all the classes and so we lack a model for working with the Phylum or a portion of the Phylum that is not delineated by a Class or Division. This chapter introduces a model that is appropriate for any real-world problem area that transcends a discipline of the Phylum. It can be used on any part of the Phylum. The Phylum is the knowledge-base of humanity.

The model provides a business method or way of working with a configurable part of the Phylum appropriate for interdisciplinary research.

### **4.3 Description**

I am creating a model known as a 'model of any disciplines' (MOAD), which is a new concept, original with this dissertation, using the concepts of forms (Plato, 1955); holism (Smuts, 1926, Koestler, 1967, Wilber, 1995, Jantsch, 1980); integral philosophy (Wilber, 1995); the sequence of development: disciplinary, multidisciplinary, interdisciplinary, transdisciplinary (Max-Neef, 2005); the tiers of disciplines in transdisciplinarity (Max-Neef, 2005); the activation of underlying mechanism (Bhaskar, 1987); the rational inter-subjective exchange of uncoerced mutual understanding (Habermas, 1987); the validity claims (Habermas, 1984); the 'high cohesion – low coupling' design pattern (Gamma et al., 1995); and soft systems methodology (Checkland, 1990). Design patterns in turn originated in the discipline of architecture (Alexander, 1997).

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Christopher Alexander had noticed that problems often have associated patterns, and if the patterns can be recognised, then solutions can re-use successful existing patterns, and avoid reinventing the wheel. He documented such patterns and created a pattern language for architecture. If we can see patterns it can mean that there is an underlying system, and that is what is creating the patterns. The concept of design patterns has been strongly developed in the engineering of systems, in which I am experienced, and I use this systems background in creating the model.

A MOAD is a designed abstract system, which can be implemented as a network of human practitioners, which would make it a human activity system (Figure 15), or else it can be implemented in software, which would make it a designed physical system (Figure 16). Communications in the software system would be messaging between software modules, whereas communications in the human activity system could be verbal, or textual such as email or electronic messaging between academics or practitioners.

The designed physical system would be testable with repeatable results given a fixed version of software which implemented a fixed knowledge base in a database. The human activity system on the other hand could never be a single testable account, as the account would vary with the specific actors in the specific scenario, with their individual extraction of meaning.

A MOAD can be configured with any number of disciplines networked together with interfaces between disciplines. This approach is generic to any problem transgressing the boundary of a discipline. It is the configuration (the chosen network of particular disciplines) that makes it applicable to any specific, highly context-dependent and particular problem area.

The aims of using a MOAD are

- (a) knowledge production
- (b) information extraction
- (c) problem solving
- (d) to help manage complex problem areas that are beyond the scope of a discipline.

These are not problems to be solved, but problem areas to be managed. For example, achieving sustainable development goals or a resource-based economy.

Using soft systems methodology, I gather together the definitions to construct the conceptual model. Sections 4.4 to 4.6 (the philosophical definitions) are copied down from the critical synthesis in chapter 2. The model definition is then created in section 4.7.

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## 4.4 Philosophy

All of the philosophy is attributed to the philosophers. It is not the creation of the researcher. Tenets of philosophy are powerful statements that are not easily substantiated but can be used by an engineer, not because they are true, but because they have suitable functional fit.

### 4.4.1 Philosophical Methods

The following methods were useful in creating and using the model.

Socratic method	Cooperative dialogue, starting from a place of not knowing, and seeking understanding through the dialogue.
Dialectic method	Debate, without rhetoric and without subjective or emotional appeal, with different points of view, establishing truth through reasoned argument.
Descartes' method	We have enough rules if we (1) look for evidence, (2) deconstruct into parts, and (3) order from simple to complex, and finally (4) be thorough to assure completeness so we know when we are truly done.
Hegelian Dialectic	Dialectic, in which a first proposition (thesis) and an apparent contradiction (antithesis) are reconciled in a third proposition (synthesis) which is at a higher level of truth and transcends the contradiction. This aligns with Einstein's comment that we cannot solve a problem with the level of thinking that created it.
Habermas' method	Communicate at the highest level through the rational inter-subjective exchange of uncoerced mutual understanding.
Bhaskar's method	Experiment in a way that activates the underlying mechanism. If it is a natural science system this is more easily done. If it is a human activity system, activating the underlying mechanism is more difficult and must consider the social structure which imposes on individual agency.
Wilber's method	Include all the perspectives. Include the inside/subjective view and the outside/objective view. Include individuals and collectives with their inter-subjective and inter-objective patterns. Include lines and levels of development, and non-developmental states and types.

### 4.4.2 Tenets of Holistic Philosophy

Summarised from (Smuts, 1926, Koestler, 1967, Wilber, 1995, Jantsch, 1980).

1. Reality is composed of holons (wholes which are also parts).
2. Holons have the capacities of
  - a. Self-preservation (they remain individuals in any context, they have agency)
  - b. Self-adaptation (they accommodate themselves; they have communion)
  - c. Self-transcendence (they become part of a greater holon)
  - d. Self-dissolution (holons breakdown in the reverse sequence of building up)
3. Holons emerge (e.g. quarks, atoms, molecules, cells ...). Emergence produces layers.

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4. Holons emerge holarchically (as a hierarchy of component holons). Hierarchy is a natural emergence, not a socially constructed concept.
  5. Holons transcend and include predecessors (e.g. molecules include atoms).
  6. The lower sets the possibilities of the higher; the higher sets the probabilities of the lower. (the higher is only possible through the lower parts; the lower can only do what it is constrained to do as a part, so for example hydrogen behaves as constrained by water when it is part of a water molecule even though it is hydrogen).
  7. Depth is the number of levels in a holon (e.g. cells (level 4) are made up of quarks (level 1), atoms (level 2) and molecules (level 3). Span is the number of holons at any given level.
  8. Each level has greater depth but lower span than the previous level (e.g. there are always more atoms than molecules, because the atoms in molecules still count as atoms, they don't disintegrate when becoming part of molecules).
  9. When a holon is destroyed, all holons above it are destroyed, but no holon below it is destroyed (e.g. if you break apart molecules you destroy cells, but not atoms).
  10. Holarchies coevolve (holons do not evolve alone, and never exist alone).
  11. The micro and the macro relate at all levels (for example people made of matter, life and mind relate physically, biologically and psychologically).
  12. Evolution has directionality (things get more complex with levels of development e.g. atoms to molecules to cells). See for example, 'The Self-Organising Universe' (Jantsch, 1980:75) 'the evolution of the universe is the history of an unfolding of differentiated order or complexity.' The tenet is not about Darwin's theory. In the short term we might get some regression, but over the long term, complexity increases.

#### **4.4.3 Tenets of Integral Philosophy**

Summarised from (Wilber, 1995).

1. Integral philosophy includes quadrants, lines, levels, states and types.
2. There are four types of hierarchies of holons which we call quadrants (4). They are the objective (individual exterior), subjective (individual interior), inter-subjective (collective interior) and inter-objective (collective exterior) quadrants. Each has a validity claim. An inside and an outside perspective can be taken on each quadrant.
3. Lines of development are exclusive but may be interdependent. For example, the moral line of development may depend on the cognitive line of development.
4. Levels are stages of development along a line.
5. States are not developmental. They come and go independently of development. Examples of states are waking, dreaming and sleeping.

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- Types are not developmental. They tend to remain for the long term, rather than come and go. Examples of types are personality and gender. For example, a developed male is still a male, so his development must be in something other than gender. The development that occurs is in the lines (above).

#### **4.4.4 Validity Claims**

The validity claims of the four quadrants (Habermas, 1984, Wilber, 1995) are

- truth by empirical correspondence (in the first quadrant / third person / it / objective)
- truthfulness (in the second quadrant / first person singular / I / subjective)
- justice (in the third quadrant / first person plural / we / inter-subjective)
- functional fit (fourth quadrant / third person plural / 'its' or they / inter-objective)

In other words when we want to check out the validity of phenomena

- we validate whether 'It' is objectively true (or false)
- we validate whether 'I' am truthful (or lying)
- we validate whether 'We' are just (or unjust)
- we validate whether 'Its' have functional fit (or are incompatible or compromised)

#### **4.5 Subset of Tenets of Transdisciplinarity**

Adapted from (Max-Neef, 2005). The model at the current state of development uses a part of the large and complex field of transdisciplinarity. It does not cater fully for transdisciplinarity.

1. The sequence or continuum is disciplinary, multidisciplinary, interdisciplinary, transdisciplinary.
2. Disciplines can be placed in tiers which coordinate or inform each-other.
3. Values disciplines coordinate normative disciplines which coordinate pragmatic disciplines which coordinate empirical disciplines.
4. Empirical disciplines inform pragmatic disciplines which inform normative disciplines which inform values disciplines.

#### **4.6 Ways of Thinking**

The following ways of thinking are used in generating and using the MOAD

1. Idealistic (emphasizing the ideas)
2. Realistic (sensible, practical, achievable, dealing with reality)
3. Critical (analytical critique, contradictory perspective, differentiation)
4. Relativistic (cultural, social and natural connections, relations & levels of development)

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5. Systemic (thinking in terms of systems and integrative mechanisms, integration)
  6. Holistic (thinking in terms of holons, transcendence and inclusion)

Absolutistic thinking is avoided so as to minimise dogma and promote uncoerced mutual understanding or free speech.

#### **4.7 Definition of a Model of Any Disciplines (MOAD)**

1. A MOAD is
  - a. A conceptual model of any disciplines in a network.
  - b. Based on integral and holistic philosophies and optionally using tiers of disciplines.
  - c. Created using various forms of thinking: idealistic, realistic, critical, relativistic, systemic and holistic thinking. Idealistic thinking sees the MOAD as an idea. Realistic thinking sees the MOAD as a useful means-to-an-end. Critical thinking sees the MOAD as provisional and limited. Relativistic thinking sees the MOAD as a device for taking perspectives. Systemic thinking sees the MOAD as a system. Holistic thinking sees the MOAD as a holon, transcending and including disciplines as subordinate holons.
2. Configuration. A MOAD can be
  - a. Configured with any disciplines.
  - b. Configured with disciplines as components in a system.
  - c. Configured with disciplines as holons in a holarchy.
  - d. Configured with user interfaces.
  - e. Configured with discipline interfaces.
  - f. Configured with a configuration module e.g. C4TD (Figure 16).
  - g. If the model is configured with disciplines on just one quadrant of the integral model, or one tier of transdisciplinarity, it is a specialisation. The model allows specialisation. It is not a requirement to use all the quadrants and all the tiers of transdisciplinarity in a configuration. This means the model can cater for special problem areas as well as general problem areas.
  - h. A model configured with disciplines with no interfaces
    - i. Is multidisciplinary, but not interdisciplinary.
    - ii. Is a conceptual tool to encourage creative questioning.
    - iii. Introduces Venn concepts of overlap and holonic inclusion or holarchy.
    - iv. Can be a first step in selecting disciplines before adding interfaces.

- 
3. Prime constructs in a MOAD are
    - a. Classes of individuals and collectives and of disciplines at all levels based on forms (Plato, Locke, OMG UML).
    - b. Networking by means of discipline interfaces.
    - c. Quadrants of perspectives: subjectivity, inter-subjectivity, objectivity and inter-objectivity (Wilber).
    - d. The Cartesian grid (Descartes).
    - e. Activation of underlying mechanisms (Bhaskar).
    - f. Communication of uncoerced mutual understanding (Habermas).
    - g. Levels of development in lines (Wilber).
    - h. Bio-psycho-social value memes (Graves, Beck and Cowan).
    - i. States and types are de-emphasised for the model.
  4. Implementation
    - a. Conceptual. A MOAD can be implemented as a conceptual model on any, all or none of the four quadrants of integral philosophy or on any, all or none of the four tiers of transdisciplinarity. In this case the disciplines and practitioners are conceptual.
    - b. Expert. A MOAD can be implemented as verbal and textual interactions between academics or practitioners (experts) in disciplines. This implementation is a human activity system. This makes it a complex system, whose outcomes cannot be predicted before execution.
      - i. For T1 research (within the academy) participants may be academics who self-select through open invitation, or who are invited to participate by the researcher, based on their expertise. They shall be open to uncoerced communications, free speech and academic freedom.
      - ii. For T2 research (bridging the academy and society) or action research in the workplace, participants may be undisciplined (lack academic qualification) but nevertheless able to contribute through local knowledge in the community on the ground. Undisciplined inputs could be labelled discipline xxx (unassigned). Such contributions may not be expert, and this is highlighted through the xxx label.
      - iii. For human activity systems, clarity can be maintained through the actions defined in section 4.11, where academics may be brought in to add discipline to undisciplined input through re-presentation. The disciplined inputs represent (or replace) the undisciplined inputs as a validation mechanism.

- 
- c. Expert Systems. A MOAD can be implemented as a system of software modules with user interfaces. This could be a knowledge-based system such as a network of expert systems or components with artificial intelligence.

#### 5. Holons

- a. Disciplines are defined as holons.
- b. Disciplines defined as holons are given a boundary.
- c. Disciplines defined as holons can form a holarchy with functionality that transcends the functionality of the component disciplines.
- d. Disciplines defined as holons conform to the tenets of holistic philosophy.

#### 6. Boundaries

- a. The boundaries of disciplines are arbitrary but are required for the model, so that we can define interfaces between them.
- b. So, we could use for example, the Dewey Decimal Classification of a discipline as its boundary. Disciplines could be classes, divisions, sections or subsections. For example, at the division level we can say medicine is whatever is defined within DDC division 610, engineering is DDC division 620 and agriculture is DDC division 630. At the lowest subsection level, we can say, for example, the discipline Lattice Quantum Chromodynamics could have the boundary defined by DDC subsection 539.120.811.
- c. A new discipline xxx can be created which communicates with various existing disciplines. The new discipline xxx would eventually be given a classification code and become a newly existing discipline. See Figure 9.

#### 7. Discipline Interfaces

- a. Discipline interfaces can be created between any disciplines.
- b. Forms of communications on the interfaces between disciplines include
  - i. Queries (requests for information). The fundamental question is 'what questions does this discipline address?'
  - ii. Commands (requests to do something). The fundamental question is 'what can this discipline do for the world?'
  - iii. Notifications (unsolicited provision of information/comments).
- c. Lists of queries, commands and notifications can be requested from any interface. These lists define the scope and capabilities of the interface, which are basically 'what questions the discipline answers, what commands it accepts to do something, and what notifications it provides.'
- d. A discipline can execute any query or command or notification on interfaces to other disciplines.
- e. Theoretically any two disciplines can have an interface.

- 
- f. Interfaces can be at any level or between any levels of disciplines (class, division, section, subsection etc.) e.g. 100 - 300, 100 - 620, 620 - 620.12, or 539.120 - 539.120.811 which is the interface between 'Theoretical problems of particles' and 'Lattice QCD.'
8. User interfaces
- a. User interfaces can be created on disciplines and on the disciplinary interfaces.
  - b. A user can execute any query or command on the user interface to a discipline.
  - c. A user can execute any query or command or notification on the user interface to a disciplinary interface.
  - d. A configuration module can be created with a configurator's user interface.
9. Inputs, Transformations, Outputs
- a. The model takes inputs in the form of queries, commands and notifications.
  - b. The model transforms the inputs into outcomes that could not be produced from a single discipline.
  - c. The output can be
    - i. Knowledge production in existing or new disciplines.
    - ii. Information extraction.
    - iii. Problem solution.
    - iv. Ideas about managing problem situations which transgress boundaries or transcend disciplines.
10. Emergent properties
- a. Outcomes obtained from the MOAD, that are not obtained from a component part operating alone, emerge from the MOAD, and this makes the MOAD a system or a holon with emergent properties.
  - b. The emergent properties of the MOAD are solutions to problems, or methods of managing problems that are not achieved within any single discipline.
  - c. Outcomes can have unanticipated emergent properties.
  - d. Outcomes may be scientific, technological, humanistic, socially robust or mixed. Validity claims may be truth, functional fit, truthfulness, justice or mixed.
  - e. For the conceptual implementation, outcomes will depend only on the researcher. It is the human activity of a single human.
  - f. For the expert implementation, outcomes will be dependent on the participants, who are free to extract meaning.
  - g. For the expert system implementation, outcomes will depend on the extent of artificial intelligence.

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#### **4.8 Representation of a Model of Any Disciplines (MOAD)**

From the concept of disciplines as holons, and their arrangement in a classification system, and by analogy with a system of components we develop a 'model of any disciplines' (MOAD) with interdisciplinary interfaces as shown in the figures below. The idea of using the Dewey decimal classification system number for the discipline is not to be rigid, but to have a well-defined boundary for a discipline, so that we can define interfaces to it. Later in this section we show that the MOAD concept can be extended to new interdisciplinary knowledge being created in new fields or new disciplines. New appropriate classification codes would be proposed. The three-digit numbers are the Dewey Classification Codes of the discipline. Any other classification system would be equally as suitable, provided only that it defines the boundary of each discipline.

I have shown interfaces as circles and disciplines as ellipses or rectangles. Ellipses are useful for showing overlaps especially when interfaces are not shown (e.g. Figure 6). Rectangles give a greater differentiation between interfaces and disciplines (e.g. Figure 8).

##### **4.8.1 MOAD without Interfaces**

The first step beyond disciplinary is multidisciplinary. We look at a set of disciplines that are not connected (multiple disciplines). A MOAD without interfaces is a conceptual tool for creative research and encourages the holonic view, capturing multiple disciplines in a holarchy of holons. Overlap indicates inclusion. Subordinate (included) holons are shown inside superordinate (transcendent) holons. This representation of the MOAD uses ellipses for disciplines. The disciplines are not connected as components with interfaces and therefore not shown as rectangles connected by circles.

Clare Graves produced a bio-psycho-social model of human development whilst researching psychology in the 1970s and this has been captured in spiral dynamics by management consultants (Beck and Cowan, 1996). For example, the MOAD of human (bio-psycho-social) elements and robotic (technological) elements shown below presents disciplines for a dominant theme of our time. Are people ends-in-themselves or means-to-an-end? Are robots ends-in-themselves or means-to-an-end? The technology exists to generate music and literature with computers, but the appreciation thereof remains subjective, in the minds of human beings. Human beings are bio-psycho-social holons and robots are hardware-software-system technological holons. Music and literature are humanities, along with the ethics and logic of philosophy and psychology of the mind. The bio element is the objective body of the living human organism. The social element highlights that holons do not exist alone

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(section 4.4.2 tenet 10). Welfare means health, happiness and fortune and is a discipline of social science.

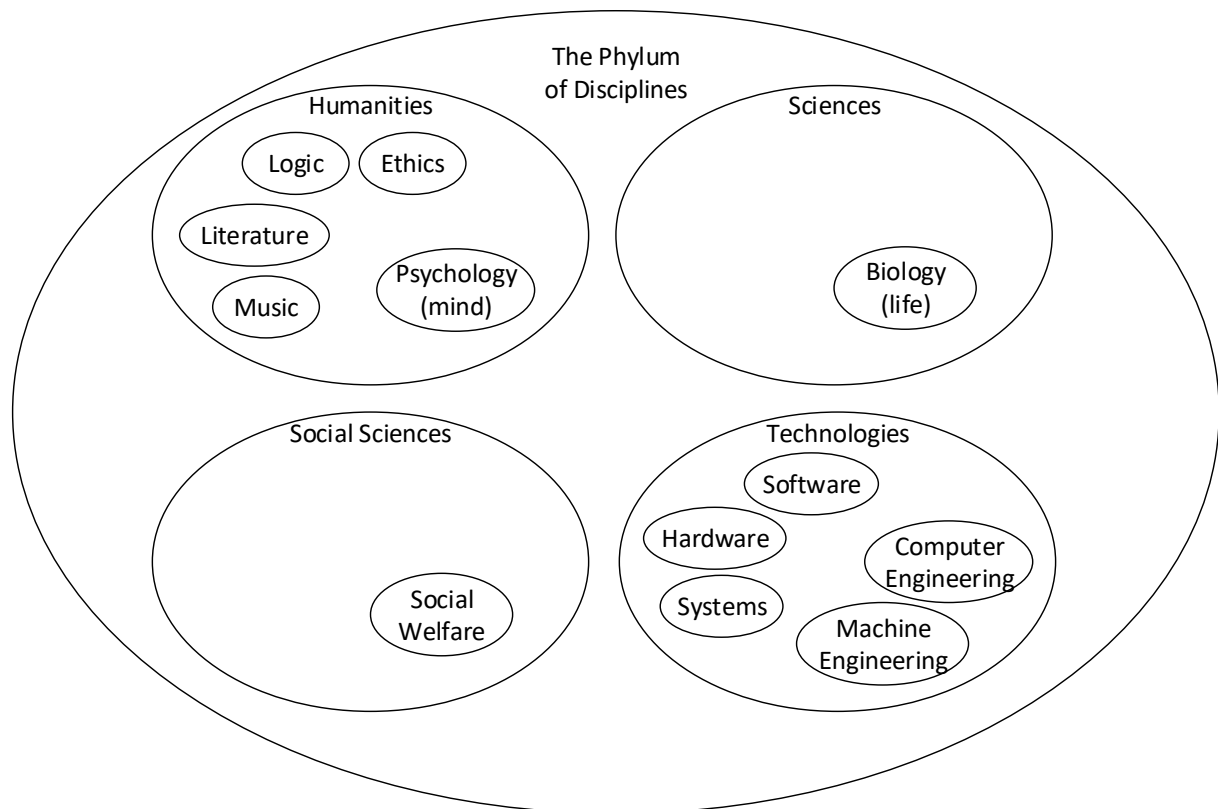


Figure 5: MOAD with human (bio-psycho-social) and robotic (technological) elements

We might add colours to represent types of thinking. The following MOAD shows: blue (idealistic), orange (critical), green (relativistic), yellow (systemic) and turquoise (holistic) thinking. These originally appeared with the development of levels 4-8 of the bio-psycho-social model of Clare Graves in the spiral dynamics of Beck and Cowan (1996) and in integral philosophy (Wilber, 1995). For example, hardware, software and computer engineering originally appeared with development of the yellow value meme, whilst social sciences are dominant in the green value meme.

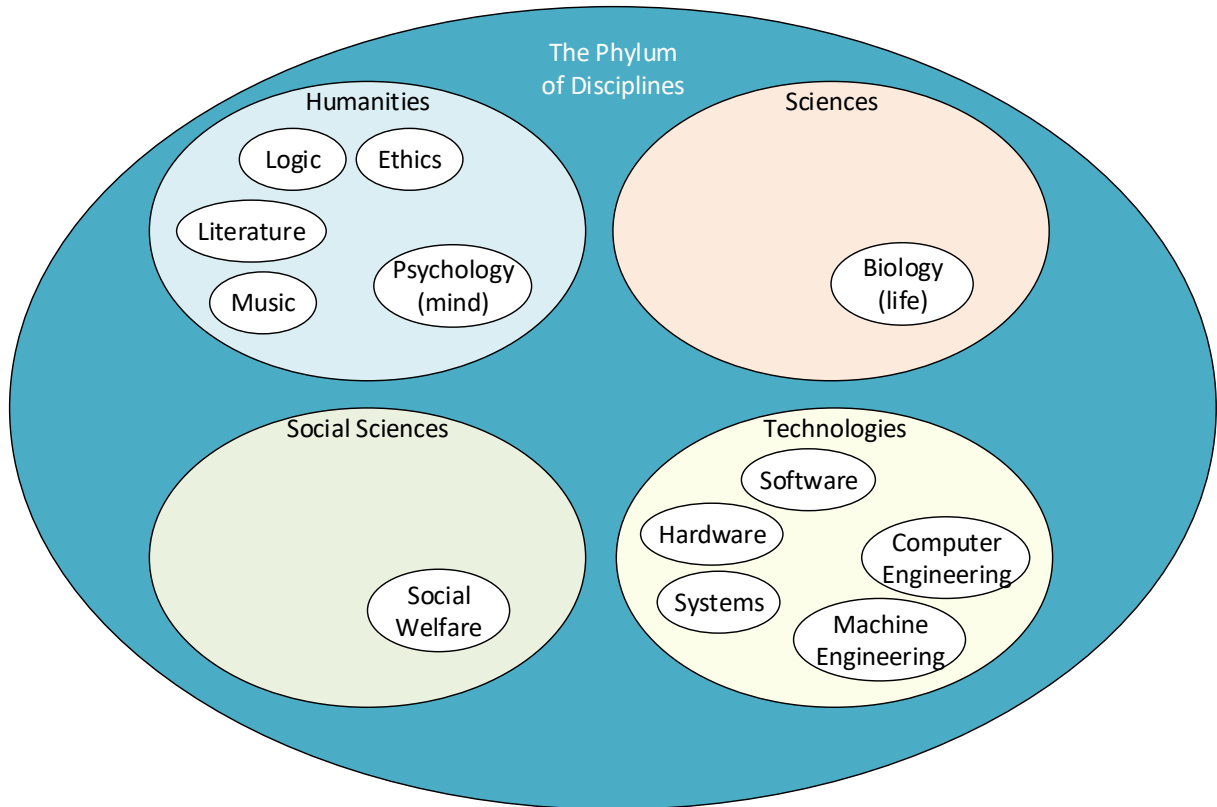


Figure 6: MOAD with human (bio-psycho-social) and technology elements in colour

#### 4.8.2 Open MOAD

The next step, beyond multidisciplinary, is interdisciplinary. Disciplines can be networked together via interfaces. The diagram below, called an Open MOAD, is not mapped onto any philosophy. The background is open white space. It is a simple interdisciplinary network.

For example, consider the 'psycho' element of the appreciation of music and exclude the 'bio' and 'social' elements for this purpose in an Open MOAD (Figure 7).

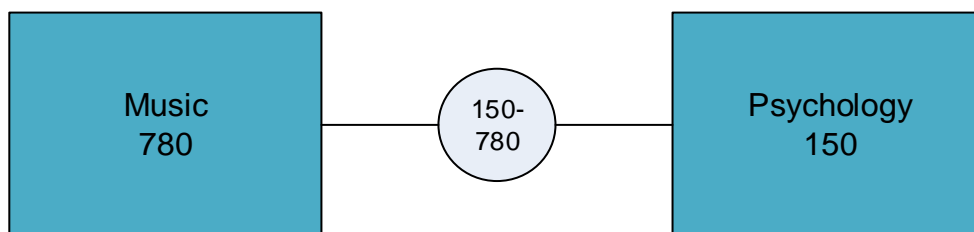


Figure 7: Open MOAD for the psycho element of appreciation of music

Furthermore, we might add colours to indicate that we are also considering the bio-psycho-social level of development. Suppose we are considering the appreciation of music, as a

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conceptual study in the library, of a researcher at the turquoise bio-psycho-social level of development. Because her thinking is holistic, she will want to take everything into account, but she will need to apply critical thinking to narrow her concern to just psycho elements. It might be difficult to exclude the natural physiological and social elements that come with an appreciation of music. The disciplines of music and psychology must be abstracted from the experience of listening to or thinking about music. If for example, we start to think about levels of dopamine and serotonin, then we are into bio and biochemical elements of the experience, which is outside the domain of psycho elements, and so out of scope for this study. If we start to contemplate phenomenology, we can debate whether to include philosophy in the study, and whether to include Husserl and perhaps Wittgenstein on language for expressing the ideas. The model in the Figure 7 helps to bring the focus back to the scope of the interdisciplinary research being undertaken.

The context for the next example Open MOAD is the LCT Centre Occasional Paper 1 (Maton and Howard, 2018), which indicates that there is political pressure for universities to cater to employers by connecting the curriculum to the workplace experience. This pressure could be modelled as interactions on the interface 320-370 (Politics to Education) and 370-650 (Education to Business). Politicians might get this drive to apply political pressure on education from a desire to raise income tax i.e. economic influence on the 320-330 interface (Economics to Politics). For the influence of business on politicians one might add the 320-650 interface (Business to Politics). The integration of science in engineering education could be modelled as interactions on the interface 370-500 (Education to Science), 370-620 (Education to Engineering) and 500-620 (Science to Engineering).

MOAD conceptual model of any disciplines

(showing a subset of disciplines under consideration & some of their interfaces as an illustration)

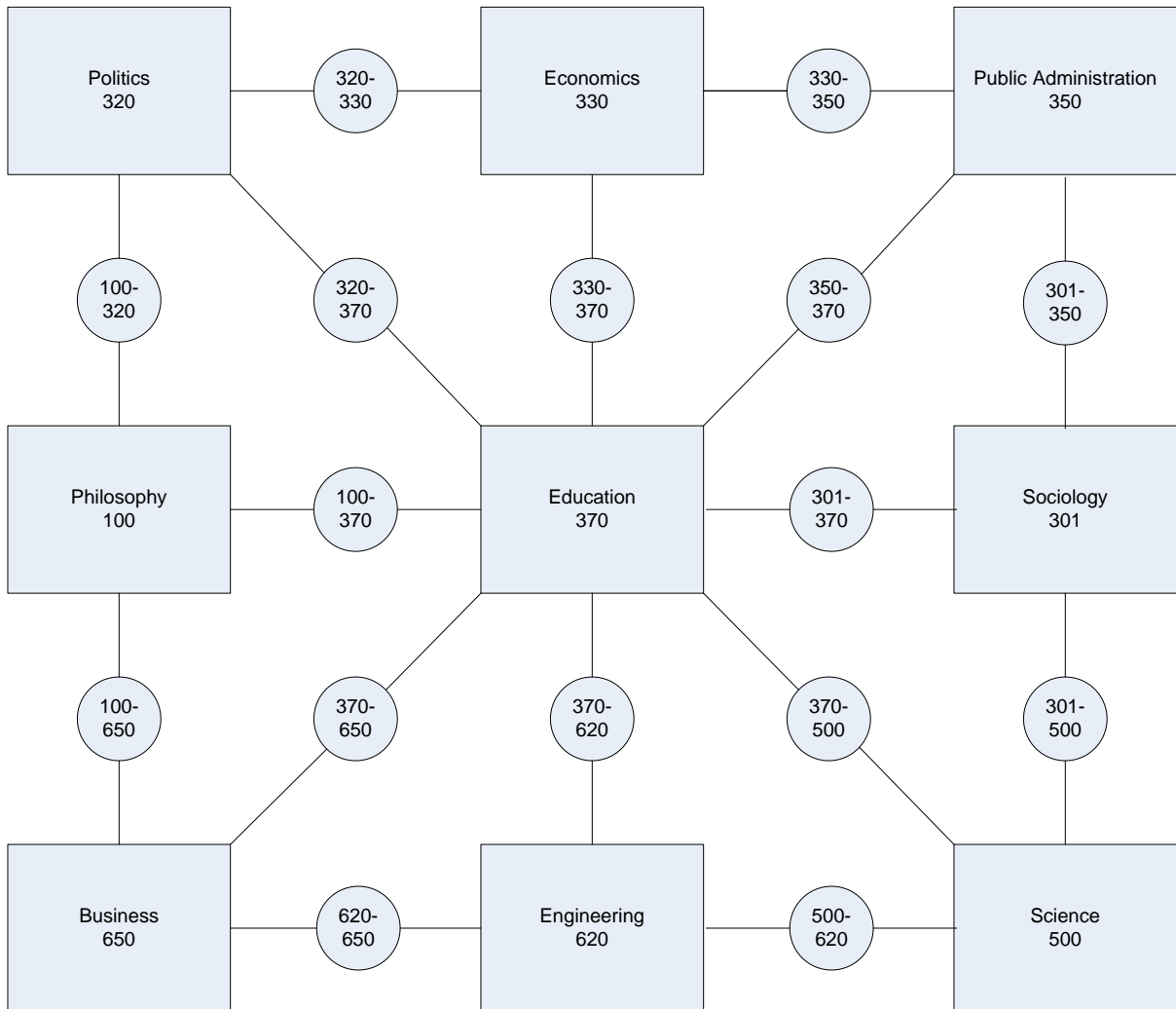


Figure 8: Open MOAD with Education shown Centrally

#### 4.8.2.1 New Discipline shown on an Open MOAD

The MOAD is also applicable for creating new fields where interdisciplinary research is creating new knowledge in a field that holds the interdisciplinary knowledge that does not belong in the original fields, such as creation of something new from biochemistry, genetics and food technology. This could cater for merging of disciplines. For example, we might create a new discipline 'biogentech,' created from biochemistry, genetics and food technology.

MOAD conceptual model  
for creating a new field xxx through interdisciplinary research in existing fields

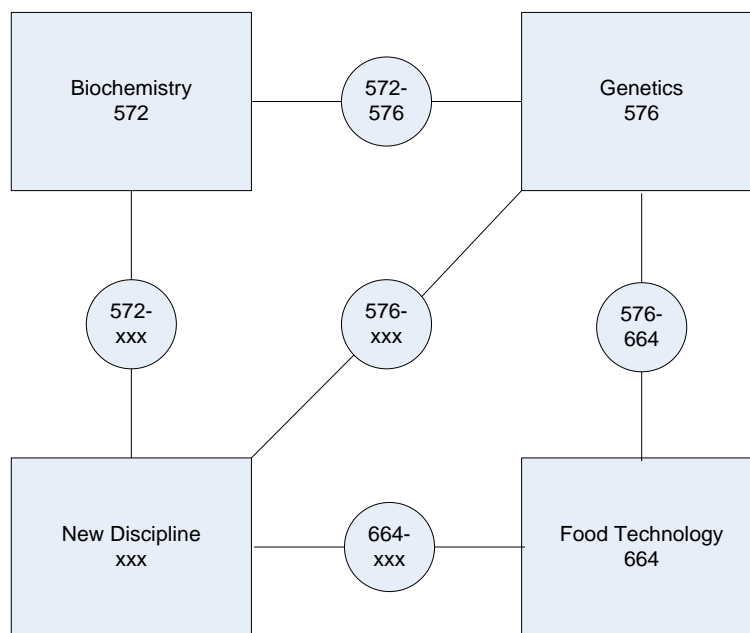


Figure 9: MOAD for a new Discipline

The model caters for knowledge production. Knowledge that transcends existing knowledge extends a discipline. Knowledge that transcends existing disciplines can be placed in a new discipline. In either case the knowledge base can be extended. In this way what was formerly transcendent becomes included and is no longer transcendent of the unified knowledge base.

#### 4.8.3 Integral MOAD

The next step in model development shows that we can represent the MOAD on the four quadrants of integral philosophy (Wilber, 1995). Dotted lines divide the background space into the integral quadrants. The example Integral MOAD in the figure below shows aspects of the bio-psycho-social model. There is no longer open white space, but integral quadrants in the background of the representation.

The diagram below shows a MOAD with some bio-psycho-social elements as part of a study on family wellness. The MOAD is shown on the integral quadrants to highlight the objective nature of 'bio,' the subjective nature of 'psycho,' and the inter-subjective nature of 'social.' The bio-psycho-social nature of holons is indicated in section 4.4.2 tenet 10 (social) and tenet 11 (physico-bio-psycho).

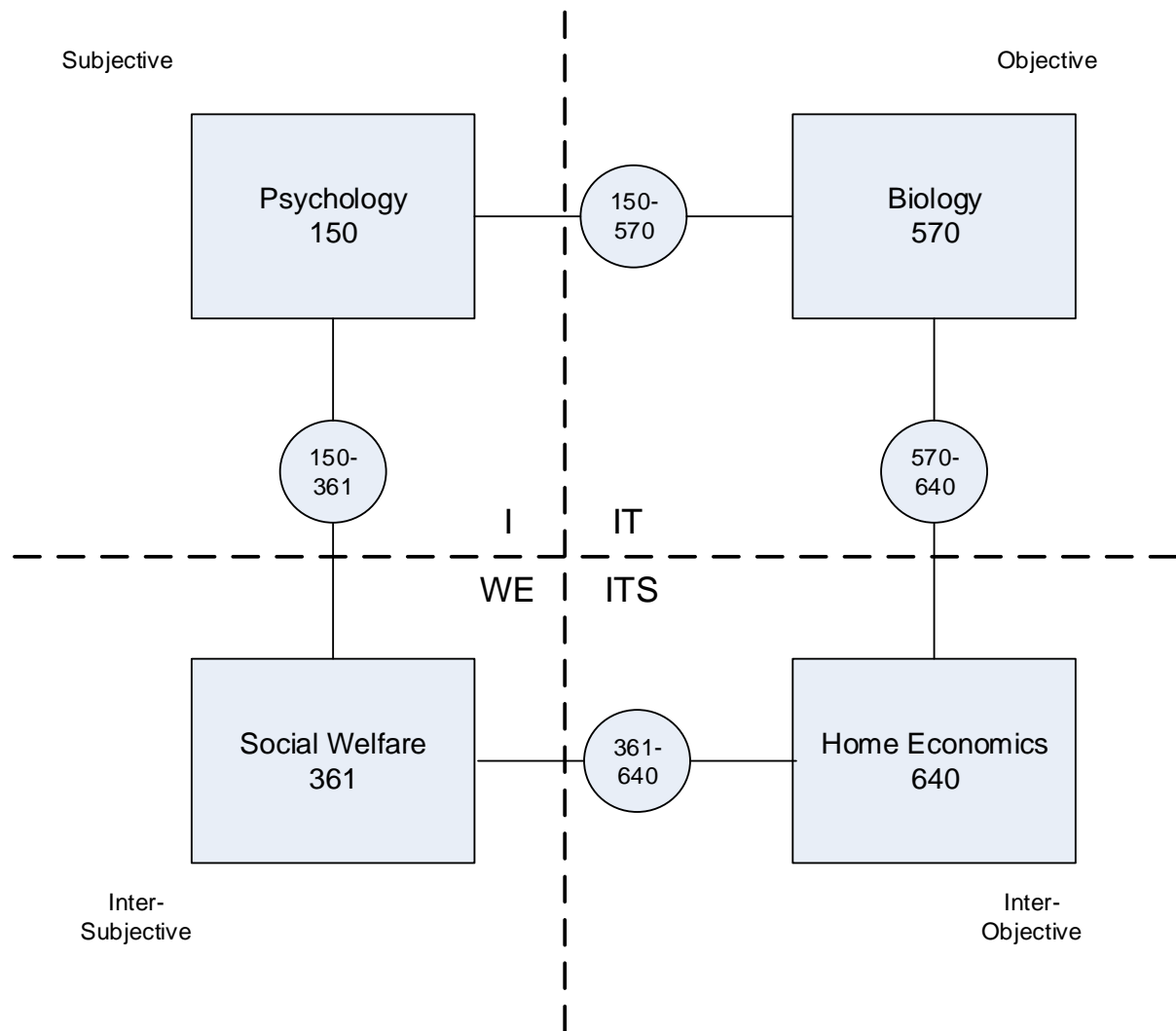


Figure 10: Integral MOAD showing some bio-psycho-social elements of family wellness

#### 4.8.4 Tiered MOAD

The next step beyond interdisciplinary is transdisciplinary but transdisciplinarity is much more than just the tiers of disciplines of transdisciplinarity, so we do not call this representation a transdisciplinarity MOAD. Instead we call it a Tiered MOAD. It is a representation of the MOAD on the four tiers of disciplines of transdisciplinarity (Max-Neef, 2005). Dotted lines divide the background space into the tiers or levels of disciplines.

Disciplines are arranged hierarchically at the value level, normative level, pragmatic level and empirical level, for example as shown below, with dotted lines added to show levels. It is not necessary to use these tiers of Max-Neef (2005) in the model, but they can be used where it adds value. It marks the first step up from interdisciplinary to transdisciplinary in the evolution of the model in the direction: disciplinary to multidisciplinary to interdisciplinary to transdisciplinary. Future work can develop the model to cater for more of transdisciplinarity.

Tiered MOAD

showing a subset of disciplines in a hierarchy of four "tiers" or "levels" (the dotted lines)  
 (the values, normative, pragmatic and empirical tiers of disciplines)

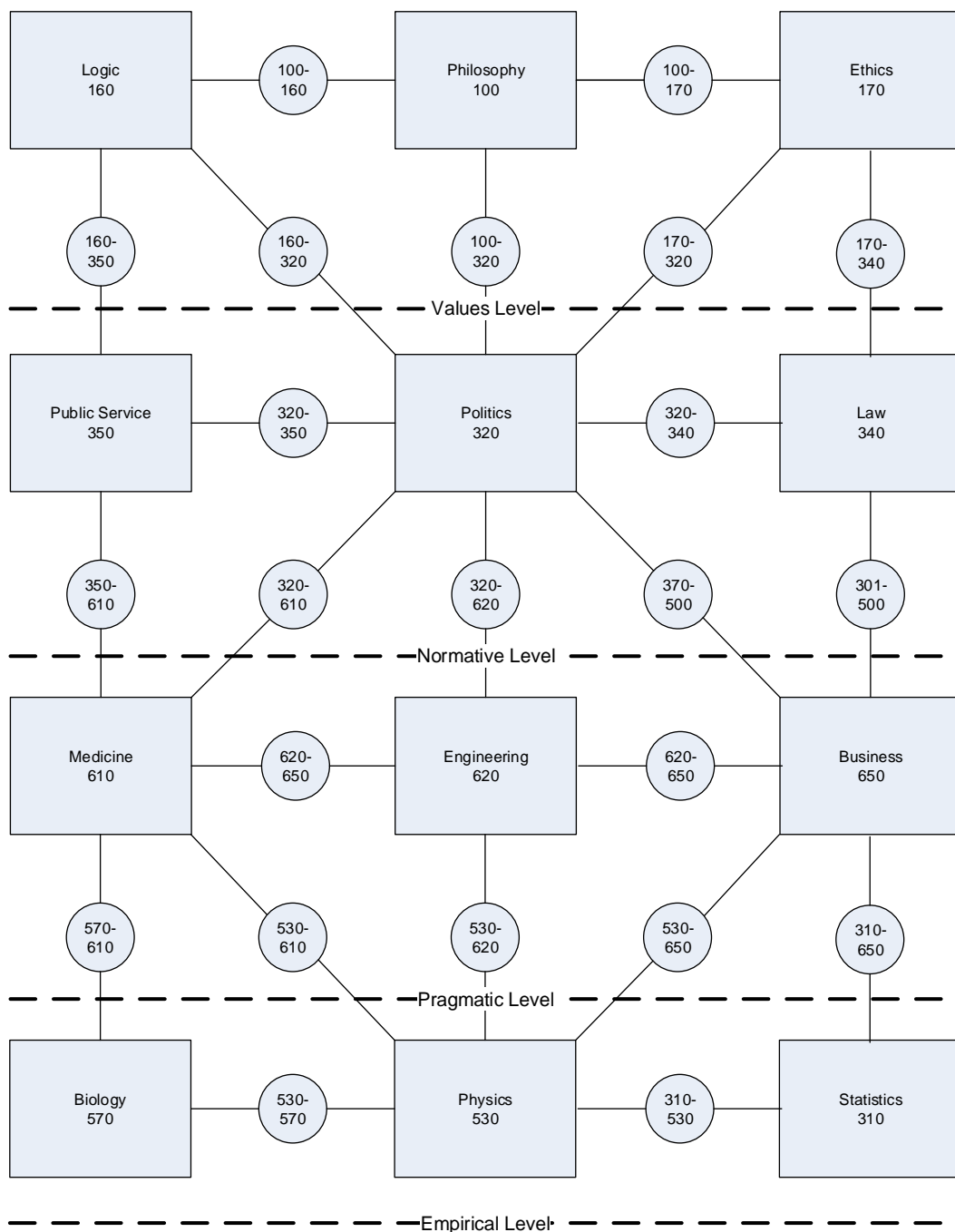


Figure 11: Tiered MOAD showing Tiers or Levels of Disciplines

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#### 4.9 Four Academic Cultures Represented in Open, Integral and Tiered MOADs

There are at least three academic cultures (Kagan, 2009), the humanities, social sciences and the natural sciences, so we will want to cover at least these three classes of disciplines, and we can add a fourth culture, the technologies. These will provide the high-level language of interdisciplinary communications of four academic cultures.

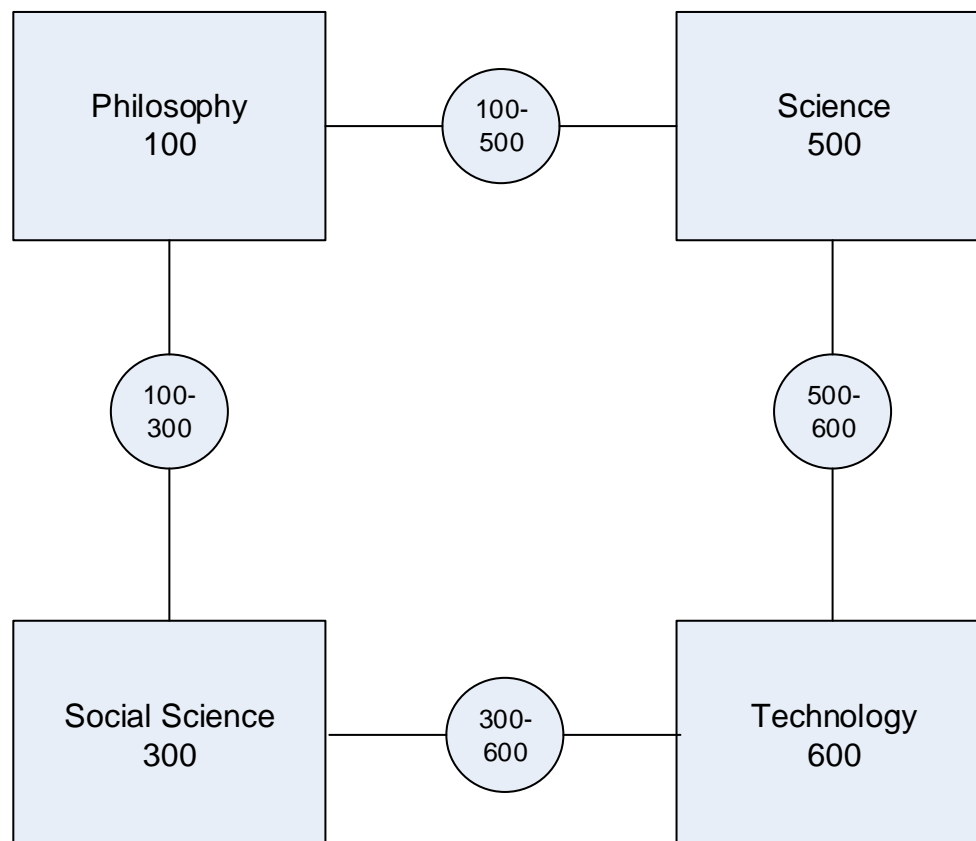


Figure 12: Open MOAD showing four academic cultures

The diagram is called an 'open' MOAD because the background is open white space. It is not organised by a philosophy or theory of transdisciplinarity, so the disciplines are openly networked.

We could also, optionally, represent the MOAD on a background of the four quadrants of integral philosophy (Wilber, 1995), or on the four tiers of disciplines of transdisciplinarity (Max-Neef, 2005) as shown in the figures below. In these cases, dotted lines divide the background space into quadrants or tiers respectively.

The four quadrants of integral philosophy are (1) objective/it, (2) subjective/I, (3) inter-subjective/we, and (4) inter-objective/its. The value of using the quadrants in this instance is that they highlight the type of language across the interfaces between the disciplines. The language between Humanities and Social Sciences is between the individual (I) and the collective (We). The language between Social Sciences and Technologies is between the collective (We) and the collective (Its). The language between Technologies and Science is between the collective (Its) and the individual (It). Finally, the language between the Humanities and Sciences is between the individual (I) and the individual (It).

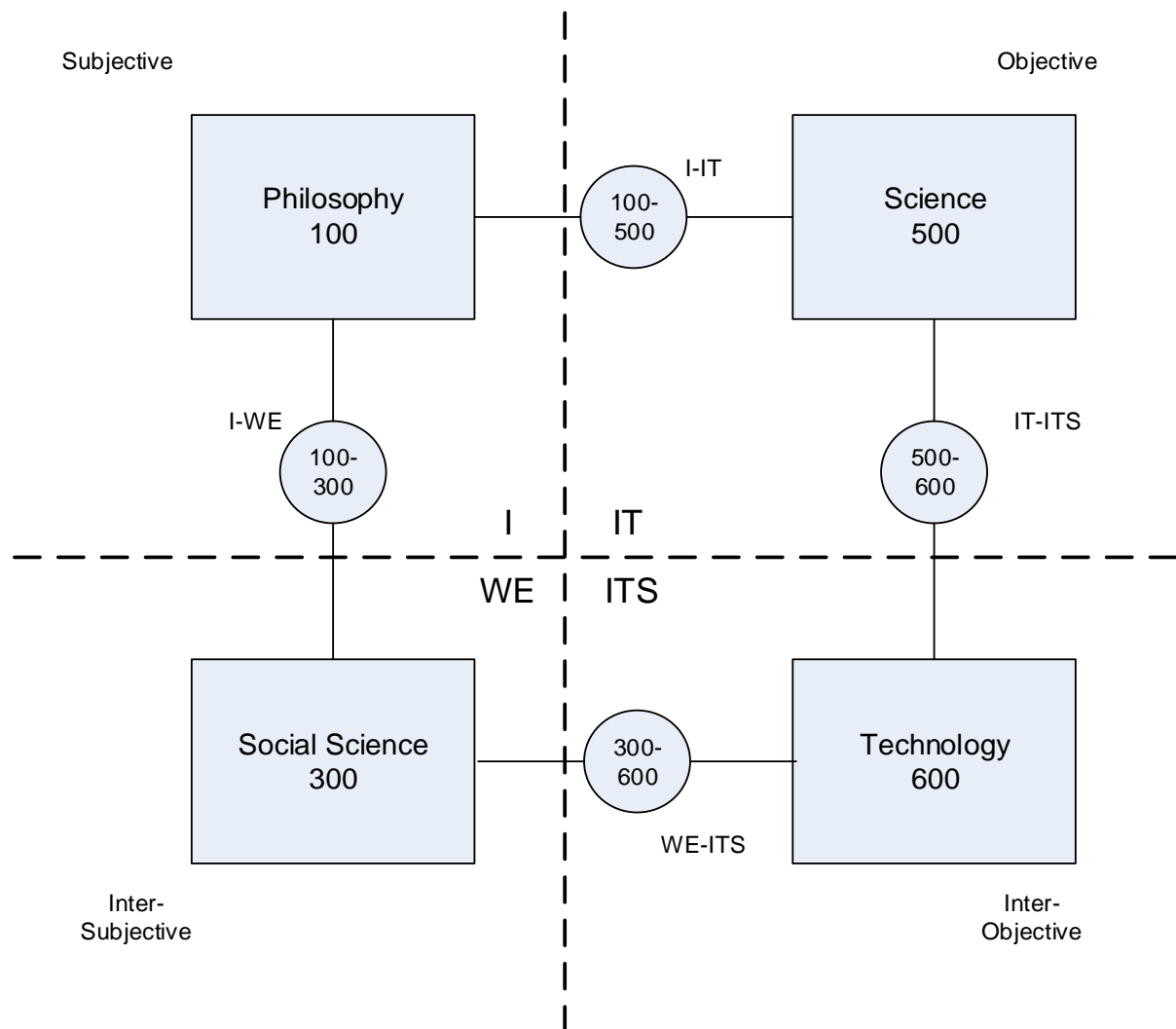


Figure 13: Integral MOAD conceptual model shown on the Integral Quadrants

The disciplines are shown on the four tiers of disciplines of transdisciplinarity in the figure below. The tiers are the values, normative, pragmatic and empirical tiers of disciplines (Max-Neef, 2005). Philosophy is the fundamental discipline of the humanities and is a values discipline. Social science is a normative discipline. Technology is a pragmatic discipline. Science is an empirical discipline.

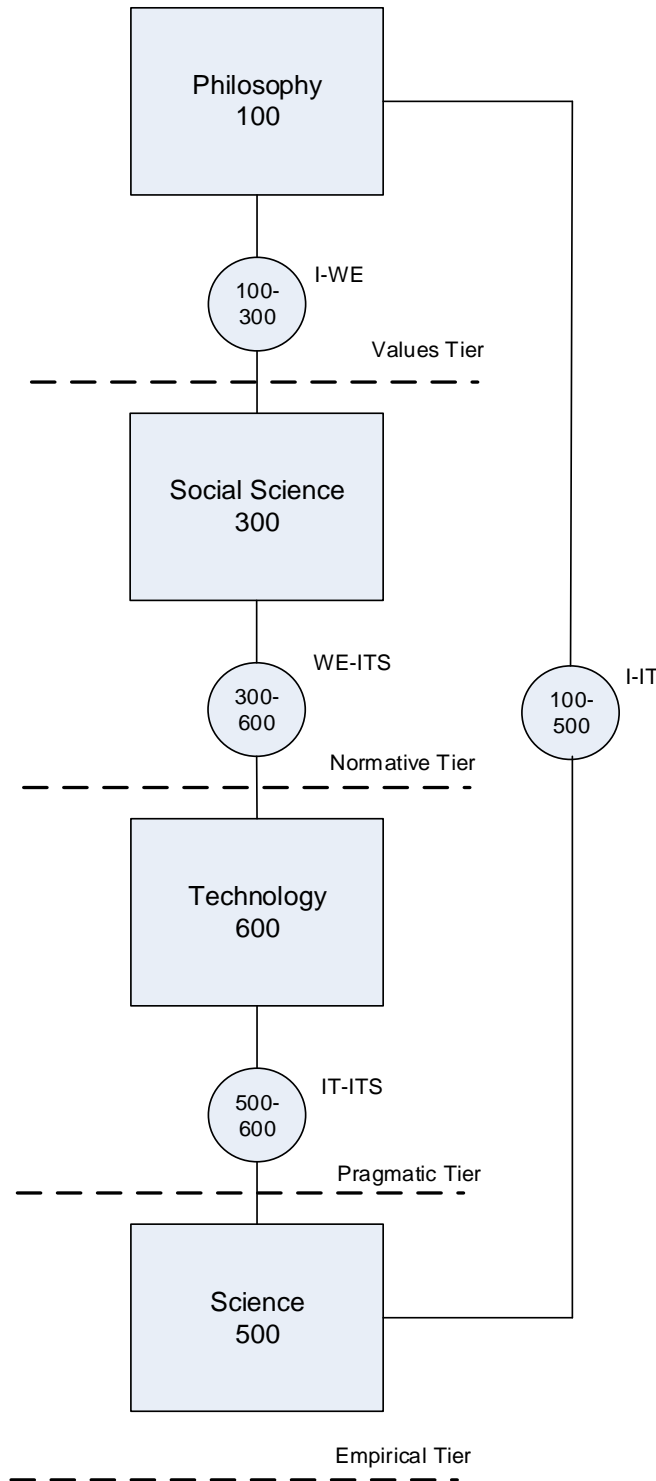


Figure 14: Tiered MOAD conceptual model showing Tiers of Disciplines

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For this model for this project, the class interfaces to be defined are

1. Philosophy – Social Science (100-300)
2. Social Science – Technology (300-600)
3. Technology – Science (600-500)
4. Science – Philosophy (500-100)

Covering these bases will mean that we have covered the types of language possible between disciplines. Going deeper, into the divisions of the classes, should simply be a refinement of the type of language. For example, including philosophy and ethics in the humanities, education and economics in the social sciences, engineering and business in technologies, and maths and physics in the natural sciences would be a more detailed network of disciplines.

#### **4.10 Implementation of a Model of Any Disciplines (MOAD)**

The model can be implemented conceptually as per the representations above, or we can implement the model with experts (people), or with expert systems (software). The experts are shown as actors (stick figures). The software modules are shown as rectangle components, with actors (stick figures) who can operate the graphical user interfaces of the software.

A configuration, control and monitoring centre can be added to the model. This would cater for monitoring and logging transactions on interfaces as well as setting up the configuration. In the case of manual use of the model this could be a person (facilitator), or else where the model is implemented as a software system, it would be a software module. Configuration would include defining which disciplines are included and which interfaces are used. Monitoring would include logging of all transactions (queries, commands, notifications).

The concept of a T-shaped person is somebody who has depth in a discipline (the vertical line of the T), as well as breadth to reach across to other disciplines (the horizontal line of the T). This type of person facilitates interdisciplinary projects. There should be at least one T-shaped person, and typically, by heuristic, 10% of large teams should be T-shaped.

### 4.10.1 Expert Implementation (Human Activity System)

The figure shows the expert implementation. The MOAD is implemented as a network of people (experts/practitioners).

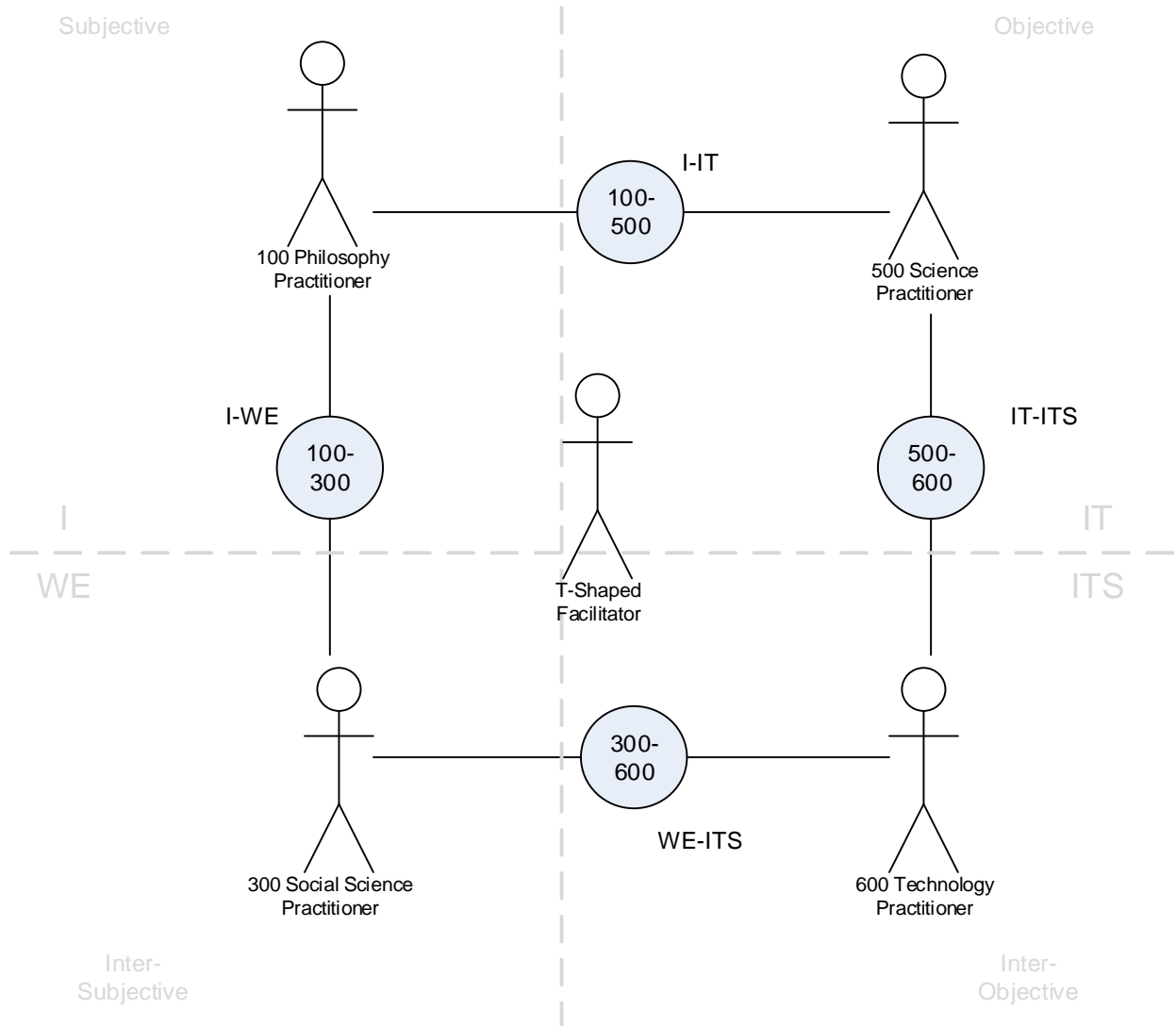


Figure 15: MOAD implemented with Practitioners (Experts)



following chapter, which documents the first few iterations of use of the model. Any number of iterations and reconfigurations can be executed to address some problem area.

#### 4.11 Keeping Clarity

Academics can work with the MOAD to manage interdisciplinary problems based on their competences, but they can also be constrained by external authorities with another agenda, so that this effort is thwarted. For example, councils, unions, politicians and corporations might exert influence on a practitioner based on their authority rather than their competence in her academic domain, so that she does not perform as expected as a competent and unbiased practitioner. She might not be operating as a pure educator, but as a union member, employee, party member, subscriber, or paid consultant. These are social structural constraints which impose on the reality as per Bhaskar's philosophical model of layers of reality (Bhaskar, 1987). An ethics affidavit can be used to assure the neutrality of participants. Declared outside influences could lead to the honourable withdrawal of project participants, so that transactions on the MOAD are based only on disciplinary competence and collaborative effort under conditions of uncoerced mutual understanding (Habermas, 1987).

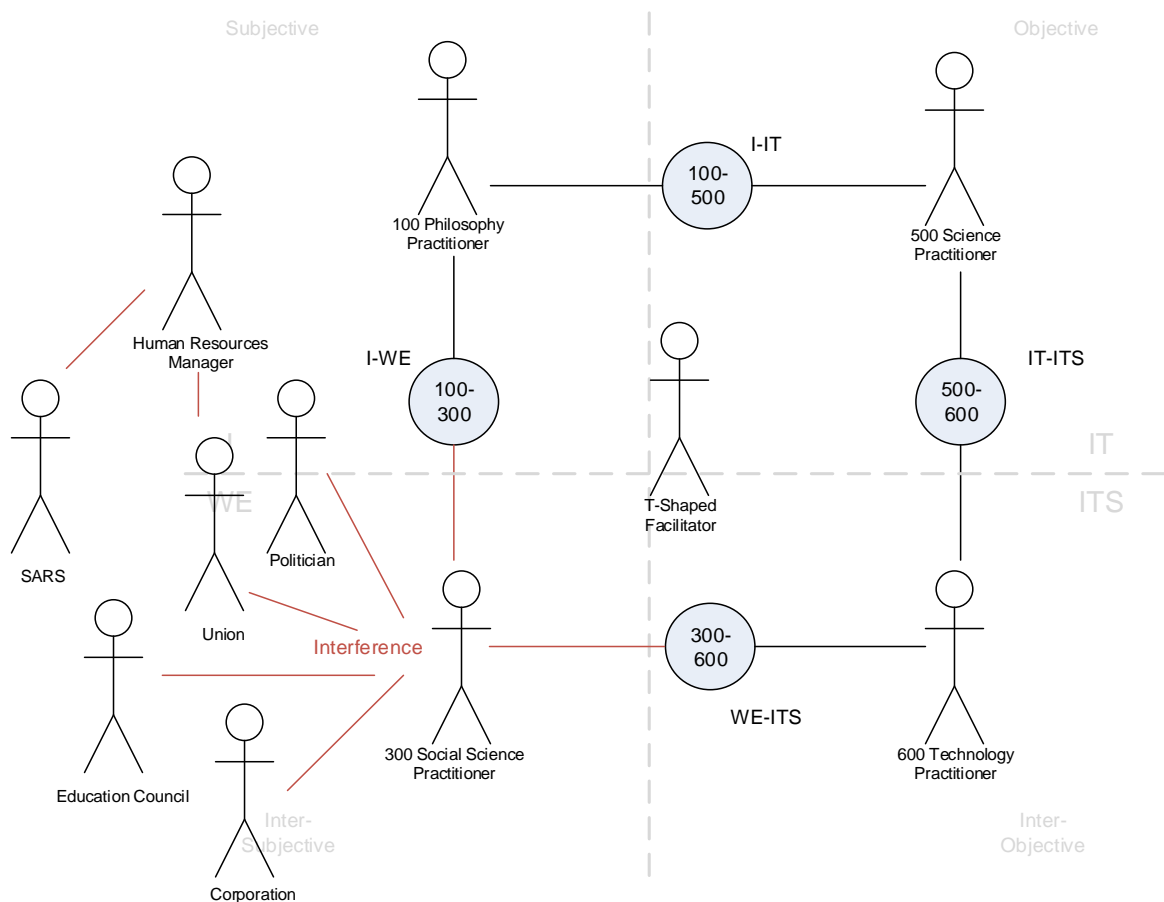


Figure 17: MOAD with external interference

If we wanted to model such outside influences academically we could configure a new MOAD including disciplines like public policy (379), business general management (658), cooperatives (334) and political process (324) to represent the disciplines of the outside influences such as the council, corporation, union and politician, and so to bring outside influences into the inside of the model and use their interactions to model and understand how these influences modify outcomes. The model is a product of academic freedom, generated from a process starting with the Socratic method and first principles, and is intended for use under the conditions of uncoerced mutual understanding (Habermas, 1987). We want to experiment in a way that activates the underlying mechanism (Bhaskar, 1987). The figure below shows the new situation, an academic examination of the influences on this social scientist. Most of the influences are in the intersubjective quadrant, using 'We' language between the collectives of councils, unions, politics and corporations.

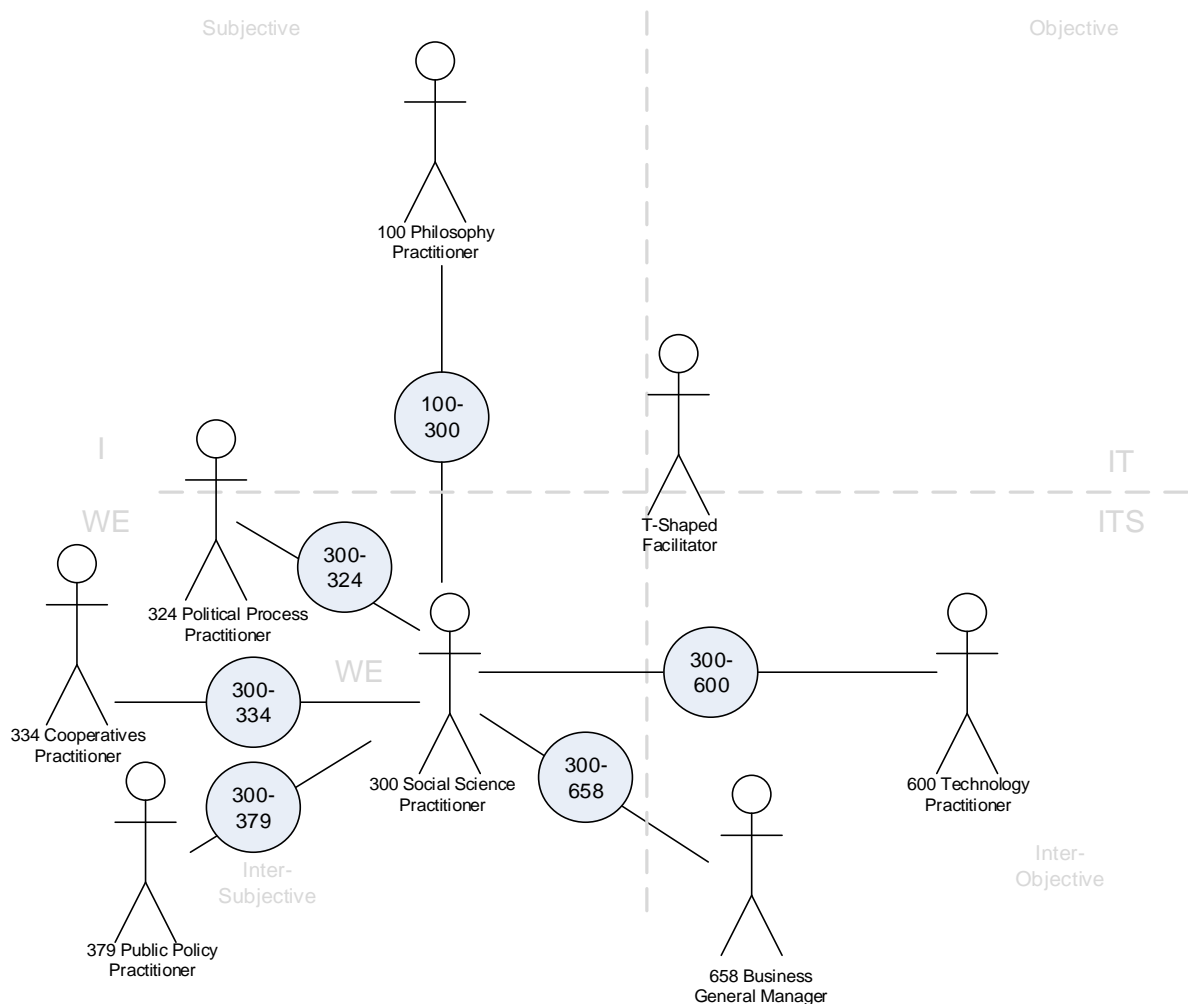


Figure 18: MOAD examining influences on the social scientist

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#### **4.12 The Next Step**

We have achieved the primary objective of the study, having created a model which networks the disciplines. The following chapter will document the results of several iterations of using the model in example scenarios in order to confirm applicability in problem areas that transgress the boundary of a discipline, and so achieve the second objective of the study.

## 5. SCENARIOS

### 5.1 Roadmap to This Chapter

The chapter starts with some comments on discipline organisation at UCT and in the decimal classification system (section 5.2) and then presents example scenarios of how to use the model on such disciplines (sections 5.3 - 5.8). The number of potential cases of use is unlimited, because the model has generic applicability and configurability. The chapter ends with a discourse analysis of the status quo, our philosophy of work in 2018 when we started the project (section 5.9) with a view to encouraging systemic and holistic thinkers to interdisciplinary work scenarios in the future.

### 5.2 Academic Cultures, Faculties and Departments

The table shows the university disciplines copied from section 1.3.4 and divided into four academic cultures (shown in blue). The faculties are shown in black and the departments in green. The library decimal classification codes for the disciplines are provided in parenthesis.

Table 5: The Disciplines

Social Sciences (300)	Technologies (600)	Natural Sciences (500)	Humanities (100,200,400,700,800,900)
<b>Faculty of Commerce (380)</b>	<b>Faculty of Engineering (620)</b>	<b>Faculty of Science (500)</b>	<b>Faculty of Humanities (100,200,400,700,800,900)</b>
Accounting (657)	Architecture (720)	Archaeology (560)	Anthropology (301)
Economics (330)	Chemical Engineer (660)	Astronomy (520)	Archaeology (930)
Finance (332)	Civil Engineering (624)	Biology (570)	Dance (792.8)
Information Systems (000)	Construction (690)	Chemistry (540)	Drama (822)
Management Studies(650)	Electrical Engineer (620)	Computer Science (000)	Education (370)
	Geomatics (550)	Env & Geographic (550)	Fine Art (700)
	Mechanical Eng (620)	Geology (551)	Historical Studies (900)
		Mathematics (510)	Language (400)
		Oceanography (551.46)	Library & Info Studies (020)
		Physics (530)	Linguistics (410)
<b>Faculty of Law (340)</b>	<b>Faculty of Health (610)</b>	Statistics (310)	Literature (820)
Private Commercial (346)	Anaesthetics (617.96)		Music (780)
Public (341, 342, 344)	Human Biology (611)		Philosophy (100)
	Medicine (610)		Political Science (320)
	Obs & Gynaecology (618)		Psychology (150)
	Paediatrics (618)		Religion (200)
	Pathology (616)		
	Public & Family (614)		
	Psychiatry (616.89)		
	Surgery (617)		

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### **5.2.1 Some comments on the organisation and independence of Disciplines**

It is evident from Table 5 above that the social sciences and technologies have become dominant as these two classes have been assigned four faculties. On the other hand, six classes of the humanities have been grouped together into a single humanities faculty. Whereas the humanities and natural sciences were dominant in the 1950s, the social sciences and technologies are dominant two generations later, in our current time, the 2010s.

Religion is a discipline of personal values (Humanities), but when conflated with state or social structures or national law it morphs into a normative discipline more aligned with the social sciences than the humanities. The same applies to philosophy. For example, in the past we have had the conflation of Christianity with the Roman State, the conflation of Islam with the Islamic State or Sharia Law, and the conflation of Marxism with the Soviet State. This is a danger of the loss of boundary between disciplines. Public Administration, Political Science, Law, Religion and Philosophy are best bounded as autonomous disciplines that can interact but not be conflated. Autonomous disciplines are subject to competence rather than authority. The disciplines are best arranged in faculties of the appropriate academic culture.

We can see that there is an academic culture clash in the UCT Faculty of Humanities because it contains social sciences (the 3xx disciplines). Whereas the humanities are subjective, cultural and personal, the social sciences are inter-subjective, social and societal. The humanities pertain to individual expression and truthfulness whereas the social sciences pertain to social relations, social structures and social justice. This academic culture clash can be resolved by moving the Social Sciences into a separate faculty, leaving the Humanities a safe space. Perhaps UCT could have a Faculty of Social Structures incorporating sociology, political science, public administration, law and education.

The library is organised by the decimal classification system, with 10 classes, 100 divisions and 1000 sections with 3-digit codes. Thus, for example the class of Philosophy (100) contains the division Ethics (170) which contains the section Occupational Ethics (174). Alternatively, we can say the academic discipline 174 'Occupational Ethics' is class 1, division 7, section 4.

### **5.3 Sample Scenarios of use of the Model of Any Disciplines**

Whilst realistic and critical thinkers continue in disciplinary work, in well-defined domains, systemic and holistic thinkers may consider applying themselves to problems which transgress disciplinary boundaries. To perform interdisciplinary work, they may consider applying the Model of Any Disciplines (MOAD).

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Sample scenarios are supplied below. These scenarios use the conceptual implementation, which is type 4a of the model definition (section 4.8). They are presented as some initial iterations of the use of the conceptual model, illustrating broad applicability.

The process will include intention, action and evaluation as follows:

1. Choose a specific problem situation for interdisciplinary research
2. Configure the MOAD with appropriate disciplines and disciplinary interfaces
3. Use the model to examine the problem situation
4. Evaluate the outcomes

The conceptual framework shown in Figure 4 has the elements of the unstructured problem situation. We express the real-world problem situation, for example, how to network ethics, education, engineering and mathematics in a university so as to implement engineering education. We take the conceptual model created in chapter 4 and configure it as a representation of the problem situation for modelling purposes. This gives us some view of the problem situation possibly relevant to improving it. A sequence of transactions is then executed on the model to provide a structured set of activities. These are not real-world activities copied from history, but new ideas generated by the researcher for the purpose of creating novel possibilities for improving the problem situation. I use the presencing process of Otto Scharmer and systems thinking of Peter Senge described in the 'Fifth Discipline' (Senge, 1990) and soft systems methodology (Checkland, 1990) to focus my attention on a problem area. I use hermeneutics to ensure appropriate queries on disciplinary interfaces. The texts consulted in the library and on the internet are referenced in chapter 7. Novel possibilities can be increased through iterations of the model configuration or of transactions on it. The Socratic method is applied. I enter the library not knowing a discipline, and then extract interpretations of what the discipline is about, what questions it answers and what it does for the world, through reading disciplinary texts.

#### **5.4 Scenario: Four Academic Cultures and the Goal of Decent Work (SDG 8)**

In this case, we investigate how the four academic cultures (humanities, social sciences, technologies and natural sciences) might address the sustainable development goal of decent work for all (UN SDG 8). The SDG is a problem situation that is beyond the scope of discipline and will benefit from networking of disciplines. This is the first attempt to use the model on a problem situation that is beyond the scope of a discipline. The idea is to network high-level disciplines (classes) to address a global situation which is beyond the scope of a discipline. The aim is to show how to use the MOAD model.

1. Choose a specific problem situation
  - a. How can the academic cultures address the goal of decent work?
2. Configure the MOAD with appropriate disciplines and disciplinary interfaces. This is done by the researcher or T-shaped facilitator (in this case the author).
  - a. We are starting at the highest level of abstraction of the disciplines. Humanities has several classes: philosophy, language, literature, fine arts and history, whereas social sciences, technologies and natural sciences are each a single class. We will use philosophy as representative of the humanities, and so the four classes to be configured in the MOAD will be philosophy (100), social sciences (300), technologies (600) and natural sciences (500).

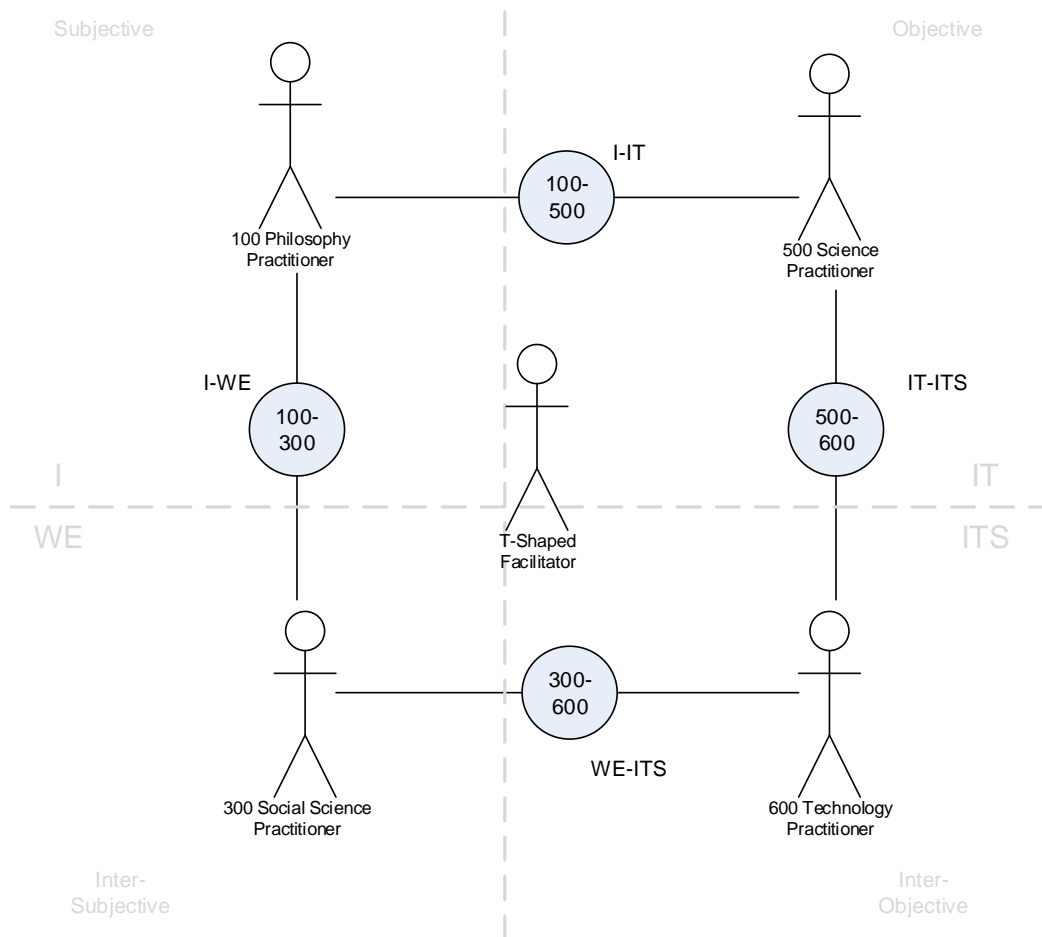


Figure 19: Class MOAD for Four Academic Cultures

3. Use the model to examine the problem situation
  - a. Execute a sequence of transactions on the disciplinary interfaces. The statistics are imaginary, introduced for the purpose of illustration.

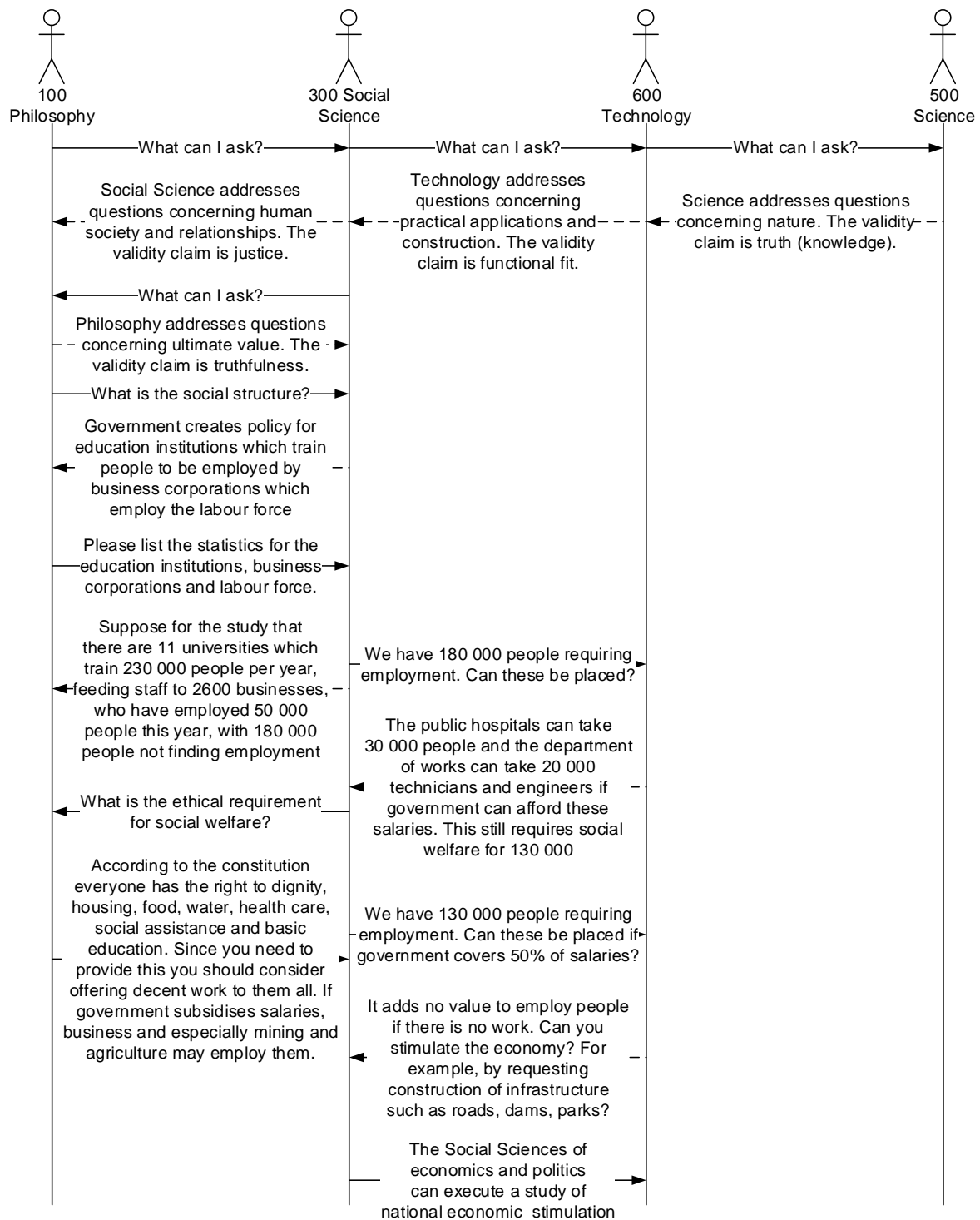


Figure 20: Sequence Diagram addressing the example of decent work

#### 4. Evaluate the outcomes

- a. The MOAD at a class level of disciplines abstracts the problem to a high level that encourages asking appropriate questions including policy and constitutional rights, economic stimuli and government-private business collaborations. Separate studies with divisions of disciplines are proposed, and this arose because of the philosophy behind the constitution.

## 5.5 Scenario: Divisions of Disciplines for Engineering Education

In this case, instead of the classes of disciplines used in the first example, we present an example using divisional level disciplines. The aim is to show how to use the MOAD.

1. Choose a specific problem situation
  - a. How can divisional disciplines address the goal of engineering education?
2. Configure the MOAD with appropriate disciplines and disciplinary interfaces
  - a. We are at the second level of abstraction of the disciplines, the divisions, and we select ethics (170), education (370), engineering (620) and maths (510).

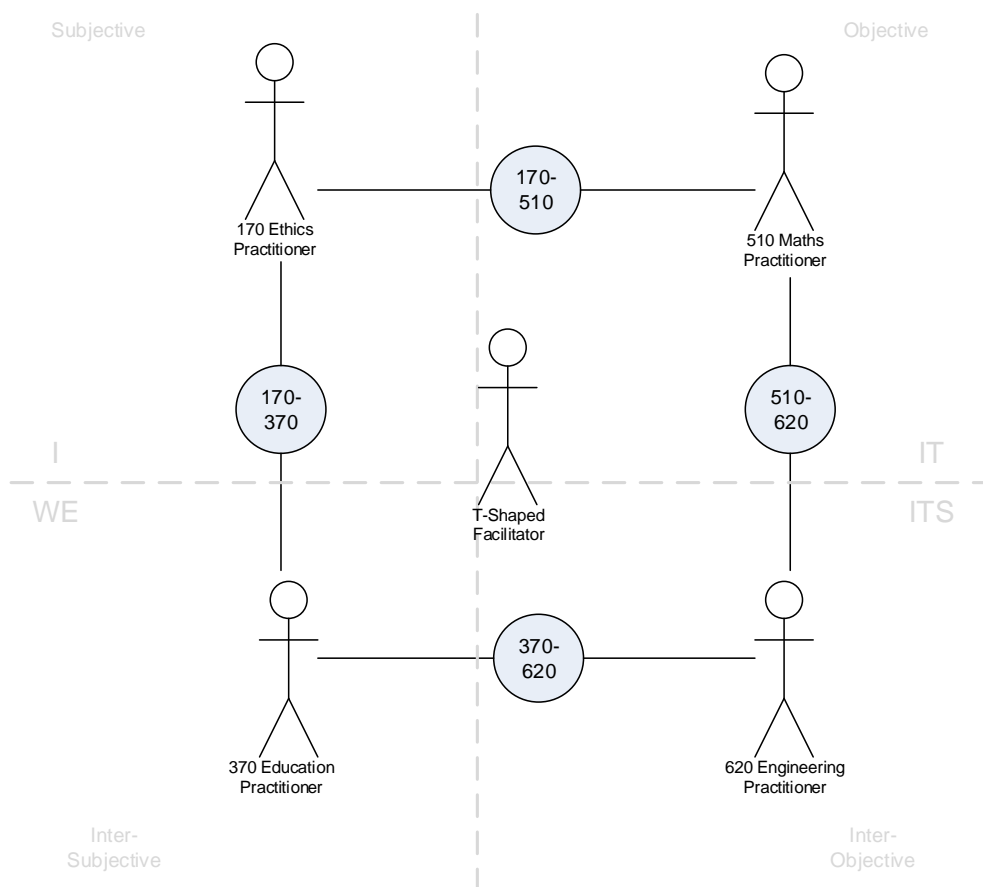


Figure 21: Division MOAD for Engineering Education

3. Use the model to examine the situation
  - a. Execute a sequence of transactions on the disciplinary interfaces

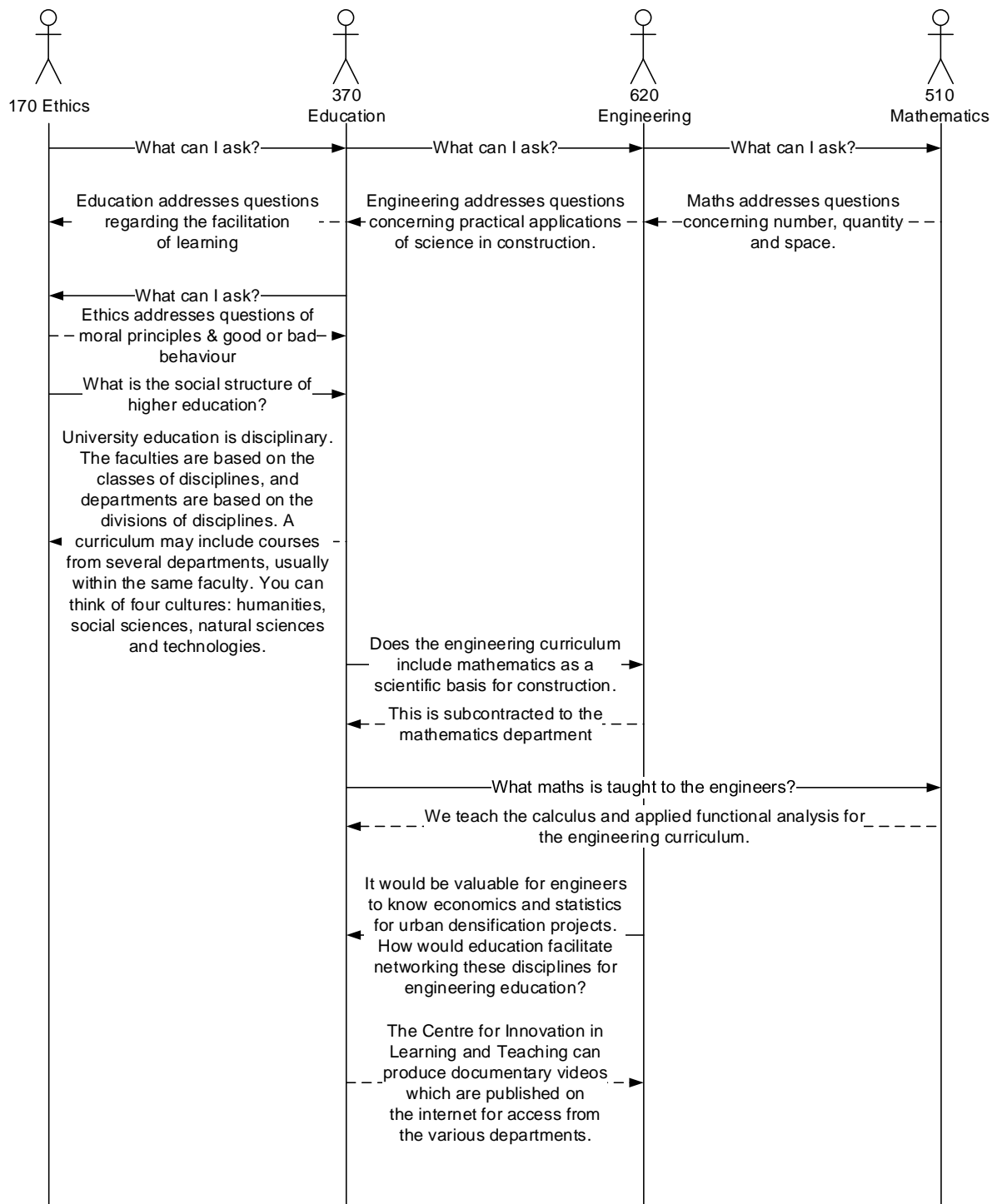


Figure 22: Sequence Diagram addressing the example of engineering education

#### 4. Evaluate the outcomes

- a. The MOAD at a divisional level of disciplines abstracts the problem to a level that encourages asking appropriate questions of detail between taught departmental disciplines.

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- b. Integration of ethics, education, engineering and maths allows each of these component holons to retain their identity and specialisation whilst facilitating engineering holistically. This is an efficient model because it uses the high cohesion – low coupling pattern. The alternative would be an unwieldy and bulky version of engineering, which included the required ethics, education and science within its own body of knowledge, and this would be a low cohesion body of knowledge (i.e. containing disparate concepts and value domains).

### **5.5.1 Disciplinary Dimensions in Engineering Education**

High cohesion of the disciplines means that they have high coherence of content (disciplinary knowledge) and low coupling means that this is not duplicated in other disciplines but rather requested from the speciality discipline. So, the discipline is a coherent, unique body of knowledge. The discipline is a holon, a whole that is part of another whole but retains its unique identity. Networking the disciplines of engineering, education, maths and ethics allows us to treat them as holons, each providing a unique part of engineering education whilst retaining their individual identities. This is holistic thinking.

A body of knowledge can have several disciplinary dimensions. Legitimation Code Theory (LCT) specifies several dimensions that we can consider (Maton and Howard, 2018). By plotting two of these dimensions on an x, y plane we get four quadrants ((high x, high y), (low x, high y), (low x, low y), and fourthly (high x, low y)). The four quadrants are given names to create a shorthand for the high/low values of the two dimensions selected. These names are called legitimation codes. For example, if we map positional autonomy against relational autonomy, then the quadrant with a high positional autonomy and a high relational autonomy is named 'sovereign.' The sovereign is a legitimation code that is high in freedom from control (positional autonomy), and high in independence (relational autonomy). For example, mathematics would be sovereign because no other discipline or authority tries to exert control on it or interfere with its independence. On the other hand, the opposite is true of education.

Consider the following four planes, each with two disciplinary dimensions:

1. Specialisation
  - a. Is the discipline high/low in ER epistemic relations (object knowledge)?
  - b. Is the discipline high/low in SR social relations (way of knowing subject)?
2. Semantics
  - a. Is the discipline high/low in SG semantic gravity (context dependence)?
  - b. Is the discipline high/low in SD semantic density (complexity)?

3. Autonomy

- a. Is the discipline high/low in PA positional autonomy (freedom from control)?
- b. Is the discipline high/low in RA relational autonomy (independence of other values)?

4. Density

- a. Is the discipline high/low in MaD material density (coherence of content)?
- b. Is the discipline high/low in MoD moral density (coherence of values)?

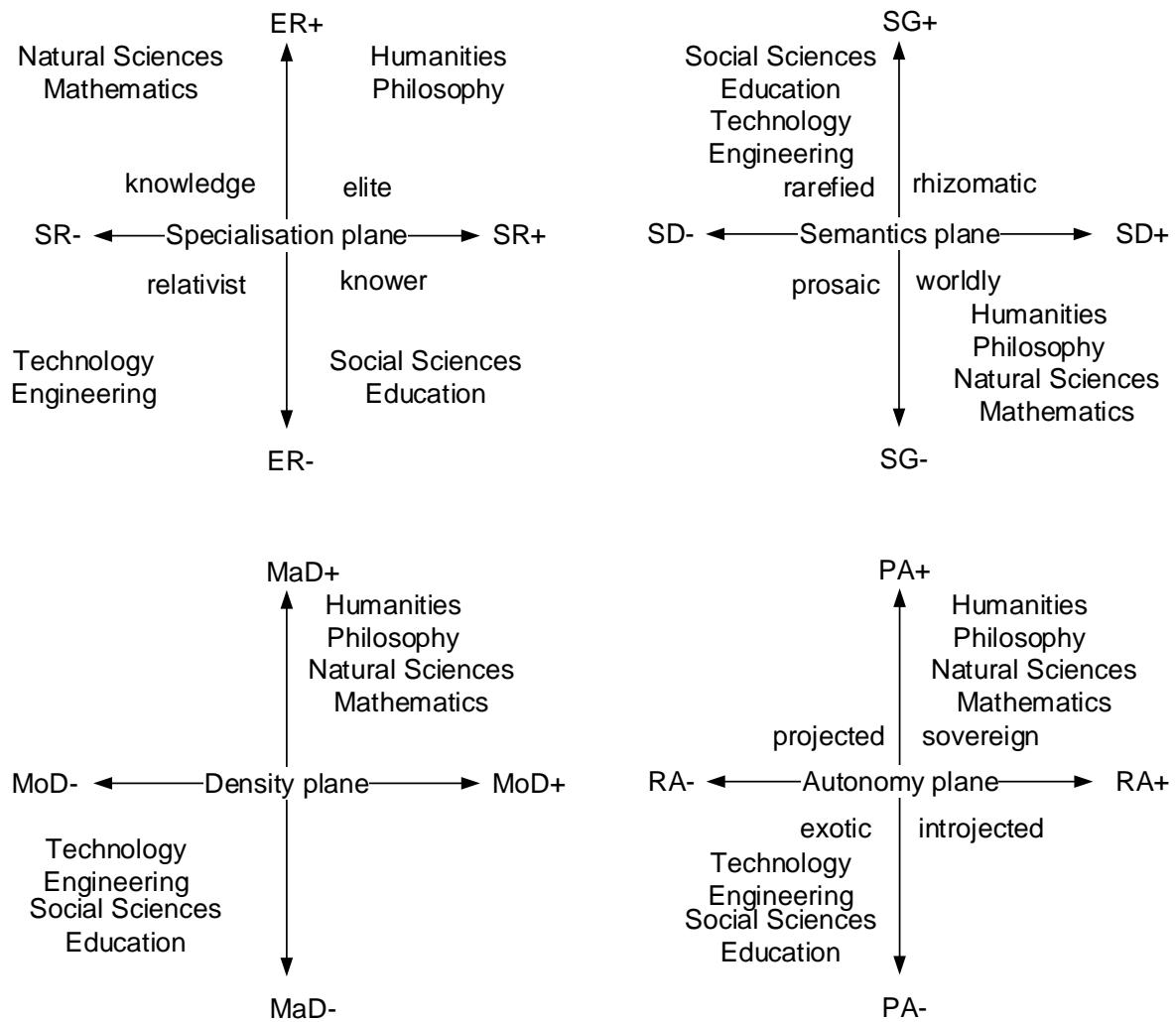


Figure 23: Legitimation Code Planes

We see that the specialisation plane shown in the upper left corner (Figure 23) has the same distribution of the disciplines as the integral model (Figure 19 and Figure 21)<sup>Note 1</sup>. In effect, the quadrants of the integral model are specialisations.

Note 1: there is a left-right mirror image because the integral model has social on the left whereas LCT has social on the right, but this has no impact on the concept of specialisation in quadrants.

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You don't have to consider other disciplines and other quadrants when you are specialising. You are allowed to specialise in any quadrant. But it is valuable that you know that you are specialising, and that others have specialised in different quadrants, and so you have different perspectives to them, and see things differently, as per the academic cultures of natural sciences, humanities, social sciences and technologies. This specialisation of knowledge in disciplines of high cohesion and low coupling should encourage mutual respect and the Socratic method when using the MOAD. Each participant has knowledge not present in other participants due to their specialisation.

### **5.6 Scenario: Water Management Mapped Three Ways**

The first two scenarios above considered the MOAD as a system which took inputs and produced outputs in the context of some problem situation. In the current case of use, we consider what disciplines might be applied in water management, and rather than look at inputs and outputs, we will consider how different representations of the model might assist in conceptualizing the problem situation.

For the problem situation of water management, we consider whether there is any advantage to looking at the disciplines mapped onto the quadrants of integral philosophy or mapped onto the tiers of transdisciplinarity, or not.

Firstly, we consider a possible set of disciplines in the context of water management.

100 Philosophy

150 Psychology

155 Developmental Psychology

155.7 Evolutionary Psychology

100 Philosophy

170 Ethics

178 Ethics of Consumption

179 Environmental and Ecological Ethics

300 Social Science

320 Political Science

321 System of Government

321.8 Democratic

321.9 Authoritarian

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300 Social Science  
320 Political Science  
328 Legislative Process

300 Social Science  
380 Commerce  
381 Commerce & Trade  
381.3 Commercial Policy & consumerism

500 Science  
570 Biology  
577 Ecology  
577.6 Aquatic Ecology & freshwater

500 Science  
550 Earth Science  
551 Hydrology  
551.3 Surface Processes  
551.31 Icebergs and shelf ice

600 Technology  
620 Engineering  
628 Sanitary Engineering  
628.5 Pollution

600 Technology  
650 Business  
658 Management  
658.1 Finance

We can model the integration of these speciality disciplines in various ways for the problem situation of water management. Our intention in this thought experiment is to consider whether there is any advantage to looking at the disciplines mapped onto the quadrants of integral philosophy or mapped onto the tiers of transdisciplinarity, or not.

Secondly, we configure the MOAD with the disciplines: ecology, evolutionary psychology, ethics, government, commercial policy, legislative process, finance, engineering and hydrology.

Thirdly, we create and compare different representations of the water management problem situation: Open MOAD, Integral MOAD and Tiered MOAD.

### 5.6.1 Open MOAD

The thought pattern for this open MOAD is that evolutionary psychology and the corresponding value memes and ethics direct the social sciences and technologies so that we finance engineering to apply its knowledge of the water sciences to resolve pollution problems and supply potable water.

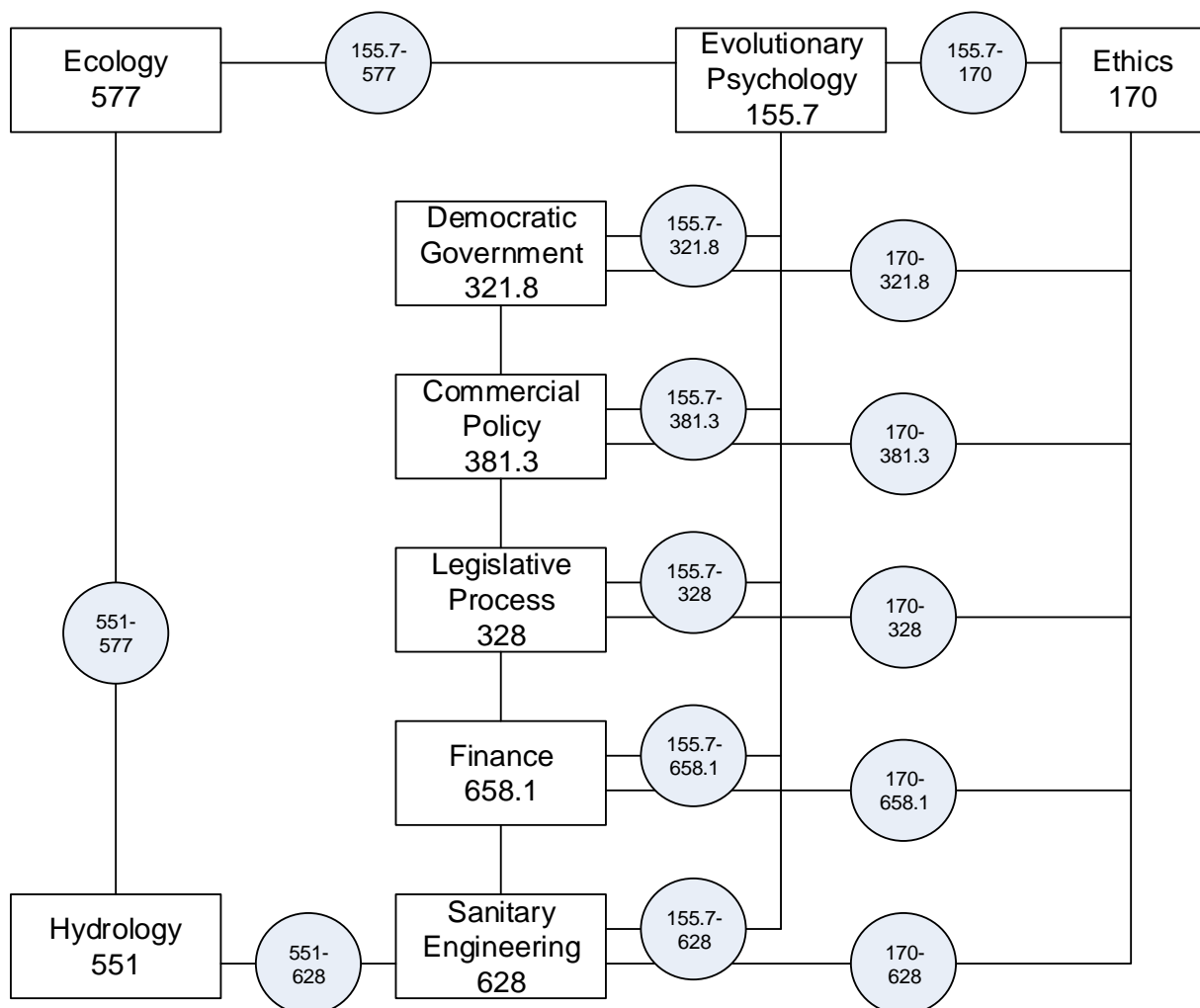


Figure 24: Open MOAD for water management

### 5.6.2 Integral MOAD

The thought pattern for this integral MOAD is the validity claims of these disciplines. Evolutionary psychology and ethics are values disciplines with a validity claim of truthfulness. They coordinate the normative disciplines in the social sciences based on their appeal to conscience and being truthful to oneself and one's values. Politics and commerce are normative disciplines with a validity claim of justice. They coordinate the technologies of finance and engineering based on their appeal to the justness of water management. The technologies in turn coordinate the sciences of hydrology and ecology based on the validity claim of their functional fit. Hydrology and ecology are natural sciences with a validity claim of truth. No matter what our values or concerns with justice and function in the management of water, nature presents constraints to man in the geological, ecological and meteorological conditions that are the ultimate facts of reality or the undeniable truth of the problem situation.

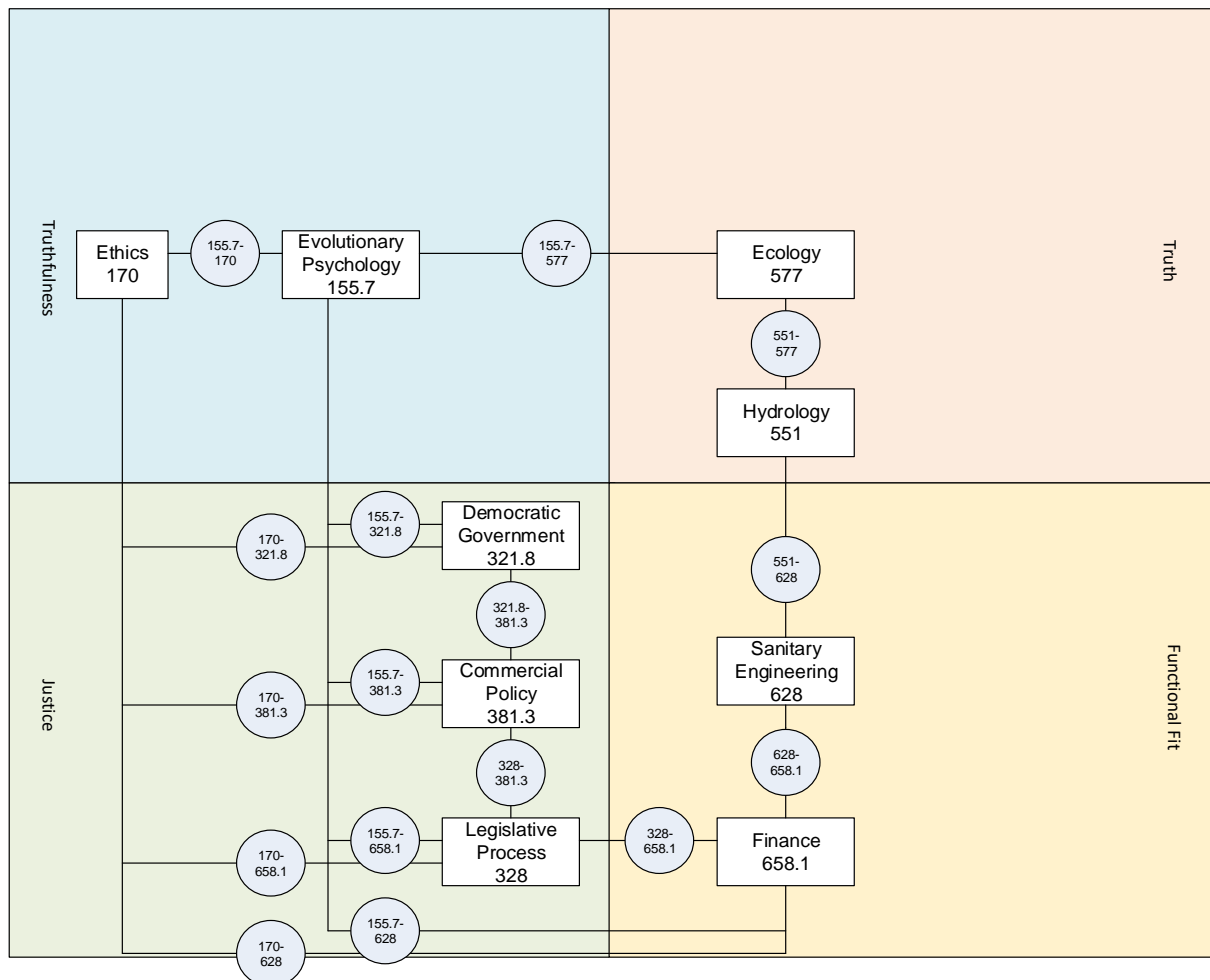


Figure 25: Integral MOAD for water management

### 5.6.3 Tiered MOAD

The thought pattern for this tiered MOAD is that evolutionary psychology and ethics are values disciplines that coordinate the normative disciplines in the social sciences of politics and commerce, which in turn coordinate the technologies of finance and engineering, which in turn coordinate the sciences of hydrology and ecology in the management of water. But the natural sciences inform the technologies of the facts on the ground, and the technologies inform the social sciences of the technical possibilities, and the social sciences inform the values disciplines of the normative requirements.

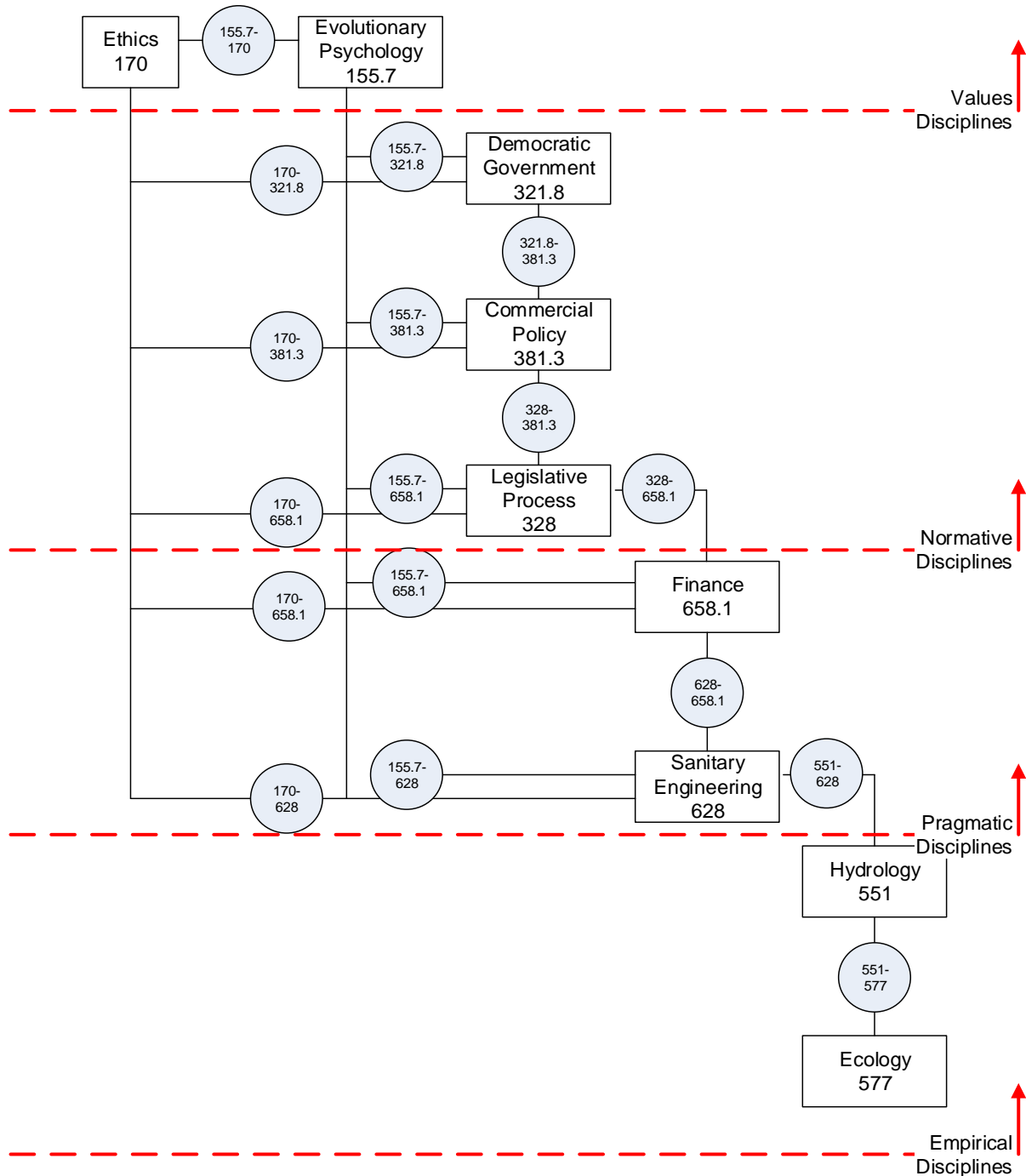


Figure 26: Tiered MOAD for water management

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#### **5.6.4 Comparison of Open, Integral and Tiered MOADs**

The Open MOAD is functional and addresses the problem of water management, whereas the Integral MOAD is more circumspect with regards to the problem, and highlights what everybody is trying to get out of the situation based on their perspectives and validity claims. The Integral MOAD makes these concerns visible and accounts for why the purely functional solution isn't necessarily executed. The tiered view suggests a prioritization. The empirical situation must be accommodated (the facts on the ground cannot be ignored), and the pragmatic situation gives options how they can be accommodated. The normative disciplines make judgements on this information. The values disciplines explain why these judgements are made. The ethics are associated with the value memes of the psychology of the participant-observers.

Different representations of the same problem highlight different considerations. Drawing different MOADs can be valuable to highlight considerations that might not otherwise be seen.

#### **5.7 Scenario: Situational Analysis**

Situational analysis means that when we consider the business situation, we take into account the Political, Economic, Social, Technological, Legal and Environmental (PESTLE) factors that possibly impact the business.

We construct a MOAD representing PESTLE situational analysis including the corresponding disciplines: Politics (320), Economics (330), Sociology (301), Technology (600), Law (340) and Ecology (577) connected to Business Management (650). This is shown in Figure 27 below.

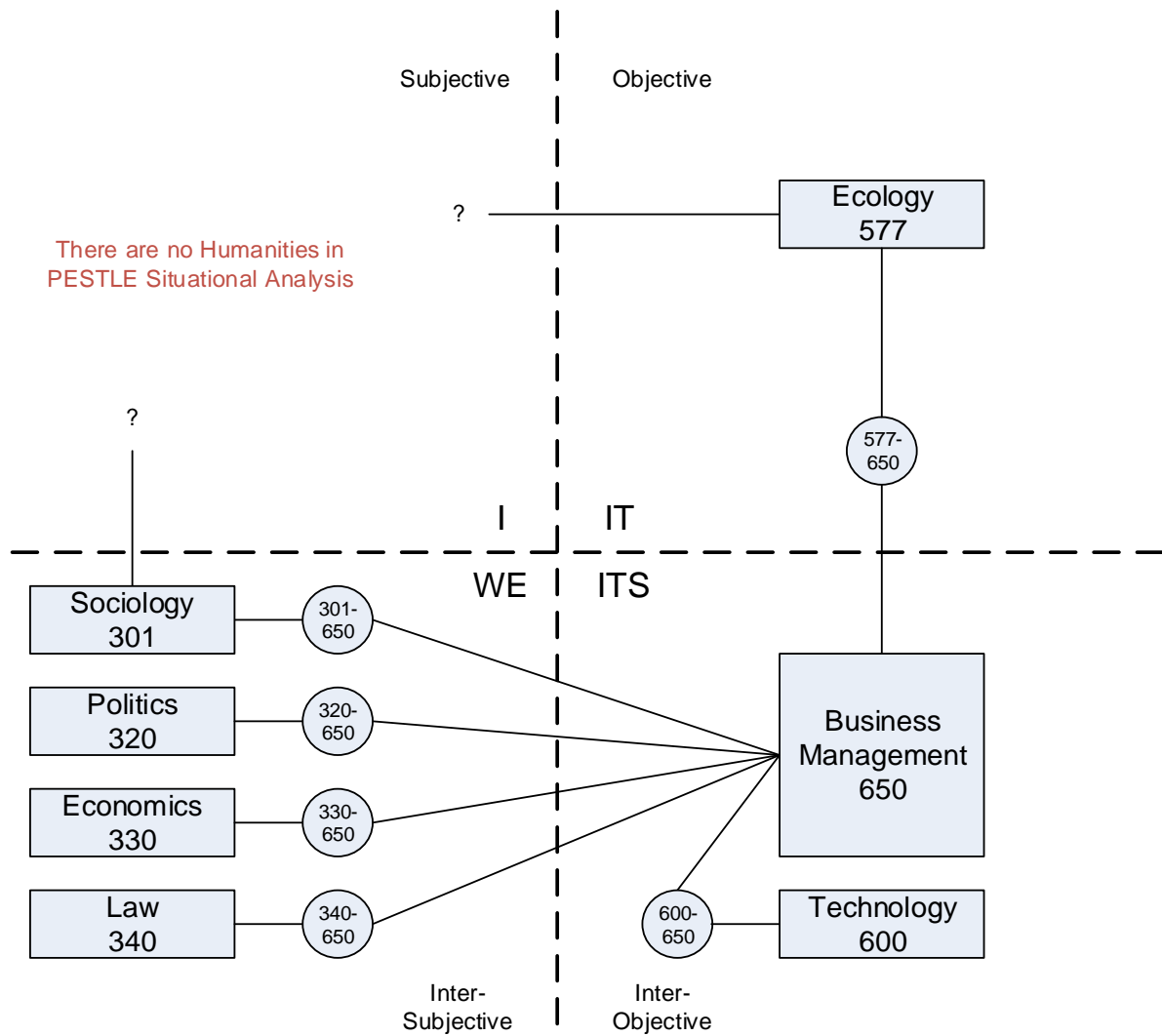


Figure 27: Integral MOAD for PESTLE Situational Analysis

It is clear from MOAD (Figure 27) that humanities are absent from the analysis. This means that there has been no consideration of subjective and cultural disciplines (the Humanities in the subjective quadrant of the MOAD). Whilst PESTLE situational analysis was supposed to include all factors, it has in fact omitted humanistic factors like psychology, religion and ethics. It is left for future analysts to factor in the humanities, for example examining artificial intelligence in the workplace from an ethical, philosophical or psychological perspective. Human values disciplines are in the humanities. Our humanity flourishes in our values.

The third law of transdisciplinarity (Max-Neef, 2005) states that 'Because of what is not there, it is possible that there is what is there; and because of what is there it is possible that there is not what is not there.'

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The model is seen to point out what is not there. What is missing is the subjective perspective of the humanities. The subject object divide which was first highlighted in the conceptual framework (section 3.11.4 and Figure 4) appears here as the exclusion of the subjective in PESTLE analysis.

### **5.8 Scenario Completion**

We have shown how to use the model in some sample scenarios, and thus achieved the second objective of the study (section 3.4).

### **5.9 Our Philosophy of Work**

The third objective of the study is to examine our philosophy of work in 2018 in order to show the limitations of the status quo and attract systemic and holistic thinkers to a new model of working (beyond the scope of a discipline). The literature review of philosophy above showed the pre-modern, modern, postmodern and integral approaches and they all coexist in our globalized world which is complex and networked.

In order to reveal the status quo in our philosophy of work, we used discourse analysis to show its socio-psychological characteristics. We looked at values and actions in the social structure. The discourse analysis was not confined to the discipline of sociology where it is usually employed. Instead we used discourse analysis on the critical synthesis presented in the literature review and on the public presentation of prospects of corporate employment found on corporate websites in March 2019.

What do we mean by integral, holistic and transdisciplinary? By integral we mean comprehensive, considering as broad an inclusivity as possible, and multiple perspectives. By holistic we mean in accordance with the tenets of holistic philosophy based on holons. The transdisciplinary approach uses layers of reality, the included middle, and complexity. Layers of reality are illustrated in Figure 1, Figure 4 and Figure 13. The actuality layer is what is there, present as itself, actual. The empirical layer is the seeing (our perception of the actual). The reality layer contains the underlying mechanisms that enable us to see the actual. The underlying mechanisms are generally not seen empirically (visually), but they explain the actual and so are seen rationally through reason. The social structure layer imposes constraints. The included middle means that something can be itself and something else at the same time. Complexity shows there is emergent behaviour that is not present in the parts, as illustrated in holons (section 2.3.4.2.2).

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How should we think of complexity in our philosophy? Complexity introduces non-linearity. Non-linear functions are described as follows. If we have a seed value  $x_1$  which we put into a function  $y=f(x)$  we will get a value  $y_1=f(x_1)$ . If we use  $y_1$  as  $x_2$  and feed it back into the function, we get  $y_2=f(f(x_1))$ . If we use  $y_2$  as  $x_3$  and feed it back into the function, we get  $y_3=f(f(f(x_1)))$ . In creating philosophy, the philosopher has  $x$  as the life conditions and  $y$  is the philosophy produced. In a later era, the philosopher has new life conditions which have been informed by past philosophy. In this case, we have premodern philosophy  $y_1=f(x_1)$ , modern philosophy  $y_2=f(f(x_1))$ , postmodern philosophy  $y_3=f(f(f(x_1)))$ , and integral philosophy  $y_4=f(f(f(f(x_1))))$ . Then we have a critical synthesis of the philosophy literature  $z=f(y)$ . And we have a discourse analysis of the critical synthesis  $z=f(f(y))$ . This shows how holistic thinking embodies complexity and both use pattern analysis. Complexity theory denies the possibility of prediction. One simply executes the function and sees what comes out. When we executed the discourse analysis, we were interpretive, open-ended, probabilistic, historically situated and culturally contextual. Non-linearity in development of our philosophy of work means we can only explain it after the fact, we can't predict it *a priori* as we can with a linear process. It is the same with quantum physics and Schrodinger's cat. We can't predict the situation *a priori* as we can with a linear process. The discontinuity of the non-linear process eliminates the ability to predict. The execution of the experiment, whether in philosophy or in quantum physics, yields a result that cannot be predicted before doing it. This happens all the time in social science. Will the UK leave the EU? The decision to leave does not mean it will happen. We have to execute the politics and see what result turns out. We do the experiment and find out the result, and prediction doesn't enter into it. But the underlying mechanisms are activated in the process, so for example, experiments in quantum physics always produce the precise statistical probabilities of the quantum theory, verifying it. In the same way, the underlying mechanisms may validate philosophical and economic theories when they are activated.

From a holistic perspective we observe people selecting education, training and careers based on their personality preferences such as introversion/extraversion, sensing/intuiting, thinking/feeling and perceiving/judging (subjective) and on prior life experiences in family and school (inter-subjective). The life experiences were within our societal structure (inter-objective), and this includes the pre-modern and modern (Figure 1). The addition of feminism and postcolonialism in the postmodern era did not change the societal structure, but simply its content, so the discourse started to include relativistic thinking in the modern social structure. The addition of ecological economics and sustainable development also did not change the societal structure, but simply its content, and the discourse included holistic thinking. There are few holistic thinkers, many critical thinkers, and mostly realistic, idealistic and absolutistic thinkers (from tenet 8, section 2.3.4.2.2). This shows that our philosophy of work as society

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cannot be integral and holistic at our current level of development in 2018. There are too few holists.

Starting with the Dutch-East-India Company (VOC), and public-private venture funded via a stock exchange created for the purpose in Amsterdam in 1611 (de la Vega, 1688), modern corporations have been separated from their financing through investment. Investors on the stock exchange need no knowledge of the business of the corporation, and only desire a financial return. Corporations are the means-to-an-end, the vehicles to attain economic prosperity. They are an invention of modernity and have been made juristic persons. Being juristic persons means that corporations can sign contracts and sue and be sued, as if they were persons, although they are actually 'objects.' When people are employed it is the corporation that is the employer, not the line manager. One is employed by an object. We just call it a juristic person. In 'reality' the corporation is a means-to-an-end, but in 'actuality' it is considered a person, which is an end-in-itself (Kant, 2008). We no longer have personnel departments in corporations. We have human resources departments. Any selected corporation that is a juristic person and which has a human resources department meets these criteria. When we looked for evidence on corporate websites we found most of them have a human resources department. Sometimes the corporates use the term 'human capital,' which is the capability of labour to produce economic value, and this is a very similar concept. The careers pages of corporate websites show that the application process is through a hiring line manager and a human resources officer or a human capital executive. Kant (section 2.3.2.3) showed in modern philosophy that people are ends, and not means to an end (resources). Therefore, the introduction of human resources departments shows that corporations have regressed from modern to pre-modern philosophy regarding personnel. The corporate perspective is that they have modernized, by moving to an objective stance (people as objects) rather than the old-fashioned subjects of the Queen or King (people as subjects). In a similar way, public facilities are no longer labelled 'ladies' and 'gentlemen' but 'male' and 'female' or 'gender neutral.' So, we currently have the situation where the employees are resources, or means-to-an-end, and the corporation is a juristic person, or end-in-itself. This is a demonstration of the included middle (a pillar of transdisciplinarity). The people are the resources (i.e. the ends-in-themselves are the means-to-an-end). The corporations are the juristic persons (i.e. the means-to-an-end are the ends-in-themselves).

This discourse analysis revealed that our philosophy of work in 2018 is modern, objective and corporate. The corporations are juristic persons and the employees are resources (objective and gender neutral). The persons in this philosophy of work are not human (they are corporations), and the humans are not people (they are resources). This is the 'resource-

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based view' which is an exploitative strategy of business management for competitive advantage of the business corporation and channels the wealth from the 99% to the 1%.

Therefore, the introduction of robots will not be a dehumanizing of work. The dehumanizing of work has already happened through the concepts of juristic persons, human resources and the resource-based view. Robots introduce the dematerialization of humans in work, and this may in fact be humane because it gets people out of the situation of being the means-to-an-end or resources of the corporations.

By contrast with the 'resource-based view' of business, the 'resource-based economy' is a global holistic solution defined by the limitation of natural resources and necessarily includes ecological and environmental concerns (Fresco, 1995, Raworth, 2017). This will be achieved with people as ends-in-themselves, and not only as means-to-an-end (Kant, 2008) and is therefore a humanitarian enterprise as well as an ecological-economic enterprise. This should not be confused with the resource-based economy that preceded industry and service-based economies. Rather, the 21<sup>st</sup> century resource-based economy is focused on preservation and sustainable use of resources, rather than being focused on money.

The description of our philosophy of work in 2018 is not intended as knowledge to be filed away. It is more like an understanding of the situation, so that we can move forward to the way we will be working in the 2020s. Realistic and critical thinkers may be content as corporate functionaries, but the growing number of holistic thinkers (tenets 3 and 4, section 2.3.4.2.2) are less likely to be corporate employees in the integral era. The space for these people will more likely be in the academy, in the public sphere as consultants, and in entrepreneurial enterprises which compete with corporations by providing people-centric services. People will be looking for places where they can be people and have human experiences. They will be T-shaped, Pi-shaped and Comb-shaped people in teams of complementary disciplines:



Figure 28: T-shaped, Pi-shaped and Comb-shaped

That is, they will have developed depth in one or two disciplines or assembled teams with the required disciplines. Activities in the academy, public sphere and entrepreneurial enterprise will expand to cater for interdisciplinary and transdisciplinary research whilst the social structure itself remains unchanged.

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The philosophers through the ages have been oriented to the emancipation of people and a strongly eudaimonic approach, where happiness exists in love and work. We can align with our emancipative philosophers by adopting systemic, integrative and holistic thinking. In addition to our modern, objective and corporate approach of 2018 we can begin a new post-postmodern, subjective, intersubjective and inter-objective approach to a philosophy of work for the 2020s. This dissertation provides a model for working in this way. The objectives of the study have been achieved.

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## 6. CONCLUSIONS

### 6.1 Roadmap to This Chapter

The conclusions chapter does not introduce any concepts not already covered in the dissertation but presents summary conclusions and confirmation of completion of the project. It comments on possible future work arising from the study.

### 6.2 The Model of any Disciplines

The dissertation introduced a model that is appropriate for any real-world problem area that transgresses the boundary of a discipline. Whilst we are used to working with 'Classes' of disciplines and 'Divisions' of disciplines in University 'Faculties' and 'Departments,' we generally do not think about the 'Phylum' of disciplines which contains all of these classes and divisions. The dissertation introduced the concept of the Phylum, and a model that can be configured for any part of the Phylum.

The model provides a business method or way of working with a configurable part of the Phylum appropriate for interdisciplinary research (e.g. practical implementations like water management, green gentrification, and urban food production). It provides a method for problem management and knowledge generation that is beyond the scope of a discipline and oriented to real world complexity. If we network experts, then it is enabled as a human activity system. If we network expert systems (software) then it is enabled as a designed physical system (a software network of expert systems). Software like this might be used for big data analysis. These are not products, but ways of working.

The model has been shown to be compatible with integral philosophy and can optionally use the tiers of transdisciplinarity. We can include subjective values and inter-subjective cooperation as well as objective science and inter-objective technology. The model is however not restricted by this. There is no objection to using the model in a highly specialised way in objective disciplines alone. For example, the model could be used by a scientific research group networking nuclear physics, string theory and topology in mathematics. There is also no objection to using the model in a highly specialised way in subjective disciplines alone. For example, the model could be used by a research group investigating the use of music and drama in philosophy lecture videos. Integral philosophy simply points out that these groups are working in specialised quadrants and have good reasons for doing this. Such projects are multidisciplinary or interdisciplinary. Transdisciplinarity points out that values disciplines and normative disciplines have a place when working on global systemic problematiques, and

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when the four layers of disciplines are networked, the project is transdisciplinary according to the theory in (Max-Neef, 2005).

When looked at with systemic thinking the model is seen as a system. The system is a network of disciplines and practitioners. When looked at with holistic thinking the model is seen as made of holons. Disciplines and practitioners are holons and do not lose their identity when they are networked (as per the tenets of holistic philosophy). Specialisation and expertise are retained. The model facilitates the use of multiple disciplines in problem management in scenarios that do not belong to any one discipline.

The importance of the model is that it provides a practical way of working to manage problem situations which transgress disciplinary boundaries whilst accessing the expertise of disciplined practitioners. The model can find wide applicability. Users need only have the will for uncoerced mutual understanding or free communication, along with their disciplinary expertise.

### **6.3 Completion of Project**

The project is considered complete because

- We have created a conceptual model which networks the disciplines, using constructs from philosophy and the tiers of transdisciplinarity using systemic and holistic thinking.
- The model is shown to provide a way of working on problem areas that transgress the boundary of a discipline.

### **6.4 Future work and use of the Model of any Disciplines**

Further work can be done to reduce the model to practice. When reduced to practice the model is used on real-world problem areas which always come with criteria of relevance, quality and reliability. This could be performed as case studies in any real-world problems that transcend a discipline, such as water management, green gentrification, urban food production, engineering education, multi-media presentation, poverty alleviation, ecological economics, decent work, quality education, and life under water, to name a few. These scenarios could be implemented as type 4b (expert) or type 4c (expert systems) of the model definition provided in section 4.7. If type 4b was implemented and successful, then a cost-benefit analysis could be done for implementing type 4c. Any such implementations would be iterative and incremental, selecting particular disciplines as described in chapter 5. Reduction to practice would probably be done initially in the academy (T1 Research), and then in the community (T2 Research) or workplace (Action Research). Experts can be academic practitioners in the academy or professional practitioners in the workplace.

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There is a transdisciplinary working group in the university, looking for executive approval of transdisciplinary work. UCT could form a centre for transdisciplinarity or integral institute. The model provides a business method for these T-shaped people to work by, at least for interdisciplinary research.

It is always worth considering the goal of interdisciplinary research. Who is the work for? Who will work on the team? Self-selection may be used to decide this. Academics can be invited to attend if they think they can contribute. For example, a recent seminar on resilient cities at UCT attracted over 50 academics from various disciplines. They self-selected as attendees, by responding to the open invitation. Round table discussions then produced interdisciplinary communications. An example is modelled in the scenario in Figure 19 and Figure 20.

The model is suitable for academics working on problems not contained within a discipline. It is sufficient, by heuristic, if 10% of the interdisciplinary team is T-shaped, and 90% are specialists in their own discipline. In this way the critical thinking of specialists within disciplines is retained, whilst the T-shaped person facilitates the networking of the specialist experts through systemic and holistic thinking. The model can be used to build a shared vision of managing the problem situation. In future the model may be extended from the academy into the workplace, especially in learning organisations.

The model has been created chiefly from philosophy and from systems engineering, which fall into the subjective and inter-objective quadrants respectively. It is a work of philosophy and technology with validity claims of truthfulness and functional fit, rather than a work of science and social science with validity claims of truth and justice. However, the model may be used in any domain, including those of justice or truth. Users may apply the model in future work in scenarios that transgress the boundary of a discipline.

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## 7. REFERENCES

- Alexander, C., 1997. *A Pattern Language*. Oxford, UK: Oxford University Press.
- Aristotle, 1955. *The Ethics of Aristotle: the Nichomachean Ethics*. Aylesbury, UK: Penguin.
- Beck, D. and Cowan C., 1996. *Spiral Dynamics: mastering values, leadership and change*. Oxford, UK: Blackwell Publishing.
- Bhaskar, R., 1987, *Scientific Realism and Human Emancipation*. London, UK: Verso.
- Brooks, F., 1975. *The Mythical Man-Month*. Addison-Wesley Publishing Company.
- Burrell G. and Morgan G., 1979. *Sociological Paradigms and Organisational Analysis, elements of the sociology of corporate life*. Oxford, UK: Heinemann Educational Books.
- Checkland, P. and Scholes, J., 1990. *Soft Systems Methodology in Action*. Chichester, UK: John Wiley and Sons Ltd.
- Checkland, P., 1993. *Systems Thinking, Systems Practice*. Chichester, UK: John Wiley and Sons Ltd.
- Checkland, P., 1999. *Soft Systems Methodology: A 30-year retrospective*. Chichester, UK: John Wiley and Sons Ltd.
- De la Vega, J., 1688. *Confusions de Confusiones. The World's First Stock Exchange*, Amsterdam, 1611. Available: <http://www.worldsfirststockexchange.com/the-worlds-first-stock-exchange.html>
- Descartes, R. 1649. *Discourse on the Method*. London, UK: Thomas Newcombe.
- Dewey Decimal Classification Edition 23, 2011. Maintained at the Online Computer Library Centre: <https://www.oclc.org/en/dewey/resources/summaries.html>.
- Dick, B., 1993. *Action Research Theses*. Chapel Hill, Queensland: Interchange.
- Drucker P., 1989. *The New Realities: in government and politics, in economy and business, in society and in world view*. Oxford, UK: Heinemann.
- Drucker P., 1999. *Managing Oneself*. *Harvard Business Review* 77(2) 64-74, 185.
- Fresco, J, 1995. *The Venus Project: the redesign of culture*. Venus, Florida: Global Cyber-Visions.
- Frodeman et al., 2010. *The Oxford Handbook of Interdisciplinarity*. Oxford, UK: Oxford.
- Gamma, E., Helm, R., Johnson, R., Vlissides, J., 1995. *Design Patterns*. Westford, Massachusetts: Addison Wesley.
- Gardner S.K., 2013. *Paradigmatic differences, power and status: a qualitative investigation of faculty in one interdisciplinary research collaboration in sustainability science*. College of Education and Development, University of Maine: Digital Commons. Publications. 57.

---

Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P., & Trow, M., 1994. *The new production of knowledge: The dynamics of science and research in contemporary societies*. Newbury Park, CA: Sage.

Giles J., 2011. Social Science lines up its biggest challenges. *Nature* 470: 18-19.

Graff, H.J., 2015. *Undisciplining Knowledge: Interdisciplinarity in the Twentieth Century*. Baltimore, USA: Johns Hopkins University Press.

Graves, C., 2010. Professor of psychology. [https://en.wikipedia.org/wiki/Clare\\_W.\\_Graves](https://en.wikipedia.org/wiki/Clare_W._Graves).

Habermas, J., 1984, *The Theory of Communicative Action (Volume 1): reason and the rationalisation of society*. Cambridge, UK: Polity.

Habermas, J., 1987, *The Theory of Communicative Action (Volume 2): the critique of functionalist reason*. Oxford, UK: Blackwell.

Habermas, J., 1991, *Structural Transformation of the Public Sphere*. Cambridge, Massachusetts: MIT Press.

Hansen, M.T., 2001. *Introducing T-shaped Managers: Knowledge Management's Next Generation*. Available: <https://hbr.org/2001/03/introducing-t-shaped-managers-knowledge-managements-next-generation>.

Jantsch, E., 1972. Interdisciplinary and transdisciplinary university. *Systems approach to education and innovation*. *High. Educ.* 1 (1) 7-37.

Jantsch, E., 1980. *The Self-Organising Universe*. Oxford, UK. Pergamon Press.

Johnston, D.L., 1978. Scientists Become Managers-The "T"-Shaped Man. *IEEE Engineering Management Review*, 6(3), 67–68. doi:10.1109/emr.1978.4306682

Kagan, J., 2009. *The Three Cultures: Natural Sciences, Social Sciences and the Humanities in the 21<sup>st</sup> Century, Revisiting C.P. Snow*. Cambridge, UK: Cambridge University Press.

Kant, I., 2008. *Kant's Critiques*. Radford, USA: Wilder.

Kirby, A. 2019. Transdisciplinarity and Sustainability Science: A response to Sakao and Brambila-Macias in the context of sustainable cities research. *Journal of Cleaner Production* 210 (2019) 238-245.

Klein, J.T., 2010. *Creating Interdisciplinary Campus Cultures*. San Francisco, USA: Jersey-Bass for the Association of American Colleges and Universities.

Klein, J.T., 2014. Discourses of Transdisciplinarity: looking back to the future. *Futures* 63 (2014) 68–74.

Koestler, A., 1967. *The Ghost in the Machine*. London, UK: Hutchinson.

Lao Tzu, 1995. *Tao te Ching*. London, UK: Judy Piatkus Publishers Ltd.

---

Locke, J., 1964, Essay Concerning Human Understanding. London, UK: Wm Collins Sons and Co. First published 1690.

Ma, J., 2018. Jack Ma turns 54 today. His Alibaba exit shows he takes his own advice. Available: <https://www.cnbc.com/2018/09/10/billionaire-jack-ma-alibaba-exit-takes-his-own-advice.html>.

Maton, K. and Howard, S. K., 2018. Taking autonomy tours: A key to integrative knowledge-building, LCT Centre Occasional Paper 1: 1–35.

Max-Neef, M., 2005. Foundations of Transdisciplinarity. Ecological Economics 53 (2005) 5–16.

Nicolescu, B., 2000. Transdisciplinarity and Complexity. Paris: Bulletin Interactif du CIRET.

OMG Object Modelling Group, 2015. About the Unified Modelling Language. Available at <https://www.omg.org/spec/UML/2.5/About-UML/>

Piaget, J., 1972. The Epistemology of Interdisciplinary Relationships. Centre for Educational Research and Innovation (CERI): Interdisciplinarity. Problems of Teaching and Research in Universities. OECD, pp. 127-139.

Plato, 1955. The Republic. London, UK: Penguin.

Popa, F. et al. 2015. A pragmatist approach to Transdisciplinarity in Sustainability Research: from complex systems theory to reflexive science. Futures 65 (2015) 45-56.

Raworth, K., 2017. Doughnut Economics: Seven Ways to Think Like a 21st-Century Economist. Vermont: White River Junction.

Schrodinger, E., 1944. What is life? The physical aspect of the living cell. Cambridge, UK: Cambridge University Press.

Senge P.M., 1990. The Fifth Discipline: The Art and Practice of the Learning Organisation. Cambridge, USA: Currency.

Smuts, J., 1926. Holism and Evolution. London, UK: Macmillan and Co. Ltd.

Tejedor G., et al., 2018. Transdisciplinarity in Higher Education for Sustainability: how discourses are approached in engineering education. Journal of Cleaner Production 175 (2018) 29-37.

United Nations, 2015, Transforming Our World: The 2030 Agenda for Sustainable Development.

Watts A., 1951. The Wisdom of Insecurity. New York, USA: Random House.

Watts A., 1967. This is It. Toronto, Canada: The Macmillan Company.

Watts A., 2002. The Tao of Philosophy. Vermont, USA: Tuttle Publishing.

Wilber, K., 1995. Sex, Ecology, Spirituality. Boston, Massachusetts: Shambhala Publications.

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