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Basden, A

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Understanding Artefacts related to Human Aspects: The Case of Information Technology and Systems

Andrew Basden,

Salford Business School, University of Salford, U.K.

INTRODUCTION

Stafleu's article clearly outlines a systematic account of what he believes about artefacts and technology, remarking that "both Dooyeweerd and Strauss ... almost ignor[e] technology." He takes some time clarifying ways in which he agrees and disagrees with Dooyeweerd and Strauss in their views of aspects, things and theoretical thought. Some of his clarifications are very useful, forming a good basis for further discussion about artefacts.

Stafleu's view is that both artefacts and technology are made possible and meaningful by human functioning in the aspect, whose kernel is formative power, and the main aim of his discourse seems to be to set out his understanding of different kinds of artefact. (Though Dooyeweerd calls this the historical aspect, and Stafleu calls it the technical aspect, it is useful to express its meaning as richer than these with the term 'formative aspect', which will be used here.)

Artefacts are entities in which formative power is key, but there are many different kinds of artefact, and these may be differentiated, suggests Stafleu, by reference to the aspect onto which the formative power or technical activity is projected. This is a very useful insight, but unfortunately Stafleu limits it and introduces some confusion.

Stafleu's discussion is restricted to artifacts where formative power is projected onto one of the six pre-human aspects. This restriction might make it dangerous to generalise because the human aspects open up many philosophical and practical possibilities beyond these. So my response will consider a kind of artefact and technology directed to one of the human aspects, the lingual: the computer and 'information and communication technology' (ICT). It is useful to consider ICT because it is that technology which is so significantly changing our lives today for both good and ill.

This article may be treated as more than a response to Stafleu, in that it outlines how Dooyeweerdian philosophy can be exceedingly fruitful in studying ICT, and even how that study can inform Dooyeweerdian philosophy itself.

A note on terminology: Though Stafleu replaces Dooyeweerd's term 'aspect' with 'relation frame', I revert to Dooyeweerd's usage, as being more comprehensive in that it expresses things other than relations, and as more faithful to the importance of meaning and normativity, which are important in ICT.

Stafleu's View of Artefacts

Stafleu locates artefacts primarily in the formative aspect and secondarily in one of the six pre-human aspects to differentiate six kinds of artefact. For each he illustrates activities, concrete technical artefacts and disciplines.

- Quantitative examples: counting, calculators, mathematics;
- Spatial examples: measurement, instruments, geometry;
- Kinematic examples: travelling, railways;
- Physical examples: stone-working, tools, chemistry;
- Biotic examples: cultivation, ploughs, agriculture;
- Psychic examples: cycling, bicycles.

For each of these, he proposes corresponding processes, techniques, artefact types, and technologies, and briefly charts the historical development of these. Each illustrates Dooyeweerd's suggestion that progress or history is constituted in 'opening up' (the potential of) each aspect, though Stafleu refers to this idea only later.

He calls this application of technology, projection of the formative aspect onto earlier ones. He seems to be referring to the application of technology to serve or assist the functioning in another aspect. This idea of 'application' of one aspect for the sake of another is important, but not adequately developed in Dooyeweerd.

He also claims it can replace Dooyeweerd's notion of retrocipation. This is confusing, because retrocipation as I understand it involves either foundational dependency or an analogy, whereas the 'application' or 'serving' relationship is distinct from both of these (Basden 2008a, 72). Stafleu seems to conflate the notion of founding aspect with that of application, especially in discussing projection to the physical and biotic aspects. In the rest of this paper I will take projection to refer to the application rather than foundational dependency.

Unfortunately, Stafleu restricts his discussion to the pre-human aspects. It is curious that he does this, and does not consider technical activities and artefacts where formative functioning is projected onto (serves) the later aspects. After all, did not Dooyeweerd emphasise that things function in all aspects? Restriction to the pre-human aspects means that many issues of normativity in the creation and use of artefacts are likely to be ignored, and that kinds of complexity found in later aspects are not addressed. That later aspects open up new meanings and laws, only dimly echoed in earlier aspects, makes it questionable how far one can generalise from Stalfeu's account of projection to earlier aspects.

The computer is an artefact in which our formative functioning is projected onto the lingual aspect. Programs are written rather than built (though some building serves the writing process). The associated technology is called information (and communication) technology (IT or ICT) or information systems (IS) when in use. 'Computer' refers not

only to mainframes, desktops and laptops, but also to mobile devices and embedded devices, such as in hospital monitoring equipment.

The Lingual Artefact that is the Computer

Computers exhibit a kind of complexity that Stafleu does not discuss: that of the programmable device, so flexible that it can be employed for almost anything we wish. However, to understand this, we must recognise that the computer presents itself in several different guises. The first is the computer before being programmed. The second is the computer with operating system and general purpose software libraries. The third is the developed application for use in the world, such as Twitter or health systems. The fourth recognises the importance of the user. The fifth sees the artefact as a global phenomenon. The sixth concerns research that investigates all these.

So, in discussing the nature of this multiple artefact, we will cover the following:

- The nature of computers, programs and the Internet;
- Software libraries, computer languages and HCI: the realization of lingual possibilities in ICT;
- Development of information systems (IS) for use in the world;
- Actual usage of ICT in its diverse normativity;
- ICT in the world and society;
- Research appropriate to ICT and IS.

For each, a brief history of development will be given, followed by a proposal for understanding the issues of each based on Dooyeweerd's philosophy. Our discussion is necessarily a summary; fuller discussion of each of these can be found in Basden (2008a).

I believe the qualifying aspect of the computer is the lingual rather than the formative (which qualifies most other technology). This cannot be proven, but in the discussion below, several pointers are given why it is appropriate.

The Nature of Computers, Programs and Internet

Can a computer be like a human being? This 'artificial intelligence' (AI) question has been debated for over 50 years. The debates have been dialectical conflicts, and three kinds grounds for debate can be discerned:

- Computers are material, mind is mental; can 'mind' emerge from 'brain'?
- Computer causality is physical, human causality is biological;
- Computers work by deterministic laws while humans are free.

These are almost direct expressions of the three dualistic ground-motives that Dooyeweerd identified: matter-form, nature-supernature (lower and higher levels of existence), nature-freedom. (Basden 2008a) suggests that this can explain the non-

resolution of the debates, and that a debate grounded in the Biblical ground-motive of creation, fall, redemption might bring fruitful resolution, as follows.

The three questions compare computers to the human self, but Dooyeweerd claims theoretical reflection on the human self is impossible, so what computers must be compared to is human functioning in the aspects. Dooyeweerd's notion of subject and object is helpful, which Stafleu explains as: "With respect to a given law, something is called a subject if it directly or actively satisfies that law. It is an object if it indirectly or passively satisfies that law." Computers, therefore, may be treated as either subject or object. We can ask the AI Question from the perspective of either object- or subject-functioning, and can do so in each aspect; see Table 1.

Table 1. Computer as Dooyeweerdian subject and object

Aspect	Subject-functioning	Object-functioning
Quantitative - physical	"Computer obeys electro-magneto-optical laws"	ditto
Organic [Note 1]	-	"Computer is mouse, keys, VDU that match the user's organs."
Psychic	-	"Computer displays colour, sound; responds to stimuli from user."
Analytical	-	"Computer stores, receives and displays distinct data."
Formative	-	"Computer processes and structures data."
Lingual	-	"Computer answers my questions." "Computer tells us where to go." "Computer sends emails."
Later aspects	Depends on application - see below	

Note 1. This stretches the kernel meaning of the biotic aspect from life functions to 'organism', and is argued in (Basden 2011b); not everybody agrees.

In this way a Dooyeweerdian answer to the AI question might be both "Yes" and "No", depending on whether we answer from the point of view of subject or meaningful object. The debate then is no longer a conflict but can move on to more fruitful discussion of various aspects in which the computer functions.

The most important element of a computer is that it is programmed. What are computer programs? The conventional answer is "sequences of instructions", but what are "instructions"? Since Dooyeweerd roots the being of things in meaningfulness (1955,I,4), we find ourselves asking what is the meaningfulness of programs? There are several 'levels' at which programs can meaningfully be said to exhibit programmable behaviour, one level per aspect. The first sees programs from the psychic aspect, as bit patterns, pixels and their manipulation. At the analytical aspect, this is seen as data, like numbers, items, colours or text, and primitive operations like add, subtract, at the formative aspect, as structures and processes, and at the lingual aspect, as the signification of these structures and processes. For example, a bar chart on screen signifies a set of quantities, with more-less comparisons, while five horizontal lines, dotted with ovals that have

vertical lines attachec, signifies rhythm and melody on a musical stave, which might be played through the computer's speakers. The manipulation, operations and processing all serve the signification activity, as earlier aspects of it.

Thus the program represents information or knowledge in a way not found in other technologies. This representation role is one reason why the lingual aspect is the most important one.

Programs can represent meaning of any aspect (the above examples were of the quantitative and aesthetic). Basden (2008a) suggests that the program may be seen as a virtual law side - (a representation of) the law side in which the information in the computer operates. They are usually deemed good programs if their representation is faithful to the laws of the represented aspects; in a hospital monitoring program, faithful representation of knowledge of biotic laws means its information is processed in biotically appropriate ways. However, in computer games some laws might be modified; for example, the biotic law of death is set aside in many games, in that characters return to life. This way of understanding programs can encourage clarity, direction and responsibility among programmers.

What is the Internet? Are our computers 'part of' the Internet (or Cloud), or is the Cloud 'part of' our computer? Dooyeweerd's notion of correlative enkapsis is useful here: just as a forest comprises trees but each tree only fully actualizes its potential in a forest, so with Internet and computers.

The functioning of a computer in all aspects (including later ones) depends on two things: to what extent the computer is designed to function well in each, and how its users use it in each, as discussed in the next three sections.

Software Libraries, Computer Languages and HCI: Encapsulation Knowledge of the World

There are two kinds of programming, in both of which knowledge is represented or encapsulated, to yield an artefact that takes action in meaningful ways - it might be a calculator, a hospital monitoring computer, a word processor, social media like LinkedIn, a music mixer, and so on. The second kind of programming, undertaken by IS developers and discussed in the next section, encapsulates knowledge of specific types of meaningful reality so that humans can use them. The first kind, undertaken by computer scientists, encapsulates generic knowledge of the way the world works, as software libraries made available to be employed by IS developers. "Generic knowledge of the way the world works" is, under Dooyeweerd, knowledge of the laws of aspects, so it is useful to classify software libraries according to aspect. In Stafleu's terminology, this projects the lingual aspect of representation onto each aspect in turn.

Originally, the main kind of meaningful reality that computers were tailored to handle, and for which libraries were created, was quantitative (from which 'computers' were named). In the 1970s, it became clear that they could also handle entities and properties,

which cannot be reduced to numbers. In the 1980s text, graphics and sounds started to be handled, then animation and music. Video followed in the 1990s. In parallel with these, techniques developed for handling spatial and kinematic meaning, as in SatNavs. The 2000s saw the tailoring of computers to handle social content. Dooyeweerd's notion of progressively opening up aspects accounts for this history surprisingly well.

The software libraries encapsulate three things for the aspect: information structures and processes (algorithms) meaningful in each aspect, 'languages' in which to represent our knowledge of these, and user interface facilities by which users will interact with them (e.g. bar charts, musical staves). For example, quantities may be appropriately expressed by digits, bar charts, but not musical staves. Table 2 gives examples of things and operations meaningful in some of the aspects, from which information structures and processes are constructed; Basden (2008a) discusses these, with languages etc. for all aspects.

Table 2. Meaningful things and operations represented in computers

Aspect	Meaningful things	Meaningful operations
Quantitative	Numbers, more, less	Arithmetic and statistical operations
Spatial	Areas, planes, shapes, directions inside, outside, left, right, near, far	Rotate, clip, merge, occlude, surround
Kinematic	Path, speed, animation; fast, slow	Find path, follow path, render animation
Psychic	Colour (hue, saturation, brighness); sound (volume, pitch, timbre), octave	Darken, shade (e.g. antique), increase contrast, detect edges; create waveform, play it
Analytical	Concepts, inequalities, truth values	Create, delete, deduce
Formative	Relationships, structures, instructions	Relate, build, modify, execute
Lingual	Words, sentences, etc., diagrams, headings, emphasis, cross-references, vocabularies, glossaries, thesauri	Write, emphasise, rewrite, spell-check, add to vocabulary
Economic	Resource stocks, budgets, currencies, value, transactions	Double-entry bookkeeping operations, transaction processing, materials requirements processing

The mandate of computer science and engineering may thus be seen as creating software libraries (information structures, algorithms, languages and interface constructs) that encapsulate or express our best understanding of each aspect. (This is a second reason why it is appropriate to see computers as qualified by the lingual aspect.) Since aspects are irreducible to each other in their meaning and laws, no software library can adequately stand in for others and, where this is attempted, development becomes difficult, errors abound, and costs soar. For example, trying to treat complex spatial objects in terms of their (quantitative) coordinates can lead to errors like the inability of coping with shapes with holes. However, a Dooyeweerdian understanding of aspectual inter-dependency shows how libraries etc. should relate to each other, and inter-aspect analogy can guide design of user-interactions.

Unfortunately good libraries etc. have yet to be developed for all aspects, so IS developers must resort to expressing the laws of one aspect in terms of others. Though this is possible because of inter-aspect analogy (c.f. Dooyeweerd 1955,I,59), research must continue to develop a full set.

Development of Information Systems for Use in the World

The second kind of programming builds applications for use in human life, using the libraries created above. Methodology for this has developed since the 1960s, when it was conflated with the first kind. After it was differentiated from the first in the 1970s, methods were devised that were driven by deterministic views of economics and control (c.f. nature-freedom ground-motive). In the 1980s the human element was recognised in, for example, 'soft systems methodology' (Checkland 1981), and during the 1990s the importance of social structures was recognised. During the 2000s, the kinematic, aesthetic and juridical aspects of development were recognised in Agile Methods, and ethics became recognised.

An information system (IS) is an application (technical software artefact designed for certain purposes) in its human or organisatonal context (such as rules for its use). Developing these is multi-aspectual human functioning, and Dooyeweerd's aspects, because of their innate normativity, lend themselves to guiding development.

Once we begin to separate out norms and laws, we find each aspect is meaningful in several different ways, and that there are at least four different human activities involved: eliciting knowledge of the domain of application from experts, anticipating use by getting to know what potential users need and how they are likely to use it (often called 'user requirements analysis'), creating the IS by design, knowledge representation and testing, and orchestrating the entire development project ('project management') (Basden 2008a). Table 3 shows examples of these for three aspects.

Table 3. Example of aspects of four activities in IS development

Aspect	Knowledge elicitation	Anticipating use	Creating the IS	Orchestrating project
Analytic	Clear concepts of domain	Clear understanding of what users need (needs v. wants)	Clearly written programs	Clear objectives
Formative	Structuring domain knowledge	Structuring user needs	Designing the program structure	Planning; achieving objectives
Lingual	Interviews with domain experts and reading around the topic	Interviews with potential users	Programming, documentation	Team communications
Social	Relating to domain experts, so they provide tacit knowledge	Relating to potential users	Team working	Leadership
. . .				
Ethical	'Loving' domain	Patience with users who	Incorporating	Generous, self-

	knowledge	change their minds	flexibility	giving leadership

Basden (2008a) discusses all aspects more fully.

Aspects fulfil different purposes. In knowledge elicitation, they are directed to existing knowledge while in anticipating use, they are directed to future possibility, and in the other two they are directed to present behaviour. In each of the four activities a different aspect is of primary importance. That of programming is the lingual rather than the formative because it is an activity primarily of writing and representation. Quality of IS development tends to increase when all aspects function well. This idea was developed into an international Masters course on 'Key Issues in Information Systems Development', which proved to be remarkably popular with the students (Basden 2007).

The benefit of referring to Dooyeweerd's aspects in this way is that it helps to uncover and guide the diversity of real-life IS development, so that no key issue is overlooked, in contrast to many formal methodologies and training courses, which focus on a limited range of aspects.

Usage of ICT in its Diversity

From this point of view the computer artefact is in use. It really comes into its own because it was intended for use. Up to the 1970s the focus was on analytical correctness and functionality. The 1980s saw interest in ease of use, and the 1990s also in benefits like 'productivity' or 'effectiveness'. Home computing and gaming, where benefits were more varied, began in the 1980s and flourished in the 1990s. The 1990s saw increasing informational use in the World Wide Web and social use via email. This developed into social networking in the 2000s. Meanwhile, e-commerce and e-government were becoming fashionable. Today sees an increase of individual, mobile use. Each kind of use expresses a different meaningfulness, which, of course, can be addressed via Dooyeweerd's aspects.

Issues for analysis and research in this area include kinds of things they are used for, ease of use and usefulness, benefits and detrimental impact, unexpected and indirect impacts, learning to use, how the shape of the technology changes people's ways of working and living, and so on. Ethical issues are obviously important. Impacts from use of ICT are on the user, colleagues, organisations, society and world, and are of great variety. Some are hidden. Dooyeweerd's suite of aspects lends itself well to analysing and researching use because it enables us to understand and tease out variety and also to expose that which is hidden (Strijbos 2006; Winfield & Basden 2006).

A computer in use might be seen as having both qualifying and leading aspects. The qualifying aspect does not vary with application but expresses what all computers do vis a vis the user's interaction with it, and this is primarily lingual because the user interacts by means of symbols that carry meaning. The leading aspect is that which is most

meaningful to the specific application of the computer, which was usually set during IS development. For example, LinkedIn is led by the social aspect, a translator program is led by the lingual (as well as qualified by the lingual) and a computer program embedded in hospital monitoring equipment is led by the aspect of health care (ethical and/or biotic). Occasionally users find uses that had not been designed for. This taxes traditional understandings, but Dooyeweerd's discussion of the antique shawl being used as a wall hanging (1955, III, 146) might help us understand this.

However, restricting interest to two aspects does not do justice to the richness of ICT usage. Basden (2008a) shows that *all* Dooyeweerd's aspects are important to understanding the usage of ICT. Doing this revealed something else as well, which those in the field had not explored.

Ease of use and usefulness have traditionally been studied in completely separated fields (human-computer interaction, and information systems). Despite Davis recognising both in a seminal paper in 1989, there has little real dialogue between the two fields. Basden's (2008a) multi-aspectual analysis showed not only that ease of use and usefulness both involve all aspects, which provides a basis for integration, but also that there is a third issue distinct from both: engagement with meaningful content (i.e. information), which neither field can properly cover (Breems & Basden 2014, Joneidy & Basden 2013). Analysing the aspects of engaging with content helps address issues the community finds challenging, such as computer procrastination (Breems & Basden 2014), email scams, virtual reality and gaming. Just as in IS development there are four multi-aspectual functionings, in ICT use there are at least three.

Dooyeweerd can make a major contribution to the study of ICT usage. The inherent everyday normativity of Dooyeweerd's aspects adds a practical edge to this approach which opens up fruitful new avenues not only in research and teaching but also in practice. Ahmad & Basden (2013) use Dooyeweerd to emphasise the importance of, and suggest a way to study, 'down to earth' issues in ICT use. This view has been made the central thrust in an undergraduate course on 'Rich Media' (Basden & Whatley 2012).

Impact of ICT on the World, and Vice Versa

When millions of individuals use ICT in a certain way, it affects society and the world, and this has been the topic of endless discussion in Information Systems circles, including hopes in 1970s for increased leisure time and freeing workers from drudgery, through fears that computer games of the 1980s would de-socialize youth, hopes for global information exchange in the 1990s, concerns about technology dependence, privacy and security in the 2000s, and about the impact of social networking software today.

Repeatedly ICT's promises to humanity have been broken: the 'paperless office' consumes more paper, productivity-oriented systems reduce profits, time-saving email consumes more time, social networking software makes people more lonely and self-

centred, e-government systems disenfranchise people, and so on. Such conundrums call for explanation.

Research has been governed by paradigms of technological determinism (TD), social construction of technology, which reacted against it, and social shaping of technology, which tried to combine them but criticised both for ignoring social structures of power. The characteristics of these are well explained by the poles the nature-freedom ground-motive and Dooyeweerd suggests attempts to combine them ultimately fail. None of them really address the problems above.

Instead, Dooyeweerd opens the way to a more fruitful view, as expounded in Schuurman (1980), which sees the development of technology as a whole as led by aspectual norms, and suggests that technology should be led not by its own norms but by the norms of all other aspects. Strijbos & Basden (2006) propose an 'Integrative Vision For Technology' and Krishnan-Harihara & Basden (2010) explores Goudzwaard's (1984) notion of idolatry to explain failures in e-government.

In parallel with this, Giddens' (1993) work has been applied to technology, especially his structurated relationship between agents and society, of norms, power and meaning. What Giddens actually says about these echos Dooyeweerd's juridical, ethical and pistic aspects. Dooyeweerd offers two ways to enrich Giddens' approach. One is an understanding of how these three 'societal' aspects echo and depend on individual and organisational aspects. The other is correlative enkapsis, which helps us understand the circular structurational relationship itself. Coupled with a Dooyeweerdian understanding, from other fields, of computer use as law-subject-object relationships in all aspects, and Internet as enkapsis, these might open new doors to understanding how the attitudes and actions of agents impact and are impacted by society.

Within this field, ICT tends to be lumped with all technology, and thus viewed as qualified by the formative aspect, because the view does not penetrate to actual usage and development as covered by the first four fields. However, there is a growing interest in 'technology as text' (Grint & Woolgar 1997), to escape the clutches of technological determinism.

Scientific Research Appropriate to ICT and IS

Research is underway in each of the above five areas. None of them are natural sciences. Though initially the methods applied were those of corroboration of hypothesis statements (which is how Stafleu characterizes science; see later), it became clear from the 1980s onwards that these are inappropriate.

Research in the first field is partly philosophical. The second field employs design science, the main method of which is to encapsulate, in artefacts, laws that work. For example, in order to develop a software library that is appropriate for the economic aspect requires designing this library from conceptual understanding of its laws, testing it in a wide variety of situations and refining it accordingly. The library may then be said to

encapsulate an understanding (a 'theory') of the laws of that aspect, though in working form rather than in the form of statements. Research in IS development and use is interpretive or hermeneutic in nature. This seeks insight about situations that are too complex to express in hypothesis statements, and involves the hermeneutic circle instead of corroboration (Klein & Myers 1999). Research into the relation between ICT and society can be interpretive but is often critical-social in nature, the aim of which is to critique and transform the status quo and make a better world (Myers & Klein 2011).

Stafleu's view might fit the natural sciences, but Dooyeweerd's (1955,I) transcendental critique of theoretical thought adroitly fits all of these varied kinds. Dooyeweerd's critique recognises three elements:

- In research, data are obtained by abstracting aspects of the world that are important to the researcher (a '*Gegenstand*' relation). The choice of aspect(s) is pre-theoretical. While hypothesis-corrobation research limits itself to one aspect, interpretive research is open to multiple aspects.
- Each aspect defines a different rationality. Since there is no over-arching rationality, the researcher takes responsibility for orchestrating them to generate new findings from the data that might make a contribution to humanity's body of knowledge of the field. This responsibility is pre-theoretical. While hypothesis-corroboration research often involves two rationalities, design research requires tacit combination of many, and interpretive and critical-social research require explicit consideration of many.
- Such potential contributions are discussed and refined. This discourse is "supra-individual" (Dooyeweerd 1955,I:59), involving critical self-reflection, which ultimately requires reference to an Origin of Meaning. What the research community treats as its Origin of Meaning is governed by prevailing religious (pre-theoretical) ground-motives. Both critical-social and philosophical research of the first and fifth fields involve critical self-reflection ("What is human?") and Dooyeweerd's ground-motive of creation-fall-redemption offers new insight into the functioning of humans, computers and society.

Dooyeweerd's transcendental critique resonates well with the realities of IS/ICT research, and can advance our understanding thereof. Eriksson (2003) argues that Dooyeweerd can overcome an assumed incommensurability between IS research approaches and Basden (2011a) details how they can be fruitfully integrated. It frees Christian thinkers from an antithetical approach to extant research, enabling them to engage with them by affirmation, critique and enrichment (Basden 2008b).

Conclusion So Far

Stafleu's views lead him to a valuable first step in understanding artefacts, namely to differentiate broad kinds of artefacts on the basis of which aspect the formative functioning of humanity is projected onto. While Stafleu restricts his discussion to the pre-human aspects, my response considers a human aspect, the lingual, which makes possible information and communication technology and systems. We have shown how it

is possible and fruitful to go further, by employing aspects and other portions of Dooyeweerd's philosophy to understand the nature of computers as artefacts in five different ways.

- Computers are subjects and objects in aspectual functioning, programs are virtual law sides;
- Software libraries, computer languages and HCI are realization of lingual possibility of representing aspectual laws;
- IS development is four multi-aspectual human functionings;
- Usage of ICT is three multi-aspectual functionings;
- ICT in society is correlative enkapsis, directed by norms of all other aspects.

A Dooyeweerdian understanding in each of these can offer fresh ways of understanding (new paradigms) in each, which spawns new insights and opens up new opportunities in each area.

In addition, this article has shown how Dooyeweerd's transcendental critique very nicely accounts for research in these areas, beyond the hypothesis-corroborating approach that Stafleu assumes. Design, interpretive and critical-social sciences must be taken into account alongside natural sciences.

What Dooyeweerd Can Offer

The discussion above has demonstrated the fruitfulness of Dooyeweerd's philosophy when applied to a discipline like information technology and systems. The following collects together portions of Dooyeweerd's thought found most useful; Table 4 summarises them.

Dooyeweerd's transcendental critique of theoretical thought is particularly useful to understand the way research is carried out in the various fields related to IT/IS, because it can embrace not only hypothesis-corroboration research found in the natural sciences, but also design research, philosophical research, interpretive research, critical-social research, which are important in the various fields discussed. Dooyeweerd's transcendental critique can do this because it begins with the pre-theoretical attitude and asks what is meaningful, because it does not assume one over-arching kind of rationality but relies on human responsibility, and because it recognises that research includes communal discourse that refers to an Origin of Meaning.

Dooyeweerd's notion of ground-motives is helpful in two areas. First, since ground-motives are origins of meaning in theoretical thought, they can be used in understanding the dialectical fashions in research in each area, and Dooyeweerd's ground-motive of creation-fall-redemption can point a way to fruitful integration (Basden 2011a). Second, they are helpful in understanding the philosophical conflicts around the Artificial Intelligence Question of whether computers can be like humans, and offering fruitful new ways of approaching the question.

Dooyeweerd's notion of a diverse law side is useful in developing software libraries that encapsulate the laws and structures of the world. Computer programs may be seen as an alternative law side by means of which virtual worlds exist and occur.

Dooyeweerd's radically interesting notion of subject and object is useful in artificial intelligence to show that the AI Question in fact conflates two questions. His notion of correlative enkapsis is important for understanding computer-Internet and technology-society relations.

Finally, Dooyeweerd's aspects, both his idea that all things are meaningful, and function, in all aspects and his suite of aspects, are perhaps the most important portion of his thought, and are used in all areas. They provide different levels at which to understand computers, guidance in developing software libraries that afford realistic laws and structures, a way to ensure that no key issues are overlooked in IS development, a way to understand ICT use, and norms to guide technological development within society. In some of these areas, important new avenues for study have been revealed. Finally, they provide a way to understand the kinds of data researchers seek, the kinds of rationalities they employ and the kinds of meaningfulness that drives the community's discourse.

Table 4. Importance of Dooyeweerd's Ideas

Field	Aspects	Ground-motives, Transcendental critique	Other Portions
Nature of computers	Ways of functioning (subject, object); Diverse law-side of program	Understands the AI debate	Correlative enkapsis for Internet; Law-subject-object relationship
Knowledge representation	Kinds of meaningful things, operations and ways of expressing these		Virtual law side; Irreducibility, dependence, analogy
IS development	Ways of functioning; Kinds of possibility; Uncovering diversity		
IS use	Ways of functioning; Uncovering diversity		Subject-object
ICT in society	Aspectual norms; Ways of relating to society	Understanding different technology paradigms	Correlative enkapsis
IS/ICT research	Spheres of meaning; Kinds of rationality	Three elements of TC; Origins of meaning	

What ICT and IS can Offer Dooyeweerdian Philosophy

"It is a matter of life and death for this young philosophy," remarked Dooyeweerd (1955, I, vii), "that Christian scholars in all fields of science seek to put it to work in their own specialty." It may be that the application of Dooyeweerd's idea to ICT and IS can feed back and contribute to the development of Dooyeweerd's philosophy.

It can provide examples of the application of the philosophy. This can be valuable because much of the application is to the everyday experience of ICT users and developers, not just in IS research. In this role, it can affirm, sharpen up and even challenge some of Dooyeweerd's idea. For example, a wide range of examples confirm Dooyeweerd's idea of multi-aspectual functioning with intrinsic normativity, and most affirm Dooyeweerd's suite of aspects. However, that both ICT use and IS development involve several multi-aspectual activities intertwined provides interesting material for development of this notion.

It provides copious material for discussion of the kernel and constellation of meaning of aspects, in line with Dooyeweerd's contention (1955, II, 556) that "A more penetrating examination may at any time bring new modal aspects of reality to the light not yet perceived before. And the discovery of new law-spheres will always require a revision and further development of our modal analyses." If ICT and IS are seen as part of humanity's opening up of the lingual aspect, then a sensitive understanding of all kinds of ICT use and development can help expand our understanding of that aspect as affording more than just reading, writing, etc. As mentioned in the footnote to Table 1, it may be that the biotic aspect can be slightly modified from life functions to organisms. The material might also be useful for clarifying contended understandings of Dooyeweerd's notions of anticipation, retrocipation, dependency and analogy, and Stafleu's notion of projection.

The approach to ICT and IS outlined here reaffirms Dooyeweerd's emphasis on meaningfulness as the root of being, process and rationality. Aspects are usefully seen as spheres of meaning as well as law-spheres, and ICT and IS can stimulate philosophic discussion of what meaningfulness is, and its relation to law. Dooyeweerd's notion of law side can perhaps be enriched by the suggestion that programs are artificial law sides for virtual worlds, and it may be that ICT opens a way to empirical, not just philosophical, investigation of Dooyeweerd's idea.

That the interaction between user and computer exhibits both subject-subject and subject-object relationships simultaneously might provides material for deeper philosophical exploration of Dooyeweerd's version of these. The idea of aspects as possibility challenges Dooyeweerd's contention that possibility is of the subject side of temporal reality, and might help us clarify Dooyeweerd's notion of anticipation and retrocipation.

ICT and its use might reveal new kinds of enkaptic relationship in addition to the five Dooyeweerd discussed. It might also reveal new roles for aspects beyond those Dooyeweerd discussed (qualifying, founding, leading and internal leading).

Finally, the usefulness and intuitive usability of aspects in analysis, especially of 'down to earth' issues (Ahmad & Basden 2013), might contribute to Dooyeweerd's theory of knowledge, especially opening up new avenues of understanding of intuition and pre-theoretical engagement.

Reflection on Stafleu's Views

In the light of this, and the need to introduce Dooyeweerd to people in each field, certain of Stafleu's views are particularly helpful to us while others are less so.

Stafleu's explanation of Dooyeweerd's subject-object relationship, and calling the fact side the "subject and object side", are both clear and helpful. What is particularly helpful is Stafleu's discussion of projection of one aspect on another, when seen as the functioning in one aspect directed to serve purposes in another. Projection expresses a kind of relationship between aspects that Dooyeweerd did not seem to give much attention to. That this is not mere analogy, as Stafleu asserts, is important. This not only helps delineate types of artefact, but also expresses what knowledge representation is doing when laws of various aspects are encapsulated in software libraries. It is a useful idea in thinking about application of technology, such as for agriculture, counting, etc.

Basden (2008a) also recognised this kind of relationship, calling it 'reaching out', and gave examples of writing (lingual functioning) directed towards the topic of writing, or the quantitative aspect directed towards what it is that exhibits amount. Stafleu's discussion is more detailed than Basden's, but unfortunately Stafleu confuses it with the idea of founding aspect, and limits it to projection to earlier aspects. He need not do so; the application of technology (whether informational or other) is often towards later aspects, such as social or aesthetic.

However, his designating aspects as relation frames is not particularly helpful, especially for introducing scholars and practitioners in these fields to Dooyeweerd's ideas. 'Relation frame' speaks too strongly of ways of relating, while in most fields of ICT the importance of aspects lies elsewhere, as shown in Table 4. Though it may be argued that the concept behind the label "relation frames" can include some of these, the label itself misleads, and the old label "aspects" seems preferable.

Stafleu rejects Dooyeweerd's view "that it would be possible to start theoretical thought from something that is not theoretical" and holds instead that "Theoretical thought is nothing but thought aided with theories, which in turn depend on artefacts like statements and concepts." As a result, he holds a rather narrow view that "science works with hypothetical statements about laws, trying to corroborate these statements by confronting them with states of affairs considered as facts and by relating them." His view does not express the realities of design, interpretive or critical-social sciences that are important in the ICT fields. Hypothesis-corroboration presupposes that hypotheses have already been formulated; Dooyeweerd's first element makes this explicit, and so does scientific practice of the past forty years (e.g. Glaser & Strauss 1967; Klein & Myers 1999; Myers & Klein 2011). Dooyeweerd's view fits research in the above five areas more closely than does Stafleu's. Does Stafleu's limitation arise from his long-term penchant for natural sciences?

Curiously, Stafleu makes no reference to the ground-motives that Dooyeweerd believed lie at the root of all theoretical thought. We have shown how they have been important in at least two of the fields above.

Stafleu focuses on artefacts because Dooyeweerd and Strauss have not sufficiently done so, and he points the way. By setting off in the direction he points, we can use Dooyeweerd's philosophy in ways that even Stafleu does not seem to have appreciated. Exploring kinds of artefact related to the human as well as pre-human aspects, we discover fresh insights that make genuine contributions to the various fields of scholarship and practice.

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