Three-dimensionality emerges out of early aspects

Abstract. *The crucible for friendly cooperative work is the clear separation of concerns (**MDSOC**) without disregarding the network of holistic relationships generated by crosscutting interactions known as early aspects at the domain model and underlying models that support it. Moreover to detect a cluster of relationships that would mimic DNA molecule, undergoing embryogenesis and generating a myriad of living forms. Such is the nature of the Model of Primary, Secondary and Tertiary Waves to design and plan sustainable cities and its underlying geometric model inspired by the tilings of the Dutch graphic artist M.C. Escher. Like a living organism, it adapts gracefully to unanticipated changes due to its fine-grained extensible nature based on **MDSOC** and aspects. The surprising emergent character of aspects evince order out of chaos and complexity out of simplicity. Curiously Greimas's semiotic project also tells us how to simulate semiosis. Apparently since this is based on natural language it should be easier to understand. But it does not have the iconic character of biological processes. This is why I am stressing the biological inspiration of my **MPSTW**. Likewise to be implemented, it demands software architectures and programming languages that fit within the framework of Agile Aspect Oriented Software Development, a fusion of **ASD** and **AOSD**. AspectJ and Hyper/J should exploit the friendly side of weaving that can be achieved through sharing specified by delegation links (in split objects and Us) and create a true **Agile Aspect Oriented Programming Language.** If successful, it will represent a real breakthrough in computer science simulating semiosis and enabling mankind to generate Paradise on Mother Earth.*

1. Introduction

My main goal here is to claim that Multi-dimensional separation of concerns **(MDSOC)** and early aspects built in a generative basis at the domain model simplifies current Aspect-oriented Software Development (**AOSD)(**Pace and Campo, 2001) simply because it highlights humans as first order software components in all dimensions: the need to satisfy the user's requirements and respect human cognitive processes (Cockburn, 2002). Its way of being fits well within the Agile Software Development (**ASD**) Furthermore this agile approach copes with unanticipated software evolution gracefully of course. The need for reflective architectures reveals superfluous because addition, modification or removal of concerns happens preferably at the domain model. It opens the gate for the possibility of configurating new software architectures (Lourenci, 2002a) and programming languages (Smith and Ungar, 1996) that are agility friendly, the human and the computer meeting each other half-way so as optimize the speed with which ideas, text and graphics can be manipulated…an in the end this is very friendly to the user.

Torsten Nelson (Nelson et al, 2000) contrasts traditional approaches to modeling such as structure analysis and object orientation, while top-down approaches, where each unit of the decomposition is encapsulated in a procedure, function or class that behaves like pieces in a larger puzzle to **AOSD.** This slices the entire problem to correspond to a single perspective, at each time, discarding all the problem elements that are not relevant to the perspective and thereby reducing problem complexity without disrupting its holistic nature. *Each perspective can be thought of as a glass sheet with some aspect of a painting: one sheet may have a black outline of the painting; another, its colors; other may have shadings, textures and so on. Superimposing all glass sheets forms the complete painting* (Torsten et al, 2000). This leads to **MDSOC** paradigm. A concern that triggers speaking metaphorically the superimposition of some or all glass sheets is called an **aspect**, responsible for crosscutting concerns. Indeed *since the definition of an aspect is that it is a concern that produces tangling between two or more concerns, the nature of aspects does not confine them to being non-functional requirements. Further, aspects are concerns that are dependent on the problem domain. As a result, aspects may address either functional or non-functional requirements* (Constantinides and Skotiniotis, 2002).

Curiously the current criticism on the "tyranny of the dominant decomposition" as procedures, rules, objects, classes, functions (Tarr and Ossher) tunes with Greimas's criticism on the

"tyranny of the theory of the signs" that pervades semiotics. Greimas believes that semiotics is not a theory of the signs (words), rather it is a theory of meaning that becomes operational when its analysis is elaborated at levels above and below the sign. Thus *semes* combine to form lexemes (words or signs), minimal functional signifying units exactly like the *phemes* form the phonemes, minimal functional sound units. Black and white are signs that approach the status of single semes. A word like girl is a bundle of semes: /human/, /feminity/, /young/, etc. He shows how this generates the whole discourse in the Analytical Dictionnary translation from Sémiotique Dictionnaire raisonné de la théorie du langage. Here he visualizes the distribution of the diverse components and sub-components of the trajectory of discourse in the following diagram (Figure 1).

This opens the gate for the possibility of simulating this generative trajectory in the computer, characterizing the most evolved cognitive process known as semiosis (Gudwin, R.R., 2002). Perhaps Greimas's Dictionnary may become for **AOSD** what *A Pattern Language* from Alexander represents for design patterns movement. It is beyond the scope of this paper to introduce the reader to the Greimasian semiotics. This has been done already in (Lourenci, A. 2002a, b) and will continue being a topic for future research. The aim here is to evince how order may emerge from chaos and complexity from simple constructs.

GENERATIVE TRAJECTORY			
		syntactic component	semantic component
Semiotic and narrative structures	deep level	FUNDAMENTAL SYNTAX	FUNDAMENTAL SEMANTICS
	surface levels	SURFACE NARRATIVE SYNTAX	NARRATIVE SEMANTICS
Discoursive structures		DISCOURSIVE SYNTAX Discoursivisation actorialisation temporalisation spatialisation	DISCOURSIVE SEMANTICS Thematisation Figurativisation

 Figure 1. Greimas's generative trajectory of discourse. This semiosis process may be applied to model any object conforming to separation of concerns and early aspects.

.2. Agile Aspect Oriented Software Development (AAOSD)

An ecodesign model entitled *The Model of Primary, Secondary and Tertiary Waves to design and plan sustainable cities* was conceived in the years 1985-1986 before the advent of sustainable development (Brundtland Report, 1987). The semes of the sustainable architectonic object have been unraveled generating autopoietically Mother Earth configuring a network of holistic relations that define the urban ecosystem and is defined by it (Figure 2).

A parallel can be traced between its evolutive nature and the embryological development. Animal development initiates with the fusion of the sperm and the egg at fertilization. The fertilized egg concept can be mapped to an isomorphic reasoning structure characterized as the idea of the sustainable architectonic object, a marriage between nature and culture. The fertilized egg undergoes a series of rapid mitotic cleavages that divide its large volume of

cytoplasm into smaller cells, forming a morula and then a blastula. The cells of the blastula then rearrange to form three germ layers, which give rise to different tissues. The outer germ layer (ectoderm) gives rise to the cells lining the digestive tract and to internal organs such as the liver and pancreas, and the middle germ layer (mesoderm) gives rise to connective tissues, muscle and blood cells. The cells of these three germ layers then interact with one another and undergo a series of rearrangements to produce the organs and tissues of the body.

The rapid mitotic cleavages generating smaller cells can be mapped to the notion of separation of concerns. The rearrangement of the cells of the blastula to form the germ layers can be mapped to the separation of concerns while 1) primary waves responsible for the interaction of the architectonic object with the environment, namely *homeostasis, continuity, differentiation and repeatability*, 2) secondary waves responsible for the architectural design or the emergence of a new geometric consciousness, namely substance of the function, form of the funtion, substance of the form and form of the form and 3) the tertiary waves responsible for planning, where the process repeatability acts as a link between the local and the global. Here eMergy methods are applied to verify the sustainability of the designed architectonic object.

Figure 1. Model of Primary, Secondary and Tertiary Waves for the design and planning of a sustainable ci (MPSTW)
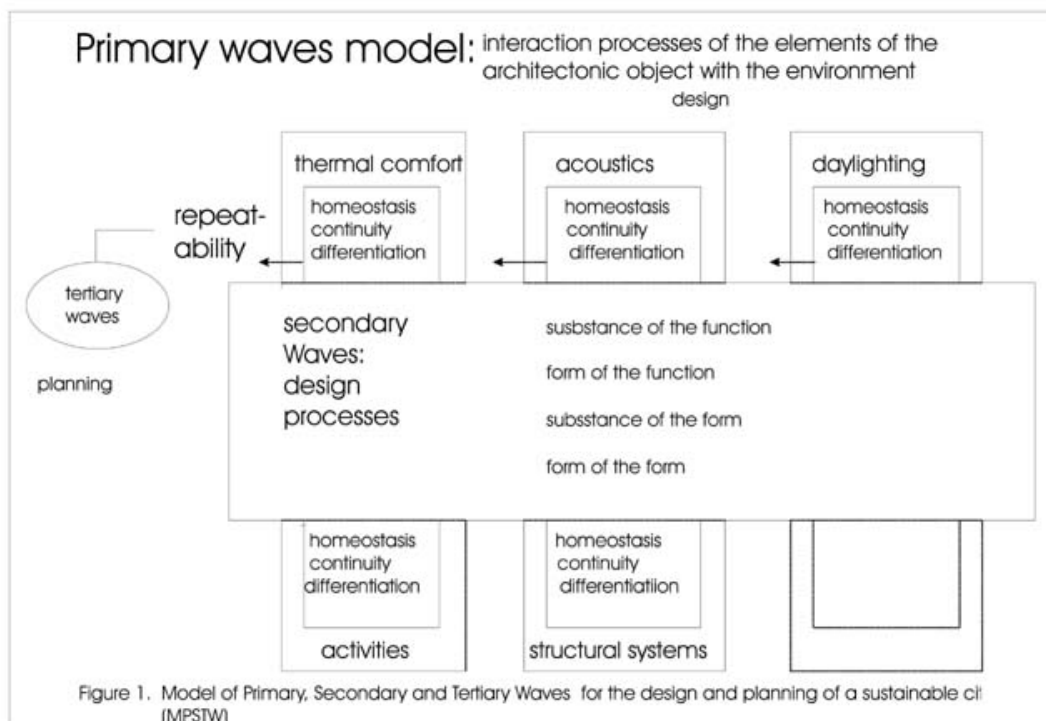
Figure 2. Clear separation of concerns, which in interaction provokes the emergence of aspects of the sustainable architectonic object leading to three-dimensionalization.

The concerns called processes here interact to characterize the ecology of the human behaviour, the environment bringing forth the elements of the sustainable architectonic object, namely, activities, thermal comfort, acoustics, daylighting, structural systems, energy-generating systems, eco-hydraulic systems, etc exactly like the organs of a body.

This network of holistic relationships attached to each element starts interacting to generate the sustainable architectonic object. The emergence of the crosscutting concerns triggers the dimensionalization of the object. Its geometric grounding has been inspired by the tilings of the Dutch graphic artist M.C. Escher. The concept of a prototile, a tile of a different shape, a breakthrough in visual thinking introduced by Escher likens the architectural design to a tiling, or the filling of the plane without gaps or overlaps. Landscape features fit well within this conception. A prototile considered as a fundamental region can be acted upon by the symmetry groups of the plane (crystallographic groups), similarity symmetry groups and conformal symmetry groups. The two latter are fractals (Lourenci, A., 1998).

Yet this can be fathomed to highlight "advanced geometric aspects" through the relationships of the subgroups of the crystallographic groups to build a bridge from the free plan of an apartment designed by the Escher's prototiles to the design of a free plan of the floor of the story and the neighbour building's form conforming to the previous form mimicking Escher's smooth metamorphosis of form. This creates homotopic environments. Hence the underlying geometric model also can generate the whole planet with the same minimal design unit. Hence MPSTW and its underlying geometric model shape a homo-iconic system. A system that reflects upon a homo-iconic system therefore reasons about structures of this single construct. All reflective discussions exist only in terms of collections of these fundamental objects in a homo-iconic system (Lourenci A., 2001).

This geometric aspect faces the same problem as a "computational aspect". How to congeal it to "an object identity". If this is not accomplished, the designer can never reproduce the whole process of the architectural and urban design twice. Due to its dynamicity, if you try to repeat it new configurations emerge. Then you perceive this configuration needs modification again and the designer is helpless. Fortunately, the problem here is the lack of measure for the sides of the fundamental region of the crystallographic groups as envisaged by the algebraist Moser. I believe a fusion of his theories with Schwarzenberger's ideas, that show how to add measure to the sides of the fundamental region would crystallize an "advanced geometric aspect" as an object identity, not as the previous positional identity. Moreover this "advanced geometric aspect" likens the "spectacle" of crosscutting concerns at play to music. Indeed architectonic chords and scales emerge. Please remember crystallographic groups are infinite! Also the notions of tilings! The combinatory of chords and scales is also infinite. This combinatory is able to mimic the myriad of life forms, insofar as an architectonic object will never be similar to a previous one.

Indeed Randy Smith and Dave Ungar put forward that Us, a subjective version of Self introduces three-dimensionality to programming languages. Procedure invocation in Fortran is a kind of message passing in a degenerate case in which there is only one message receiver. The message name is looked up in a kind of giant virtual dictionary and a resulting method is invoked. Generalizing from procedure to OO languages, one must send a message to some object by specifying the receiver. This adds bidimensionality to programming. In aspect-oriented languages a third coordinate must be taken into account when locating points.

3. How does MPSTW cope with unanticipated evolutionary changes?

Smart buildings and energy-generating buildings (Figures 3 and 4) are the emergent sustainable buildings built according to unforeseeable parameters by the time of the conception of the MPSTW. In 1985, I would never dream of an orientation of a building ensuring it would profit form the prevalent wind, which is conducted through a tunnel in the center of the building. This tunnel is designed to act as a venturi tube, which increases the velocity of the air, considerably raising the yield of the two vertical wind turbines mounted in the tunnel. The main problem of integrating a wind turbine into a building are vibration and noise. To absorbe these Future Systems provided thick concrete walls around the turbines, which not only act as a noise barrier but give the building greater stability. The concrete constitutes a major part of the building thermal mass. It is part of Zero Emission Development Project (Melet, Ed, 1999). Apparently a totally unanticipated sustainable architectural development. How will MPSTW deal with the introduction of a new concern called energy-generating systems apparently highlighting only three-dimensionality? These buildings look like rather factories. This represents no problem at all. One can add infinite concerns to the MPSTW. It is simply one more element!

Apparently shyly my sustainable conception mimic Klee's painting, deeply rooted in the art of becoming gradually or mimicking self-organization processes.

Before starting the layout of the furniture mimicking the ecology of the behaviour of a single adult, yearning for the integration of the functions and able to cope with a middle-class budget to build an apartment to live alone, I "visit" the concern "substance of the function" for each element. The main constraint here is represented by the need to build a shaft to shelter the hydraulic pipelines and to gather them along this shaft to ease maintenance and reduce costs of the building.

I hope the reader figures out the immediate three-dimensionalized feature to meet this need. And then I forget about three-dimensionalization, remembering that this must be mapped onto the free floor plan! Figure 5 shows this has been perfectly accomplished!

While the energy-generating building of figure 5 is reduced to energy-generating systems that has no conformance to the neighbour building, following the Modern Movement paradigms that create a chaotic, heterotopic environment, I would accommodate similar energy-generating system without disregarding the other human and environmental needs.

Moreover all energy-generating buildings up to date have not undergone the application of eMergy methods to evaluate costs competitive with the benefits introduced in the long run. This analysis is undergone in my model in the process called repeatability, a link between architectural design and urban planning. This link accuses the abuse of the use of concrete as a source of global warming because cement production yields CO_2 . [1] Of course an analysis may be advanced to show that this effect in a countryside is totally assimilated by the photosynthetic
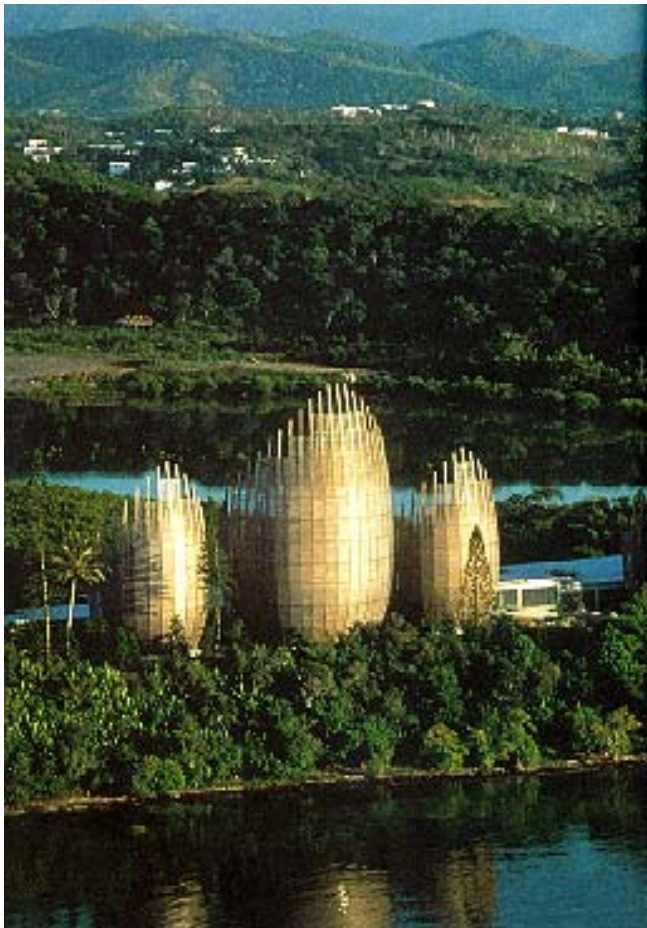

Figure 3. Smart Building. Jean Marie Tjibaou Cultural Centre New Caledonia. Renzo Piano.

processes of the nearby forests if cement production happens there. This improves concrete sustainability!

I hope I have persuaded the reader that an ecodesign model and its underlying geometric model conceived within the **AAOSD** cope with the need for separation of concerns and composition of concerns (aspects) at an early stage, enhancing freedom, creativity, performance and expressiveness.

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[1] 38% of carbon dioxide emissions in the USA comes from cement production!!!

4. The graphical editor

Ideally I could add another concern to deal with graphical representation in the **MPSTW**. Everybody is aware of the unsurmountable difficulties to implement a graphical editor. Especially one designed to mimic the paper, the archaic medium of choice for architects during the conceptual phase of design. To choose freedom and agility provided by free-hand sketch over processing power is a must in sustainable architectural and urban design. When the geometric model based on symmetry groups of the plane and the dotless plane is implemented, one can design a whole building fast and detailedly. But to try to reproduce this process manually demands plenty of time and is wearisome. Fred Lakin et al highlights that the paper allows the designer to quickly write and draw whatever s/he desires. During conceptualization, a designer is functioning like a musician, her instrument must be agile or the performance will be cramped and the ideas lost. But the agility of Computer Aided Design systems has been neglected in favor of processing power.

Jecel de Assumpção and I have implemented a graphical editor in the highly expressive Morphic System from the prototype-based programming language Self. I am not going to delve
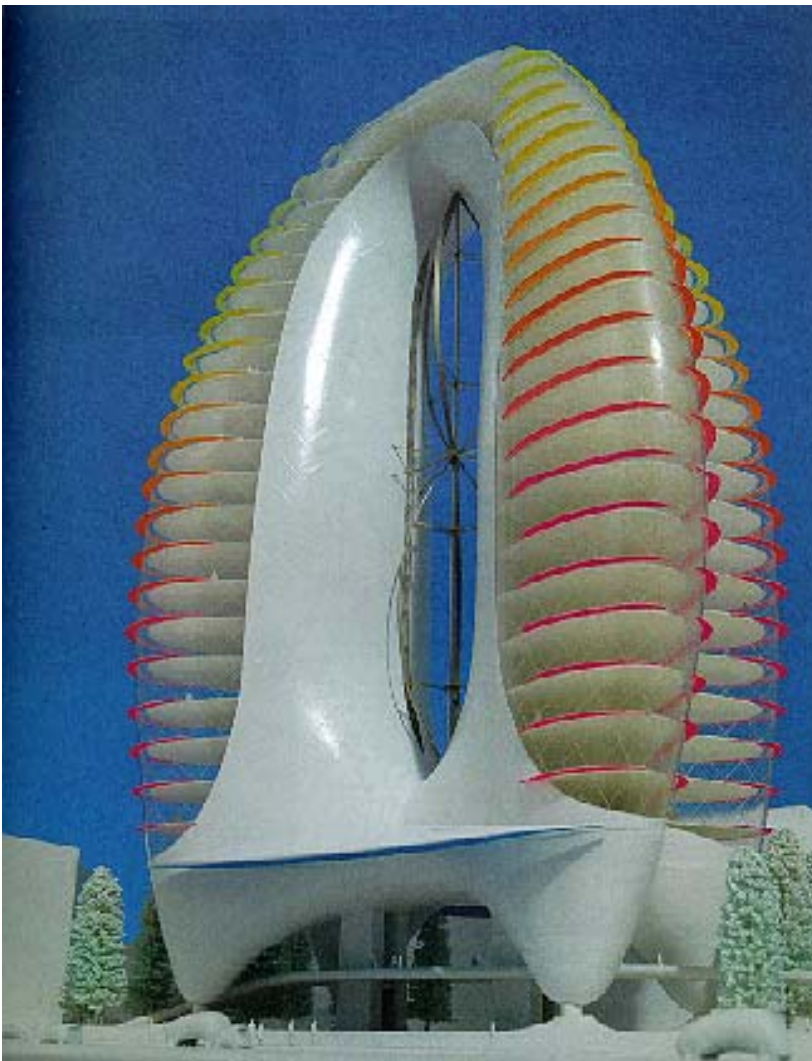

Figure 4. Office Building, Project ZED, London. Future Systems.

deeper into details here. The floor plan of a building story shown in figure   5 was   designed through it.

What I want to emphasize here is that I am in agree with Daniel Bardou: *We believe weaving does not necessarily rely on weavers and is always a process achieved once or several times as it is presented in Kiczales et al (Kiczales et al, 1997). Such processes are role models synthesis and subject composition for example. We believe the rules and the principles according to which weaving is achieved to be the more important feature of weaving. For example, specification of roles as domains for activities, subject composition rules, or even sharing specified by delegation links (in split objects and Us, a subjective version of Self) is also weaving.*

Moreover (Bent Bruun Kristensen and Kasper Osterbye, 1994) claim that a conceptual model may ensure a high degree of conformance to the expectations of the users. *A well-known problem is how the user can express his understanding and thus communicate these to the programmer.*

They claim that the development process is typically inefficient because – the program turns out not to conform to its intention mainly due to communication problems between the user and the programmer – and the program is not comprehensible due to the difference between the understanding directly obtainable from the program and the intention of the program.
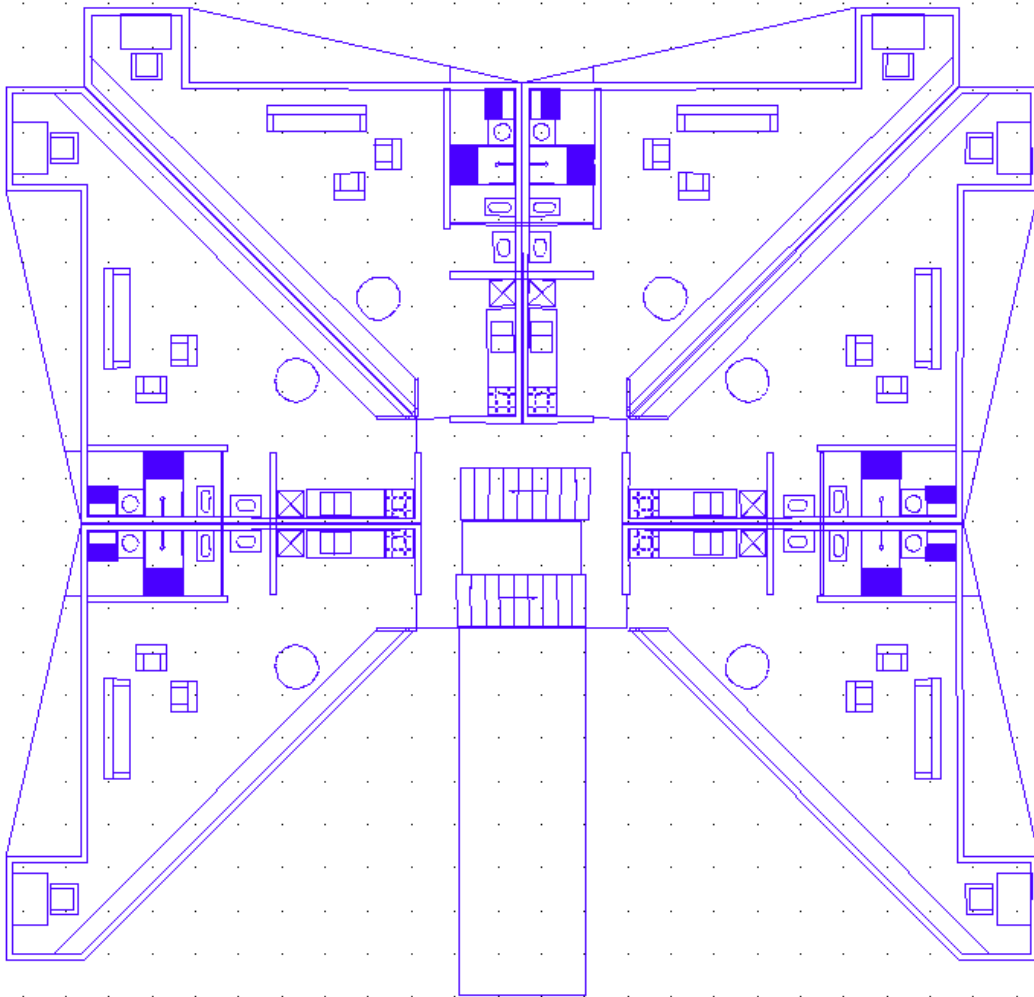

Figure 5. This floor plan was generated in a graphical editor implemented in the prototype-based programming language Self. It mimics free-hand sketch.

Hence (Pace and Campo, 2001) put forward that the strength of AspectJ and Hyper/J is performance, *but they tend to be limited regarding the facilities provided, because it is not*

always possible to know all the aspects that may come up in advance. Also, this model cannot easily deal with aspect evolution, because the mapped concerns are somewhat linked to fixed constructions. Furthermore, the integration of specific aspect languages with other tools or frameworks is not always possible or requires important integration efforts.

5. Conclusions

If I have been advancing a highly complex domain model and its underlying geometric model based on separation of concerns and early aspects, that is interactive and allows for cooperative work whose implementation in Self gives a glimpse of the possibility of what it is Agile Aspect Oriented Software Development, the hope remains that the latter may become reality soon through the emergence of new software architectures and programming languages adapted to this expressive MDSOC and aspects paradigm.

I am sure Greimas's semiotic project may inspire us in this direction (Lourenci, A., 2002a,b). Likewise the unfolding of the geometric modeling based on the subgroup relationships of the crystallographic groups of the plane applied to the generation of architectural design will evince a dynamic morphogenetic level throwing light on how to transform positional identity into object identity. This is the decisive crucible especially for early aspects and their reflection into expressive Agile Aspect Oriented Programming Languages Figure 6.
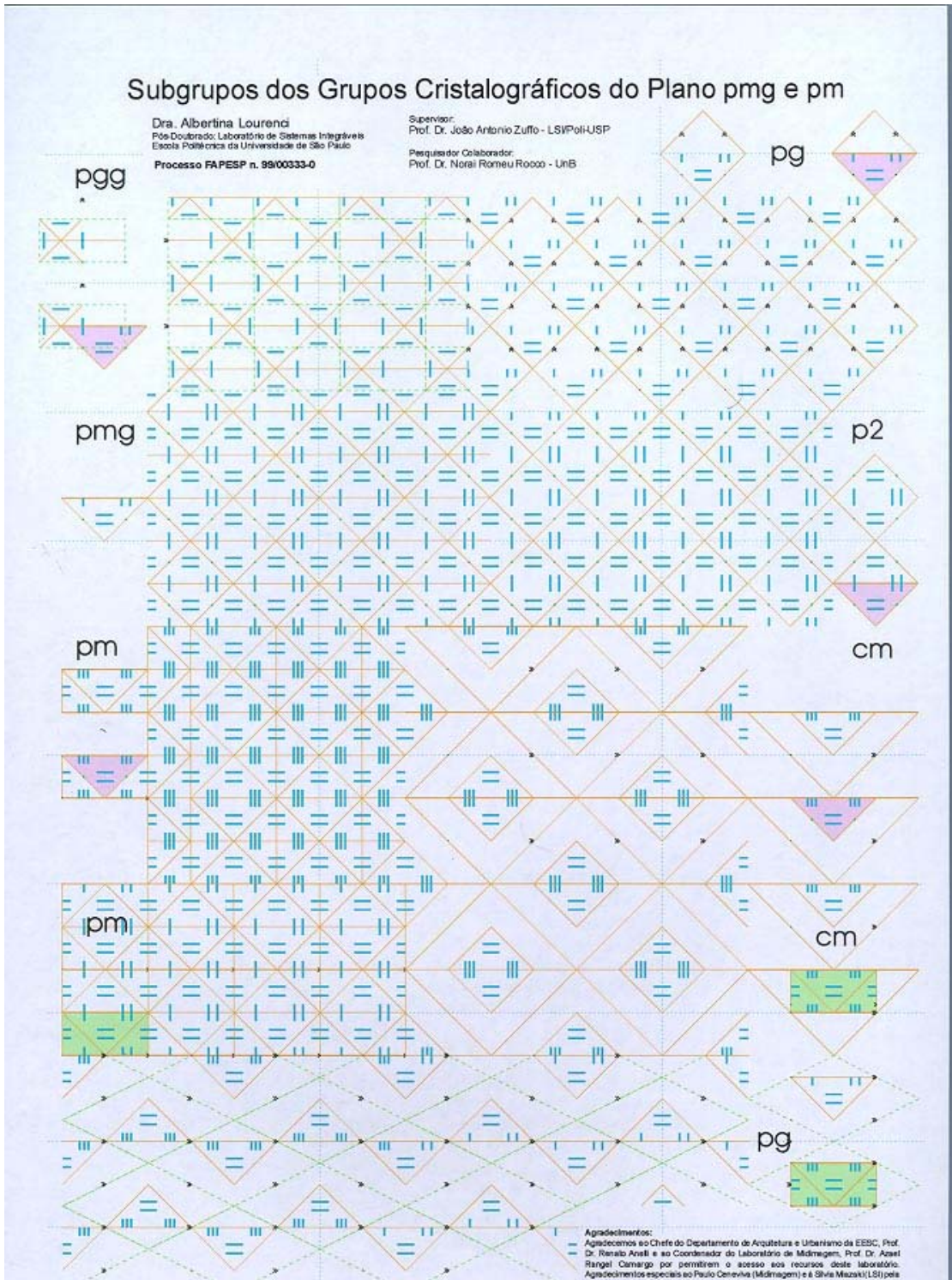
Figure 6. The subgroup relationships of the crystallographic groups. The smooth transition from one crystallographic group to another captured in this poster represents an expressive "advanced geometric aspect" to promote the crosscutting of many processes outlined in the MPSTW leading to the design of a truly free plan.

Acknowledgements

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