CHAPTER 3 TYPOLOGICAL INTERPRETATION OF RELEVANT ARTIFACTS

Sub problem 2 To gain typological understanding of an ordered data base of relevant artifacts.

Hypothesis 2 Interpretation of an ordered *corpus* of early Ionic capitals from a typological perspective can alter and increase current interpretation.

3.1 INTRODUCTION

This Chapter deals with the abstract nature of the Ionic capital, in terms of design, production and integration in architecture and votive columns. The achievement of a suitable ordering model for Ionic capitals and subsequent compilation of a data base and a reliable chronology of Archaic capitals makes possible the manupilation of the data to discern the typological content and design trends within the given period. In this section of the study the replication of all the manipulations of data included in the excellent works by Kirchhoff (EIV) and Theodorescu (LCIG) is avoided. There is rather a selective use of the achieved, integrated ordering method and comprehensive data base so that selected, important aspects pertaining to capital typology are discerned with the intention to heighten current insight.

The Chapter initially deals with an analysis of the chronologically ordered Archaic Ionic standard capitals, as well as chronologically and geographically ordered 'first generation' Ionic standard capitals up to 625 BC, in order to arrive at typological understanding. The Chapter concludes with an exploration of the *techne* involved in the capital's conception and design, its making and also its joining to other parts of the formal systems in which it occurs. Especially the first generation Ionic standard capitals up to 525 BC are subjected to analyses that brings forth new knowledge (for example the determination of capital plan ordering methods and volute construction methods, as well as deeper understanding of the integration of capitals within their built context), and the range, place and time of innovations in the design process are identified. For this there is reliance on the contents of the data base achieved in Chapter 2. The insights from this chapter are used in the preparatory work in Chapter 4 which is a primer towards the eventual construction of a founding history for the Ionic capital.

3.2 TYPOLOGICAL INTERPRETATION FROM CHRONOLOGICAL AND GEOGRAPHICAL ORDERING OF THE ARCHAIC IONIC CAPITAL

3.2.1 Morphological aspects emanating from the chronological ordering

3.2.1.1 Trends identified through chronological ordering - Quantitative criteria

All Archaic Ionic capitals from 625 to 489 BC are included in this ordering process. The quantitatively described capitals are placed in chronological order in Appendix 1, Table 1.1. Whilst all possible relationships are provided for further research, the author identified certain relationships between capital elements for the analysis that were deemed to provide the most insight into the properties of the capital form, as well as of its wider relationship with a votive column or Order.

Those capital proportions that are at the heart of the design are used in this study, whilst those that are derivative of them are excluded due to delimitation of the scope of the study (This delimitation then excludes reacting to Mace's (1978, p.123-36) proportional analysis). Only two co-incide with those looked at by Kirchhoff (EIV), namely the ratios D:E ($^{E}/_{D}$ [or *V:Va*]) and G:A ($^{A}/_{G}$ [or *Gesamt Höhe Volute: Gesamt Länge Kapitell*]). Whilst one realises that the column shaft necking diameter is the determinant to understanding the relationship capital design to column [ie building] design (in other words necking diameter : A [*Oberes Diameter : Gesamt Länge Kapitell*]), the non-existence of most buildings' and votive columns' shaft neckings, and the general dearth of column dimensions in the literature on capitals does not make it a very suitable option to discern <u>trends</u>. For this reason the chosen

Table 3.1 Trends identified through chronological ordering of all Archaic capitals - Quantitative criteria.

PROPORTION	**TREND**
B:A Capital width : capital length [$^{A}/_{B}$] or [*Tiefe Polster insg.: Gesamt Länge Kapitell*]	Relates to the plan shape: The capital plan proportions are scattered between ca 1:1,7 to 1:3,5 with a downward trend discernable until ca 520 BC [From Ion-36] when the ratio settles between 1:2,0-2,5. From this information one may say that there was a lot of experimentation regarding the proportion of the top and bottom elevation of the capital in both short and stretched variations of the capital until a canonic plan proportion was reached. Ideally one should bring any trends in proportioning the plan ordering device between the polster ends, ie E:B, into relation with the above trend.
H:A Echinus bottom ⌀ : capital length [$^{A}/_{H}$] or [*⌀d. unteren Auflagers: Gesamt Länge Kapitell*]	Relates to the capital and column shaft necking diameter*/[bottom bearing] relationship: The ratio starts at 1: 2,25 and ends at 1: 2,25, but apart from a few outsiders (a few below but mostly above, peaking at *ca* 1 : 3,4) it mostly hovers between the 1 : 2,0 to 1 : 2,5 range, decreasing over time. The ratios show a relative consensus of a capital length of between 2,0 to 2,5 times the capital bearing diameter (*capital soffit *mutatis mutandis* approximating a <u>similar</u> ratio for the column shaft necking diameter), with the decrease to 2,0 occuring after 550 BC. Of note is that the earliest capitals already fall within the favoured range.
H:C Echinus bottom ⌀ : capital top bearing length [$^{C}/_{H}$] or [*⌀d. unteren Auflagers: Gesamt Länge oberes Auflagers*]	Relates to the capital top and bottom bearing planes. The ratio starts at 1:2,25 followed by wide variations in the range between 1:1,2-3,0, but after 550 BC [Ion-15] the range fluctuates and then settles between 1:1,5-2,0 showing a fluctuation above 1 : 2,0 after ca 500 BC [Ion-50]. It seems that the favoured ratio for architectural works of the late Archaic era was *ca* 1:1,5. This, together with the favoured H:A ratio of 1:2-2,5 could possibly be part of a late Archaic canon. It is important to note that top bearing distance is not dependent on capital length (with all the devices known). Capitals' vertical bearing to bearing distances vary. In order to look at variations in the angle of transmission of load, this information must be read together with the angle of load transmission *alpha* (See 3.3.4.2.2 and App.1, Table 1.1), where the trend in variation of the angle of transmission is discussed), and also the bearing-to bearing height to width (L:B) ratio.
D:E Volute width : Distance between volutes [$^{E}/_{D}$] or [*V {Gesamt Länge Volute}: Va {Volutenabstand}*]	Relates to the horizontal façade proportion: There is an overall downward trend [The volutes come closer together] starting more erratic in the beginning, from ca 1:1-2, from ca 570 BC [Ion-10] to ca 550 BC [Ion-15] keeping around 1 : 1-1,5 , ossilating between 1 : 0,6-1,25 from ca 550 BC [Ion-64] to ca 500 BC [Ion-31] after which it remains between 1 : 0,5-1,0. Although there are variations, the overall trend is for volutes to come closer to each other over time.
G:A Volute height : total capital length [$^{A}/_{G}$] or [*Gesamt HöheVolute: Gesamt Länge Kapitell*]	Relates to the overall façade proportion: Although there are variations, the ratio decreases from between ca 1:2,5-3,5 to 1:2,0-2,75 over time, which indicates that, relative to capital length only, the volutes become relatively deeper over time.
L:B Canalis + echinus height : canalis/capital width [$^{B}/_{L}$] or [*Gesamt Höhe Kapitell - von oberes Kanalis zu unterem Auflager : Tiefe Polster insg.*]	Relates to the shape of the section of the main weight-bearing part of the capital: Over the whole period there is ossilation between 1 : 1,0 -1,75, but with most favoured seeming to be around 1 : 1,5.

Figure 3.1 Chronologically put Archaic standard Ionic capitals: Relationship between capital elements

ratio H : A [⌀d. *unteren Auflagers: Gesamt Länge Kapitell*) is chosen as a useful alternative in that it can possibly, even though in a diminished sense, give an indication of the capital length dimension in terms of the dimension of the capital's support structure (Also see * below). Trends are given in Table 3.1 and shown visually in Fig.3.1 above. The trends discerned below provide insight into the typological evolution of capital form during the Archaic period to the cut-off date of 489 BC, which may then also be seamlessly brought into relation with the conclusions for Classical and Hellenistic capitals by Theodorescu (LCIG). Apart from the fact that the occurrence of trends indicates the existence of a learning system, in other words where work builds on previous achievements and where communication between designers seems to have been a reality, these trends provide the necessary insight for the determining of the sophistication of the design system. Aspects of this analysis may in future also be used in quantitative interpretation of the Ionic Order, as well as in evaluation of the design relationship between the Archaic Ionic and Aeolic capital. The results of the analysis may be further used to assess the validity of such existing analyses that relied on a small selection of capitals.

The author's results were compared to those obtained by Kirchhoff (EIV, p.236-42) from his smaller sample. For the ratio D:E ($^E/_D$ [or *V:Va*]) the author found an overall decrease during the Archaic period, which means that the echinus element became relatively smaller and the volutes came relatively closer over time. This is opposed to Kirchhoff's finding that Island Ionic capitals showed an increasing trend, and the east Ionian showed a similar increase before decreasing. This difference is dealt with further in the geographical analysis. For the ratio C:A ($^A/_G$ or *Gesamt Länge Kapitell : Gesamt Länge oberen Auflagers*) the author's analysis and that of Kirchhoff co-incide, in that there is an overall decrease over time. Further analysis on the basis of Kirchhoff's other relationships may be done as a comparative study in order to pinpoint the major differences, but the author has already shown that his work cannot be relied upon fully due to some inconsistencies in the dating of capitals, as well as the incompleteness of the data base (See Chapter 2). An understanding of these trends on a more geographical basis, like that by Kirchhoff, is possible from the further ordering of capitals indicated below, but data from those capitals between 525 and 489 BC would have to be included from the interpretation inherent to the data included in the capital description. Also, as mentioned above, the analysis of other capital relationships are not made part of the argument here. Whilst, in the dating and classification process, knowledge of these relationships are less useful than those seen within a geographical perspective, they may be of value when the provenance of a capital is not known.

3.2.1.2 Trends identified through chronological ordering - Qualitative criteria

All Archaic Ionic capitals from 625 to 489 BC are included in this ordering process. The qualitatively described capitals are placed in chronological order in Appendix 1, Table 1.2. Whilst the Table provides the tools for a detailed analysis of chronological trends, external delineation of the study prevents the discussion of all 53 morphological aspects, apart from explaining how Table 1.2 is useful in various ways:

Apart from finding the first occurence of innovations in terms of morphological criteria (The list is provided below in Table 3.4), the user may see if a particular morphological element was widely used within the overall period or whether it was an isolated experiment, whether the use of a particular morphological element increased or decreased over time, whether any morphological aspects typical of the Classical period appear progressively more densely distributed amongst the later Archaic capitals or not, whether some later Archaic capitals may have Archaistic tendencies and, after the geographical ordering of capitals, when the initiators of regional morphological groups appear in relation to the other capitals.

3.2.2 Morphological aspects relevant to geographical ordering

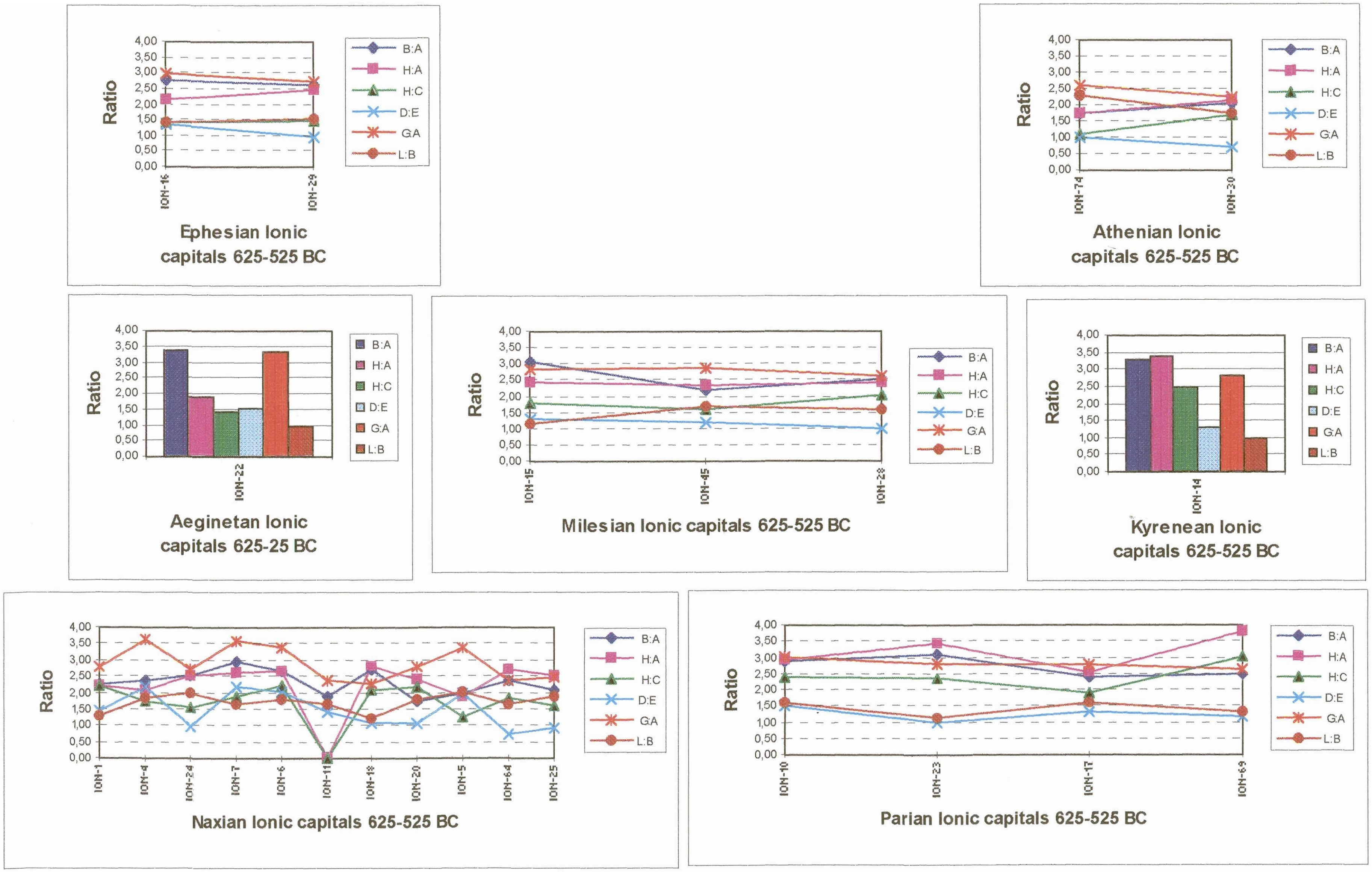
Only first generation capitals up to 525 BC are included in this analysis, which was completed as a model to show the applicational worth of the ordered data, but also to gain insight for use in the critical framework

3.2.2.1 Trends identified through geographical ordering - Quantitative criteria

Table 3.2 Trends identified through chronological and geographical ordering of all Archaic capitals - Quantitative criteria.

PROPORTION	TREND
B:A Capital width : capital length [$^A/_B$] Relates to the plan shape	In the first generation capitals up to 525 BC the Milesian [except Ion-15] capitals conform more to the post-520 BC ideal of between 1:2-2,5, whereas the Ephesian, Kyrenean and Aeginetan capitals are above [longer], the Athenian are below [shorter] and the Naxian capitals start in, then scatter below and above and then end in the range again]
H:A Echinus bottom ⌀ : capital length [$^A/_H$] Relates to the capital and column diameter* relation-ship (*bottom bearing)	Before 525 BC the length of capitals relative to column diameter*/bottom bearing for Milesian capitals are constant around 1:2,4, for Ephesian capitals increase from 1:2,15-46 against the higer value against the decreasing overall trend, the Kyrenean capital is 1:1,38, the Aeginetan one is 1:91, it increases from 1,74 to 1:2,13 in Athenian capitals close to the later ideal, Parian capitals increase from 1:2,94-3,79 [except for Ion-17] and in Naxian capitals there is no visible trend but fluctuation between 1: 1,86-2,79 [Later the Samian capitals are around 1:1,9-1,99]. Seen overall the capital length relative to bottom diameter is longer than after 525 BC.
H:C Echinus bottom ⌀ : capital top bearing length [$^C/_H$] Relates the top and bottom bearing planes	Before 525 BC Milesian capitals start at 1:1.8 then drop to 1:6 and rise to 1:2,0, the Ephesians are steady at 1:4-4,5, a Kyrenean is 1:2,5, an Aeginetan is1:1,5, the Athenian capitals rise from 1:1,1-7, Parian capitals steady between 1:2,4-3 then fluctuate to 1:1,9-3,0. The Naxian capitals fluctuate between 1:2,2-1,6[Later the Samian capitals are 1:1,6]. The Ephesian capitals come closest to the late Archaic favoured ratio of 1:1,5.
D:E Volute width : Distance between volutes [$^E/_D$] Relates to the horisontal façade proportion	Before 525 BC the Naxian capitals ossilate between 1:1 [Ion-24 being a noteable early example of the later canon] to 1: 2,0, the Parian downwards between 1: 1-1,5 Milesian capitals start with further spaced volutes of 1:1,3 and then move closer toward the later ideal [Also later the Samian is constant around 1: 1, 25], the Ephesian downwards between 1:1,4-0,9, and the Athenaian capitals downwards from 1:1,0-0,7]. The Milesian capitals, and more so the Athenian capitals come closest to the later favoured ratio). [NB See Kirchhoff's (EIV) finding that Island Ionic capitals showed an increasing trend, and that east Ionian showed an increase before decreasing]
G:A Volute height : total capital length [$^A/_G$] Relates to the overall façade proportion -	Before 525 BC the Milesian trend is slightly downward from 1,8-1,6, the Ephesian down from ca 2,9-7, the Kyrenean at 2,8 and the Aeginetan at 3,3, the Athenian drops from 2,6-2,25, the Parian drop from 3,0-2,6, and the Naxian oscilates between 3,6-2,4.
L:B Canalis + echinus height : canalis/capital width [$^B/_L$] Relates to the section of the main weight bearing element	Before 525 BC the Milesian trend is upward from 1:1,1-1,7-6, the Ephesian slightly up from 1:1,4-5, a Kyrenean capital of 1:1,0, an Aeginetan capital of 1:1,0, the Athenian trend is downward from 1: 2,3-1,7, the Parian around hovers around 1:1,6 with two capitals being lower at 1:1,1-3,and the Naxian capitals range between 1:1,65-2,0 [except Ion-18 at 1,2 and Ion-1 at 1,3]. The later Samian capitals are betwee 1: 1,7-9. The Ephesian capitals come closest to the later favoured ratio of 1:1,5, followed by the Parian.

Figure 3.2 Geographically and chronologically put Archaic standard Ionic capitals: Relationship between capital elements



for future construction of a founding theory of the Ionic capital which focuses on the earlier capitals, even though questions pertaining to the relationships between Archaic and Classical capitals are addressed here. The chronology of geographically and chronologically ordered, quantitatively described capitals used for this analysis is provided in Appendix 1, Table 1.3. Table 3.2 above captures the trends for the main capital relationships for each identified geographical region below and Fig.3.2 show the trends (or lack) in a visual way.

The figures speak for themselves, and they are provided in a format suitable for use for purposes of style identification when read together with the chronology of geographically ordered, qualitatively described capitals in Appendix 1, Table 1.4. Read with Table 3.1 and Fig.3.1, the trends may be seen relative to the total Archaic period. Apart from the identification of the trends, the results from Table 1.3 are intended to be used within the process of ascertaining the datums of various regarding morphological typological trends mentioned in 3.2.4 below, and as guide in dating of hitherto undated capitals where no other external evidence is available, or act as corroboratory evidence where available. In terms of Kirchhoff's (EIV, p.236-42) findings, the above trends for the ratio D:E for 'Island Ionic' [Naxian and Parian] capitals do not co-incide with his.

3.2.2.2 Geographical ordering - Qualitative criteria

From the qualitative description of capitals in Table 2.2, there is a geographically and chronologically ordered, qualitatively described description of capitals in Appendix 1, Table 1.4. From Table 1.4 it is possible to see which morphological qualities are inherent to geographically ordered groups of capitals. In Table 3.3 below the information is ordered in such a way that the occurence of morphological qualities can be more readily discerned in a chronological and geographical manner. The main qualitative typological characteristics in Table 1.4 must be read with the main qualitative characteristics in Table 1.2 to define the overall typological characteristics of the capitals and the trends involved, for the various regions and in the time period concerned. In section 3.2.4 below this information is used in further analyses.

3.2.3 A chronology of innovations in Aeolicising and first generation Ionic capitals

Identification of innovations in the evolution of the morphology of the Ionic capital was made possible from interpretation pertaining to qualitative criteria, ordered chronologically in Appendix 1, Table 1.2, from the chronology attained in Chapter 2. Knowledge of such innovations is necessary for classification of capitals, and also for insight into a the nature of design evolution. In Table 3.4 below the capital in which the innovation occurred is indicated, together with the next - chronologically following - occurence of the element, its capital indicated in [ ] brackets. It is clear that all the innovations did not occur in the earliest capitals but continued to happen right through the total Archaic period, and also that certain capitals contained many innovations. The important non-standard Ionic capitals for which there is an indication of

TABLE 3.3

Ionic capitals 625-525 BC

ORGANISATION (Front elevation: 2–4; Bottom plan: 6; Side elevat: 7) — PLAN ELEMENTS (Top plane: 11–13) — FRONT ELEVATION ELEMENTS (Canalis: 16–23; Astragal: 25–28)

Qualitative criteria: Place of origin and quantity capitals	Time of origin	2: 3-Dimensional modular co-ordination	3: Formal relation between eye & side + top column	4: Volute: Involute	4: Volute: Circle arcs 90°	4: Volute: Random arcs	4: Volute: Square	4: Volute: Circle arcs 90 + square	6: Square	6: Hexagon	6: Octagon	6: Rectangle	6: Rectangle across	7: Opposing faces: Inclined	7: Opposing faces: Vertical	11: Edge corresponds with junction of volute	12: Enlarged by addition: Spandrel palmette	12: Enlarged by addition: Angle	12: Enlarged by addition: Curved abacus	13: Enlarged by change in volute outline outward	16: Flat	17: Convex	18: Concave	19: Decorated	20: Horizontal channel bottom: Angular	20: Horizontal channel bottom: Upturned cord	20: Horizontal channel bottom: Bow	20: Horizontal channel bottom: Cord	21: Horizontal channel bottom: Total line straight	22: Separation between volutes	23: Vertical (Aeolicising) Included for comparison	25: Volute exterior: Round - single	25: Volute exterior: Round - double	26: Round with border	27: Flat line - painted	27: Rectangular raised	29: Absent above echinus / into echinus	28: Incised		
ATHENS [0]	625-550 BC																													[1]									
[4]	550-525 BC	2			3					2					3			1	1	1	2		2					4			[4]	1		1	1	1	1	1		
AEGINA [1]	625-550 BC	1	1	1								1		1				1			1							1										1		
[0]	550-525 BC																																							
KYRENE [0]	625-550 BC																																							
[1]	550-525 BC	1			1							1		1				1			1*	1										1					1			
PAROS [1]	625-550 BC	1	1	2		1						1			1	1							1						1	1	[3]	1								
[3]	550-525 BC	2	1		1			1					2		1			2				3							1	1		3					2			
NAXOS [11]	625-550 BC	7	2		8				3	1		4	1		10	1	1	8		3	4		6		2		1	5		2	[1]	1	1		1		4	3		
[2]	550-525 BC	1			2								2	outw	1	1		1			1	1			1			1				2								
MILETOS [0]	625-550 BC																																							
[4]	550-525 BC	2			3				2				1	2	1	1	2					4			3			1				3	1							
EPHESOS [1]	625-550 BC	1	1		1							1		1					1			1			1							1								
[?	550-525 BC	1	1		1								1		1							1						1				1								
SAMOS [0]	625-550 BC																													[1]									
[0]	550-525 BC																																							

FRONT ELEVATION ELEMENTS (Eye: 30–34; Echinus: 35–38; 41–44) — SIDE ELEVATION ELEMENTS (Form: 45–47; Ornament: 48–53)

Qualitative criteria: Place of origin and quantity capitals	Time of origin	30: Theoretical centre point only	31: Flat: Painted	31: Flat: Defined by groove or bead	31: Flat: Hollow	32: Convex	33: Rosette: small (eye)/big (occupying whole volute)	34: Other profiled: Circle/s with centre point	34: Other profiled: Spiral wheel	35: Ionian cyma: Flat-/Round ended leaf / border	35: Ionian cyma: Flat-/Round ended leaf /no border	35: Ionian cyma - Smooth [hanging]	36: Ionian cyma - Egg-and-tongue: Rounded	36: Ionian cyma - Egg-and-tongue: Pointed	37: Lesbian cyma	37: Superimposed cyma	38: Dome	38: Torus-smooth	38: Torus-ribbed	41: Intermediate space between echinus and canalis	42: Spandrel palmette on capital bearing offset	43: Spandrel palmette in volute/canalis angle	44: Abacus	45: Doubble-trumpet cylinder shape	46: Straight cylinder shape	47: Block: With/No ornament	48: Strap	49: Scales on Abacus side / Polster	50: Plaits	51: smooth	51: 2 flutes	51: 3 flutes (* = Flutes on strap)	51: 4 flutes	51: 5 flutes	51: 6 flutes	52: Round beads between flutes: 1	52: Round beads between flutes: 2	52: Round beads between flutes: 3	52: Round beads between flutes: 4	53: Triangular beading
ATHENS [0]	625-550 BC																																							
[4]	550-525 BC		2	2			1s						1				2			1	1	3	3	5			2	1A		3	1	1*					1			
AEGINA [1]	625-550 BC	1															1							1						1										
[0]	550-525 BC																																							
KYRENE [0]	625-550 BC																																							
[1]	550-525 BC	1								1						1						1		1			1													1
PAROS [1]	625-550 BC	1								1							1					1		3						2			1					1	1	
[3]	550-525 BC	2				1				2	1											2		2								1	2					1	1	
NAXOS [11]	625-550 BC	8		1				1		5	1	1*						2			1	9	1	9	2		1			4			3	2	1	1	4	1		
[2]	550-525 BC	2											1									1		2						1			1				1			
MILETOS [0]	625-550 BC																																							
[4]	550-525 BC	4								1			2								1	4		3								1	1				1			
EPHESOS [1]	625-550 BC	1								1												1	1	1									1				1			
[1	550-525 BC	1											1									1	1	1								1					1			
SAMOS [0]	625-550 BC																																							
[2]	550-525 BC												2											2					1											

Table 3.4 A chronology of innovations in capital morphology

INNOVATION	No	ORIGIN	NAME	DATE
Plan organisation - long rectangle	Ion-22*	Aegina	Sphinx column, Aphaia Sanctuary	Early 6th Cent BC
	[Ion-4]	Naxos	Votive column, Delos	Early 6th C BC
Plan organisation - square	Ion-1	Naxos	Votive column, Sangri	End 7th C BC
	[Ion-11]			
Plan organisation - hexagon	Ion-20	Naxos?	Votive column, Delos (theatre)	ca 560 BC
Plan organisation - rectangle across	Ion-24	Delos	Interior Naxian *Oikos*	575 BC
	[Ion-64]	Naxos	Votive column, Sangri	ca 550 BC
	[Ion-45]	Miletos	Temple (?)	ca 550-500 BC
Capital faces - vertical	Ion-1	Naxos	Votive column, Sangri	End 7th C BC
Capital faces - inclined	Ion-22*	Aegina	Sphinx column, Aphaia Sanctuary	Early 6th C BC
Capital faces - back side left unfinished	Ion-64	Naxos	Votive column	ca 550 BC
Capital faces - back side less detail	Ion-7	Naxos	Temple of Dionysos, Iria,	570 BC
Capital faces - different canalis types	Ion-14	Kyrene	Sphinx column	550> BC
Capital bearing plane flows into volute curve	Ion-7	Naxos	Temple of Dionysos, Iria	570 BC
Capital bearing plane extended - obtuse volute angle	Ion-1	Naxos	Sphinx colonette, Sangri	End 7th C BC
	[Ion-48,	Delos	Propylon II, Delos	520/500> BC
Capital bearing plane extended - angular additions	Ion-1	Naxos	Sphinx colonnette, Sangri	End 7th C BC
	[Ion-22*]	Aegina	Sphinx column, Aphaia Sanctuary	Early 6th C BC
Capital bearing plane extended - spandrel palmette	Ion-9	Naxos	Votive column, Sangri	580-70 BC
Capital bearing plane extended - curving abacus	Ion-16	Ephesos	Artemision 'D'	<550 BC
Canalis profiles differ on opposing faces	Ion-14	Kyrene	Sphinx column	550> BC
Canalis flat	Ion-1	Naxos	Sphinx colonette, Sangri	End Seventh C BC
Canalis convex	Ion-16	Ephesos	Artemision 'D'	<550 BC
Canalis concave	Ion-9	Naxos	Votive column, Sangri	580-70 BC
Canalis decorated	Ion-35	Athens	Votive column, Athens Acropolis	ca 520 BC
Canalis horisontal - bottom angular	Ion-1	Naxos	Sphinx colonnette, Sangri	End Seventh C BC
	[Ion-16]	Ephesos	Artemision 'D'	< 550 BC
	[Ion-23]	Thasos	Votive column	Mid 6th C BC
Canalis horisontal - bottom cord shaped	Ion-4	Naxos	Votive column, Delos	Early 6th C BC
	Ion-22*	Aegina	Sphinx column, Aphaia sanctuary	Early 6th C BC
Canalis horisontal - bottom bow shaped	Ion-20	Naxos?	Votive column, Delos (theatre)	ca 560 BC
Canalis horisontal - bottom in upturned cord shape	Ion-68	Paros	Unknown	Archaic[?]
Canalis horisontal - bottom total straight line	Ion-10	Paros	Votive column (Ag Katapoliani)	575-50 BC
Canalis horisontal - separated	Ion-10	Paros	Votive column (Ag Katapoliani)	575-50 BC
Canalis vertical	Iver-1	Delos	Stander, Delos	Early 6th C BC
Volute spiral - involute	Ion-22*	Aegina	Sphinx column	Early 6th C BC
Volute spiral - helix from 90° arcs	Ion-1	Naxos	Sphinx colonnette, Sangri	End 7th C BC
	[Ion-4]	Naxos	Votive column, Delos	Early 6th C BC
Volute spiral - helix from random arcs	Ion-10	Paros	Votive column (Ag Katapoliani)	575-50 BC
Volute spiral - helix from diagonals at volute origin	Ion-50	Neapolis	Artemis temple [Research needed]	500-480 BC
Volute exterior profiled moulding - round single	Iver-2	Paros	Votive column (Early Chr Basilica)	600 BC
	[Ion-9]	Naxos	Votive column, Sangri	580-70 BC
Volute exterior profiled moulding - round double	Ion-18	Naxos	Sphinx column, Delos	560-50 BC
Volute interior profiled moulding - round double	Ion-9	Naxos	Votive column, Sangri	580-70 BC
Volute exterior/interior profiled moulding - bordered	Ion-74	Athens	Enneakrounos, Agora [One face]	550-25 BC
Volute ext/int profiled moulding - rectangular only	Ion-74	Athens	Enneakrounos, Agora [Opposing face]	550-25 BC
	[Ion-75]	Athens	Kekrops column, Akropolis	ca 530 BC [ch L Arch]
	Ion-67]	Athens	Votive column, Akropolis	520 BC
Volute exterior/interior painted line	Ion-24	Delos	*Oikos* interior (See Gruben 1989 p.172)	575 BC
	Ion-30	Athens	Votive column	530 > BC
Volute exterior/interior incised line	Ion-1	Naxos	Sphinx colonnette, Sangri	End 7th C BC
	[Ion-22*]	Aegina	Sphinx column, Aphaia sanctuary	Early 6th C BC
Volute origin not defined	Iver-4	Delos	Votive column	Early 6th C BC
	Ion-4	Naxos	Votive column, Delos	Early 6th C BC
Eye at volute origin - flat painted	Iver-9	Athens	Small building, Akropolis	550 BC
	[Ion-30]	Athens	Votive column	530> BC
Eye at volute origin - groove/defined	Ion-1	Naxos	Sphinx colonnette, Sangri	End 7th C BC
	[Iver-2]	Paros	Votive column (Early Christ. Basilica)	Early 6th C BC
	[Iver-3]	Delos	Votive column	Early 6th C BC
	[Ion-74]	Athens	Enneakrounos	550-25 BC
Eye at volute origin - hollow [with insert?]	Ion-42	Massilia	Architectural	520-10 BC
	[Ion-54]			
Eye at volute origin - convex	Ion-23	Thasos	Votive column	550 BC
	[Ion-26]	Chios	Apollo Phanaios	525-500 BC
Eye at volute origin - profiled with centre point	Ion-20	Naxos?	Votive column, Delos (theatre)	ca 560 BC
Eye at volute origin - pattern (rosette/flower)	Aeol-1	Smyrna	Athenaion II [reconstruction of]	ca 580 BC
	[Ion-74]	Athens	Enneakrounos, Agora	550-25 BC
	[Ion-51]	Thessaloniki, Dionysos Temple		Late 6th C BC
Eye at volute origin - pattern (spiral wheel)	Ion-48	Delos	Propylon II	520/500> BC
Volute centre - not physically shown	Ion-22*	Aegina	Sphinx column, Apahaia Sanctuary	Early 6th C BC
Eye centre + top column relationship	Ion-22*	ditto		
	[Ion-10]	Paros	Votive column (Ag Katapoliani)	575-50 BC
Eye centre + side column relationship	Ion-22*	Aegina	Sphinx column, Aphaia Sanctuary	Early 6th C BC
	[Ion-5]	Naxos	East portico, *Oikos*, Delos	<550 BC
	[Ion-23]	Thasos	Votive column	Mid 6th C BC
Echinus completed behind bolster	Ion-4	Naxos	Votive column, Delos	Early 6th C BC
Echinus - torus smooth	Ion-1	Naxos	Sphinx colonnette, Sangri	End 7th C BC
	[Iver-2]	Paros	Votive column (Early Christ. Basilica)	Early 6th C BC
	[Ion-4]	Naxos	Votive column, Delos	Early 6th C BC
Echinus - torus ribbed	[Ion-66?]	Delphi	Votive column [Reconstructed torus]	525-500 BC
	[Ion-65?]	Didyma	Votive columns	[6th C BC]
Echinus - Ionian cyma with broad leaves unbordered	Ion-22*	Aegina	Sphinx column, Aphaia sanctuary	Early 6th C BC
Echinus - Ionian cyma with broad leaves bordered	Ion-7	Naxos	Dionysos temple, Iria	ca 575 BC
	Ion-6	Delphi	Naxian Sphinx column	575-60 BC
	Cym-2/3	Didyma	Votive column	575-50 BC
Echinus - Ionian egg-and-dart cyma: oval point	Ion-45	Miletos	Temple[?], near Miletos	ca 550-500 BC
	[Ion-29]	Ephesos	Temple [Aquaduct]	550-25 BC
	[Ion-26]	Chios	Apollo, Phanai	525-500 BC
	[Ion-32]	Delos [Naxos] Propylon IIc corner capital		520-500 BC
Echinus - Ionian egg-and-dart cyma: sharp pointed				
Sharp pointed -Painted	Ion-35	Athens	Votive column	520 BC
Sharp pointed - Sculptural	Ion-27/48	Delos	Propylon II inner/outer capital	520-500 BC
Echinus - Lesbian cyma	Ion-21	Athens	Votive column, acropolis	<489 BC
	[Ion-62]	Athens	Votive column of Kallimachos	490-89 BC
Echinus - dome patterned	Ion-22	Aegina	Sphinx column, Aphaia sanctuary	Early 6th C BC
	Ion-69	Paros	Votive column	ca 550 BC
Echinus - dome smooth	Ion-30	Athens	Votive column	ca 530 BC
Echinus inverted dome	Possibility of a lost Parian Archaic example if Parian Byzantine copies cont-8-9 are reliable copies of votive colonettes from Ag. Ant. Kephalos, Paros			
Echinus - superimposed	Ion-14	Kyrene	Sphinx column	ca 550 BC
Echinus decorations ordered around column axis	Ion-22*	Aegina	Sphinx column, Aphaia sanctuary	Early 6th C BC
Intermediate space between canalis and echinus	Ion-74	Athens	Enneakrounos, Agora	550-25 BC
Volute spandrel palmette - droplet	Ion-1	Naxos	Sphinx colonnette, Sangri	End 7th C BC
Volute spandrel palmette - abstracted/angular	Ion-4	Naxos	Votive column, Delos	Early 6th C BC
Volute spandrel palmette - petalled	Ion-9	Naxos	Votive column, Sangri	580-70 BC
	Ion-6	Delphi	Naxian Sphinx column	575-60 BC
Volute spandrel palmette - painted on	Ion-22	Aegina	Sphinx column, Aphaia sanctuary	Early 6th C BC
	[Ion-24]	Delos	Naxian *Oikos*	<580 BC
	[Ion-30]	Athens	Votive column, Akropolis	ca 530 BC
Spandrel palmette on capital top bearing offset	Proto-aeolic typology [Shiloh, 1969]			
	Iver-2	Paros	Votive column (Early Christ. Basilica)	Early 6th C BC
	[Ion-9]	Naxos	Votive column, Sangri	580-70 BC
Abacus present - outward curving sides	Ion-16	Ephesos	Artemision 'D'	<550 BC
Abacus present - rectangular sides	Ion-24	Naxos	Interior Naxian *Oikos*, Delos	575 BC
	[Ion-26]	Chios	Apollo Phanaios, Phanai	525-500 BC
Bolster shape - double trumpet smooth	Ion-22*		[very little]	
	[Ion-4]		[very little]	
	[Ion-24]		[First deep trumpet shape]	
Bolster shape - double trumpet fluted shallow	Ion-9	Naxos	Votive column, Sangri	580-70 BC
Bolster shape - double trumpet fluted deep	Ion-16	Ephesos	Artemision 'D'	<550 BC
Bolster shape - straight cylinder	Ion-1	Naxos	Sphinx colonnette, Sangri	End 7th C BC
Bolster shape - block	Iver 3	Delos	Votive column	Early 6th C BC
Bolster decoration - strap/alteus	Iver-2	Paros	Votive column (Early Christ. Basilica)	Early 6th C BC
	Ion-20	Naxos?	Votive column, Delos (Theatre)	ca 560 BC
Bolster decoration - scales	Aeol-1	Smyrna	Athenaion II[reconstruction of]	ca 580 BC
	[Altar]	Samos	Before Heraion III (Kienast, 1989, p.262)	<575 BC
	Ion-31	Selinus	Votive column	ca 500 BC
Bolster decoration - plants	Ion-42	Massalia	Architectural	520-10 BC

* Note: If the Aeginetan sphinx column [Ion-22] had a 7th C BC predecessor which was similar to it [Namely capital Cont-17], such a capital would have exhibited the first square plan ordering device, inclined capital faces, angular additions top bearing plane, flat canalis, cord shaped canalis, involute methods for volute spiral construction, volutes with incised lines, volute centres not defined, domed echinus, echinus decorations ordered around column axis, echinus continuing behind polster, unbordered broad leaf echinus decoration, lightly concave smooth trumpet polsters and painted-on volute spandrel palmettes.

transfer of form aspects - ie the Aeolicising capitals [Ie Iver-1, -2 and 4] or those from other design enclaves like the Levantine-Aeolic and Hellenic-Aeolic [Ie Aeol-1] capitals) - clearly come to the fore. By listing the geographical place where innovations occurred, there is direction for research regarding the design context in which they occurred, and to move toward locating precedents which may have been available. An example would be the volute angle spandrel palmette detail which first occurred in Naxian capitals, leading one to the possible link between this and earlier volute decorations on Naxian pottery showing a spandrel palmette in that position, and so pointing toward a specific item requiring focused research.

3.2.4 Typological developments and experimental forms from the datum

The Archaic Ionic capitals up to 525 BC were subjected to morphologic-typological ordering in terms of qualitative (App.1, Table 1.4) and quantitative (App.1, Table 1.3) criteria above. Table 3.3 above groups the morphological qualities together in geographical and chronological time-periods, and clearly shows the occurrence of morphological typological qualities of the capitals groups in the various regions. Both Table 3.2 and Table 3.3 may further be brought in relation with each other to increase information regarding typological developments in the capitals up to 525 BC, and to show those forms which were experimental, and which became geographically bound interim canonic types. The occurrence of the specific, identified elements in the regional groups and in the time slots 625-550 and 550-525 BC can be clearly read, and the various morphologically defined typological capital groupings are thus compiled. Although these typologies are included in the formulation of App.1, Table 1.2, 1.4 and Table 3.3, there can be no discussion of the geographically bound typologies between 625-525 BC in this section due to the delineation of the study, but the firstmentioned typologies are used in further analysis of the capital in Chapter 4.

The initiating experiments for new form types are identified in the chronological Table 3.4 above. Knowledge included in the above interpretations may already be applied in inquiries into typological aspects of other types of artifacts, after which feedback may further enhance the study of chronologically an geographically bound evolutionary patterns in the morphological typology of the Ionic capitals. The completion of similar interpretation for the Late Archaic capitals may easily be accomplished by applying the accomplished ordering of these capitals to the format of Table 3.3 and 3.4

3.2.4.1 Early regional canons and interim canonic phases in the Archaic period

In the knowledge of a later canonised capital type in the Hellenistic period, the standard capital with system volute identified by Büsing (1987), it must be ascertained whether regional canons did come about in the Archaic period, and as what they should be defined. The detail gained from the analysis of the geographical and chronological ordering should be further enhanced from analysis of the metrological and geometrical content of the capitals, together with detail scrutiny of sculpture style and method, to be correlated with external contextual evidence. The demarcation of capitals into regional, interim canons is identified as a separate study after completion of the current one, which is restricted in its scope.

3.2.4.2 Identification of the achievement of a Classical interim canonic form of the Ionic capital during the period 620-490 BC

Whilst Büsing (1987) states that Classical capitals do not reach the Hellenistic canonic standard type with system volutes, one may ascertain whether any Archaic capital attained what is deemed to be Classical canonic form. To do this all Archaic capitals have to be brought in relation with all examples of the Classical period within a morphologic-typological framework, similar to the inquiry in the above situation. This is a major undertaking, but may be be done alternatively by first identifying a Classical example that is deemed to be representative of the canon, after which a visual search for Archaic capitals which qualitatively match that description may be done from the visual description achieved in Appendix 2 and then correlating it with the information contained in the qualitative description in Appendix 1, Table 1.2. The quantitative criteria of all Archaic capitals may thereafter be matched to the identified example. To be able to come to such a more general preliminary conclusion, the existing interpretation of Classical capitals as done by Theodorescu (LCIG, Table 1; Plate 3) is used, because it is so complete in terms of the Classical capital examples. Because Theodorescu's (LCIG, Plate 3) evolutionary chart indicates the capital of the propylaia at the Athenian Akropolis as a Classical canonic type (as did Mace (1978, p.136)), which type also foreshadows the evolution towards peristyle capitals of the Fourth Century BC Athenaion at Priene and the Artemision 'E', which he sees as Classical progenitors of the Hellenistic/Roman canon - Büsing (1987) identifies the Erechteion capital as an intermediary form, obviously towards a canon slightly different from Theodorescu's. Nevertheless, due to the implied importance of the Athenian propylaia capital, the author proceeded to compare the quantitative and qualitative form criteria of all Archaic capitals to it, but also to the capital of the temple of Athena Nike, which is also widely held as a Classical canonical example.

3.2.4.2.1 Identification of the achievement of the canonic Classical form of the Ionic capital in terms of quantitative criteria

i The capital of the propylaia at the Athenian acropolis - Syntax (Quantitative criteria)
The proportions used for the propylaia capital are those reported by Theodorescu (LCIG, Table 1, No.57), and are shown at the end of Appendix1, Table 1.1 in Light Green. In Table 1.1 the proportions of those Archaic capitals which show affinity with the Nike capital are likewise marked in Light green. Varied groupings of the main quantitative characteristics of the canonic form which may be expressed as proportional relationships are only found in a few Archaic capitals, but never completely in a single example. From a large group where quite a few of the proportions coincide, there are actually only two capitals that come rather close. The coincidence in Ion-74 (ie the *Enneakrounos* at Athens of 550-25 BC) is remarkable, and in Ion-58 (Heraion IV, Samos, started at 540 BC and top structure begun 500 BC>) is very

good. These capitals are identified as significant in the evolution towards the Classical Attic shape, in terms of their proportional constituency.

ii The capital of the temple of Athena Nike - Syntax (Quantitative criteria)

The proportions used for the Nike capital are those reported by Theodorescu (LCIG, Table 1, No.59), and are shown at the end of Appendix 1, Table 1.1 in Purple. In Table 1.1 the proportions of those Archaic capitals which show affinity with the Nike capital are likewise marked in Purple. Varied groupings of the main quantitative characteristics of the canonic form which may be expressed as proportional relationships are only found in a few Archaic capitals, but never completely in a single example. The comparison shows that there are a few that show a reasonable affinity, but those capitals that show the most affinity are Ion-17 (ie votive column [Tr Eklesies], Paros of *ca* 550> BC), Ion-42 (the Apollonion, Massilia of 520-10 BC), Ion-31 (votive column, Selinus of *ca* 500 BC) and again Ion-74 (the *Enneakrounos* at Athens of 550-25 BC) and Ion-12 (votive column from Halkipinar, Smyrna, of [?<] 520 BC - The dimensions used for Ion-12 are not reliable, but as the Smyrna capital has previously also been indicated as an important artifact in terms of the module used in the metrication, remeasurement is proposed). More interpretation is needed to inquire into the transfer of specific proportional traits, and this interpretation only looks at an overall pattern of affinity. The emergence of capital Ion-74 in the study as a significant example in its region seems to be indicated. In terms of an affinity with east Ionian capitals stated in the catalogue, the specific antecedents for this capital may also be pinpointed.

3.2.4.2.2 Identification of the achievement of the canonic Classical form of the Ionic capital in terms of qualitative criteria

i A Classical canonic Ionic capital - Morphology

There is a lot of variety of morphological content in Classical capitals, and a lot of experimentation occurs right through the period. To come to exact conclusions regarding the antecedents of the canonical Classical capital, the Archaic capitals ordered in this study have to be brought into relation with all Classical capitals included in Theodorescu (LCIG, Table 1). However, to be able to formulate a general opinion in this study a Classical canonic capital, the capital of the temple of Athena Nike is used to see which Archaic capitals show the greatest affinity with a prominent example of Classical capital vocabulary. Various capitals obviously have details that are found in the Nike capital, but not one has all of them. Capitals that do show great affinity with the deep sweeping double-trumpet bolster is Ion-18 (of the Naxian sphinx column at Delos) and Ion-23 (Thasos), but also Aeolicising capitals like the early Iver-2 (Paros), Iver 6 (Paros) and Iver-12 (Delos). Closer to home however this bolster shape seems to be the hallmark of most Athenian capitals, like Ion-30,34,36, 67 and 76. In terms of other elements those that stand out are the corner capital Ion-32 from the Propylon II at Delos (The separation between echinus and canalis), Ion-37a from Poseidonia-Paestum (total façade shape) and Ion-50 (the flattish but concave canalis). Even though the capital of the Heraion IV, namely Ion-58, doesn't have an abacus, the canalis and echinus shapes are very close to that of the Nike capital. The capital of the *Enneakrounos* in Athens, namely Ion-74, shows the three flutes on the bolster, but its bolster is rather of the cylinder double-trumpet type as against the deep double-trumpet type. The canalis, echinus and abacus are also very similar to that of the Nike capital. Capitals Iver-2, Iver-12, Ion-14 and Ion-20 show the bolster strap/s on the bolster midline. The capital from Halkipinar, Smyrna, uses the eye very early, and the large poros (ie Kekrops column) capital from the Athenian Akropolis, capital Ion-75, shows the proportionally big volute eye. One must come to the conclusion that the half century from the beginning of the Classical period saw many more experiments with capital morphology before the canonic examples like the Erechteion and Nike capitals were designed. Just the morphological difference between these two capitals shows the amount of continuous experimentation. Nevertheless, there is a gradual evolution towards the Classical form, rather than an abrupt one.

The reader is referred to the list of innovations above in order to pinpoint the innovations present which are also in the Propylaia capital, as well as the chronologically and geographically put typological interpretation of Archaic Ionic capitals in Table 3.3 above, in order to observe geographically bound design tendencies. The capitals from the *Enneakrounos* are identified as significant as pertaining to the evolution towards the Classical Attic capital form. The conclusions by Mace (1978, p.137) regarding the exclusive use of the concave volute channel in Classical capitals, is refuted by the above analysis.

3.2.5 Statistical evaluation of the effects of introducing data arrived at from damaged capitals and reconstructions of capitals

Within the stated premise that a more representative data base will increase the insight gained from further manipulation of data, the hypothesis was entertained in Chapter 2 that inclusion of dimensions from reconstructed capitals would, in all probability, be a positive step towards supporting the aim of the premise. It is obvious that accurate deductions may only flow from using accurate data. The problem this premise has to deal with is the small amount of available non-damaged capitals. In the catalogue of capitals those damaged capitals that do not allow for any quantitative comparison, ie Ion-9, 13, 19, 21, 34, 41, 57, 60, 68, 69, 72, 73, 75, 76, 81, 82, are clearly excluded. There are however a large number of damaged capitals of which reconstructions are available. For these damaged capitals, any accurate analysis of the percentage-wise accuracy level of their reconstructions would be a major study on its own. (Assessment of this by the reconstructors themselves is acknowledged by them in only a few instances). This would involve assessment from the artifacts themselves, inclusion in the assessment of sister capitals - which hardly ever exist - in architectural instances, personal access to capitals that were historically badly documented for remeasurement, and for the others access to photogrammetrically based documentation (also very rare) or to accurate, large-scaled drawings.

Whilst this objective should not be neglected, for the synthesising view that this study set out to obtain, a more practical approach is proposed, namely working with the documentation base as it stands at the moment, being aware of the accuracy level of data, and over time increasing the accuracy level of the various artifacts. As explained in the preamble to the catalogue of capitals in Chapter 2.3.3, in order to provide understanding of the level of exactness of capital dimensions where we are dealing with damaged and reconstructed capitals, the author codes the capitals in Table 1.1 as Green (Dimensions accurate and measurable from the artefact), Blue (Some dimensions not measurable but a responsible and accountable reconstruction), and Red (Too fragmentary or impossible to reconstruct to any degree of probable accuracy, or reconstructed dimensions approximate). In this process the author relies on a hitherto understanding of capital typology as relevant researchers' approach to accuracy towards the artefact as emmanates from their documentation.

In the proposed approach it nevertheless remains necessary to know to which degree the data are 'tainted' by any conclusions of 'Red' and 'Blue' cases. A statistical evaluation of the above-stated premise is herewith introduced. The two proportional relationships H:A and G:A are identified as being a best-case (Most measurable dimensions present) and worst-case (Least measurable dimensions present) *scenario* respectively. The data is grouped into the three accuracy types (Green, Blue and Red) and three time periods (625-550, 550-525 and 525-490 BC), each providing a reasonable sample size. The exercise is to determine what the statistical effects are, in terms of the statistical properties *mean* and *variance,* and by means of an analysis of variance, if the less reliable data are introduced with the known reliable data. In terms of *mean* of the values, for the best case *scenario* (H:A) there is no difference between the mean values of the three accuracy types (p-value=0,27) or the three periods (p-value=0,31), and for the worst case *scenario* (G:A) there is no difference between the mean values of the three accuracy types (p-value=0,78), but there is a difference between the mean values for the three time periods (p-value=0,07). In terms of the *variance* of the values, for the best-case scenario (H:A) there are indications that the variances of the types of data differ in the 2nd and 3rd periods, with an interesting occurence being that the most reliable data group (Green) shows the the highest variance in the 3rd time period (One must be aware of the small sample). For the worst-case scenario (G:A) there are no significant differences in the variances.

From the results of the statistical analyses one may make two deductions, namely that from the analysis of *mean* values, the supposedly less reliable data seem to acceptably fall within the norm provided by the most reliable group, but that from the analysis of *variances* in values, one may clearly see that there is a lack of consistency in the variances of the most reliable group, precluding its use for any test of admissability for the other less reliable groups.

Whilst, on the basis of this analysis only, the inclusion of the Blue and Red group seems to be warranted in manupulation of data for a more synthesising understanding of typological evolution during the Archaic period, for more accurate analysis of trends in various time periods and geographical groupings it is proposed that the Blue group only be added in future. With this, it is recommended that the accuracy level of the examples of the Blue group be expanded on in the future, and that those examples from the Red group which may be better documented and/or reconstructed, be identified and proceeded with. An added result of doing the statistical analysis is a realisation that knowledge of the mean values and variances in values in the time periods, and eventually also the geographical groupings, may provide clearer understanding of the already achieved analyses of trends.

3.3 FORM TYPOLOGY AND THE DEMANDS POSED BY *TECHNE*

The process of designing and making Ionic capitals occurs within the context of temple and votive column production. Within the period under discussion similarly there was found the production of other artifacts, namely sculpture, kettle stands, altars and ceramic which occur, like the temples and columns, as visible examples of mainly a shared religious belief and expression. The artists' and architects' approach towards the making of these artifacts have been the topic of a multitude of research. In the absence of primary written sources by Archaic architects on an Archaic design approach and theory - Statement of this lack, together with a re-appraisal of Vitruvius's work in this regard, is found in Wesenberg (1996, p.1-15) and Philipp (1968, p.42-4)) - and of design pattern['books'] and construction technology, there has been an unabated analysis of the stones themselves in order to define the Archaic design mind. Philipp (1968, p.42, 45) nevertheless identifies a Sixth Century design yearning for precise and differentiating technical terminology and firm (design) rules and relationship of dimensions - but more so after Pythagoras, ie Polyklet - but also a concern for purely technical matters. From the collective interpretation of Hellenic artistic and architectural artifacts many conclusions on the nature of Hellenic design and execution have been expressed. In this sense Porphyrios identifies *techne* as a characteristic of Hellenic art and architecture (*inter alia)*, and expresses it as "... a deliberate human intention......an ordered application of knowledge that is intended to produce a specific product, or achieve a predetermined goal" (1991, p.29-30). The skill and knowledge (Theory of practice) involved in the craft of the *techne* however, is directed towards deepening the understanding of human as 'maker'. It is clear that there is an inherent integration of the pragmatically technical with the aesthetic. Koenigs (1990, p.132) has lately made the statement that in the Hellenic period the aesthetic aspect (expressed for instance in the λόγος, or the use of proportion motivated from a mathematically grounded aesthetic), was the overriding concern, even though the evidence shows there was due consideration - and a balanced view - of technical and functional aspects and the practical advantages inherent in systemising buildings in terms of proportions. In this section the approach to Ionic capital design in the Archaic period, and the nature of the relationship between the technical the and aesthetic, is researched from the data compiled for this study.

3.3.1 The components of form

Whereas the Doric capital is a fairly simple element (and whose evolution has been clearly demonstrated by Howe (IDO)), the Ionic capital is a complex entity. Based on existing studies and the compiled data one may state that the aesthetic and functional integration of the column-echinus element and the canalis-volute element into one single entity which may be called a standard Ionic capital, is an achievement of the first quarter of the Sixth Century BC, an achievement which clearly relied on a preceding period of experimentation. In this section there is an endeavour to enhance current insight into the form content of the Archaic Ionic capital. Theodorescu's (LCIG, Fig.1; also see Raubitschek (1938)) study clearly managed to pose the Ionic capital as an elemental form composition rather than as a single block with surface decoration. Analysis of the Doric Order (IDO) and other Hellenic artistic artifacts - for example by Boardman (1978, p.65, 241), Karo (1970, [1948], p.104), Holm (1957, p.19), Malraux (1960, p.47) and Howe (IDO, p.317) - suggests that this vision may be universal for Archaic artifacts. In this study there is an attempt to push this description further, and also to gain more insight into the machinations employed to achieve this in the Ionic capital.

3.3.2 The making and ordering of form: An approach and adherence to and evolution of tectonic rules

"*Tectonike* stands as the highest fulfilment of all construction" (Porphyrios, 1991, p.37). This section explores the tectonic interrelationships between elements of the Archaic Ionic standard capital.

3.3.2.1 Abstract tectonic rules of the Archaic Ionic standard capital

In the attempt to further pursue the achieved definition of capital form and to gain further insight into the aesthetic qualities of the Ionic capital in terms of the use of formal aesthetic principles in the design, it was deemed useful to apply to the Ionic capital Howe's (IDO) analysis of the tectonic rules underlying the form and composition of the Doric Order as well as of examples of certain Hellenic minor arts (Despite criticism against his founding theory, this aspect of Howe's work makes a major contribution to Carpenter's (1962) earlier work and to architectural understanding in general). This analysis identifies the tectonic rules underlying the form and composition of the Ionic capital, in terms of its constituent morphology and perceived syntax. This analysis is eventually integrated with that of the Ionic Order and votive column below (See Chapter 3.3.7.2).

In the vision of the Ionic capital as a composition of three-dimensional form elements - posed here as an abstract tool to discern the compositional entity rather than to presuppose an evolutionary founding history - the major elements are the disc-like echinus, the rectangular block-like horizontal channel (canalis) and the two cylindrical polsters, with the lesser elements being the abacus block and the astragal disc on the echinus soffit part, both important but optional elements in the Archaic era (in the case of the astragal the element often occurs as part of the column shaft). The other minor elements of the Archaic form repertoire are the capital-bearing- or bolster spandrel palmette, the volute angle spandrel palmette and the abacus palmette

[Illustration of the elements of the Archaic Ionic capital precedes the illustrations of capitals in Appendix 2]. All these elements exist in various guises through the use of differing decorative schemes and surface treatment (Smooth, decorated with paint or in relief).

The achieved definition of tectonic rules in Table 3.5 below tries to include the various form variations found in the Archaic period, but does not take chronology into account.

Table 3.5 Synopsis of the tectonic rules present in the Archaic Ionic capital.

Morphology nature	• Every pattern element of the capital elevation consists of compact, geometrically derived elements (round volute, rectangular canalis element straight or convexly curved at the bottom, disc-like or domed cyma, rectangular abacus, cylinder- or double trumpet shaped polster and triangular spandrel palmettes and volute angle spandrel palmettes). Some of the elements take on the function of connecting elements, like the spandrel palmette between canalis and volute edge, also connecting canalis and volute to the cyma. • Each pattern element is an individual visual element defined by boundaries or through articulation in parts. • Different forms in elements indicate differing character properties • Open spaces like the inside of the canalis and the eye are seen as voids.
permissability	• The elements are horizontally reversable due to their symmetry but vertically irreversible due to difference of top and bottom. • Decoration (whorls, rosettes, stars etc) only occur in voids. Decoration occurs mainly on the canalis and eyes.The polster is not seen as void, because only higly structered articulation is allowed (bands, straps, geometric vegetative patterns rather than free forms), or otherwise surface decoration which is both geometrically structured and tends accentuates the surface. • Much variation occurs in terms of detailing, eg spiral border mouldings, section type of the canalis. • Variation [excessive] is not allowed in functional elements on the same elevation of the capital, but is permitted between the opposing faces of the capital. • Variation of volute, abacus, and cyma forms occur. • The separate elements are not as a rule subdivided [apart from early corner capital inside volutes] and only superimposed [cyma in one example] in ways that preserve the integrity of both's form.
proportion	• There are variations in proportions of the pattern elements, which over time may be clustered in distinct style groups with unique characteristics and proportions.
Syntax position	• Each element type only occurs within a certain horizontal band. • Only the spandrel palmette is sometimes repeated on another position (volute angle spandrel palmette/angle piece) because it roughly fulfills the same function in both positions, but then its form always differs from that of the volute spandrel palmette. • Curved forms only occur at connections between elements like the canalis bottom and the volute, the canalis bottom and the cyma, the bottom of cyma leaves/eggs.
connection	• Connections between horisontal layers of elements are emphasised. The connection between cyma and canalis is accentuated by either a curved line, through extreme linearity or by means of a void. • The horizontal elements that act as connectors in the total Order ensemble, mostly the cyma but also the abacus and astragal where they occur, are most densly articulated with rounded forms that indicate elasticity [There are rectangular abaci, but the rounded is favoured]. The canalis element in between cyma and architrave is a pregnant shape and usually left void in order to signify its very important part as important cushion between visually upwards penetrating shaft and downward bearing architrave.
ordering	• The elements of the capital are ordered around a vertical axis and which creates the illusion of a supporting line on the axis. The symmetry is likewise extended to the side façade. • The vertical irreversability of elements emphasises the direction of vertical axial ordering. • A hierarchical ordering of the horizontal bands of elements exist, although their proportions do not remain constant
The formal tectonic rules show an attempt at creating a visual fiction which represents the architects understanding of the physical, in this case architectural, reality, but here through the use of the morphology and syntax of the capital elements.	

The analysis identifies the importance of the column capital connection. An important part in the evolution of the capital form is the evolution of the cyma, from torus to cyma with leafs, and thence with *ovoli,* which resulted in the more intense and sharper definition of the meeting place between column shaft and echinus. This very important meeting point is then accentuated even more through the introduction of pointed *ovoli,* and also in cases with the use of a round moulding or bead-and-reel astragal below the cyma (The astragal first being part of the column shaft, and later becoming a part of the echinus). The identified importance of the connection between capital bearing plane and statue plinth or building architrave, is solved by introducing various elements (spandrel palmette, triangular corner piece, an obtuse volute angle, and also by means of the abacus element. In some architectural capitals however (Ion-7, Naxos Dionysos Temple IV; Ion-15 Myus Lower Temple) there is preference for transition through a smooth curve away from the architrave).

The analysis shows the existence of strong formal aesthetic design rules that reflect a specific Hellenic perception and resulting understanding of a *physis*, here in terms of mechanics like the directional force of gravity, and also in terms of the specific interaction between capital elelements. The author would like to draw attention to the inclusion of a dualistic tendency in the design, in that elements of the capital are strongly segregated and well ordered, showing an adherence to geometric and modular control and of together being a static rather than moving form, whilst at the same time the elements show the tension resulting from force, like the tension in the seemingly logarithmic volute helix, the compression of the leaf cyma (and where present of the ovolo echinus), the tension in - where present - the logarithmically curved section of the bolster flutes, the springing nature of the canalis cord form, and so on, clearly interacting with each other in the total form. This interaction is taken through outside the capital form, in that the connection with the epistyle is most strongly expressed as an active point of dialogue, as is the column-capital connection.

The illusion of the elemental composition is so convincing that it is hard to believe that the capital was chiselled down from a six-sided rectangular block form. Following this analysis there is an attempt to increase knowledge of how on the capitals' six block surfaces the designers came to solutions regarding several design problems, namely overall proportion of the sides, relative proportions for individual elements, choice of element form type, articulation and decoration type, as well as the conclusion of the junctions between the elements. One must constantly keep in mind that these solutions had to meet each other deeper into the innards of the stone block.

In this study it is acknowledged that in votive columns the capital had to be integrated with the demands posed by sculpture type (sphinx, standing, seated, striding persons), and in architectural works the capital dimensions had to be integrated into a bigger proportional and structural scheme where functional considerations, in which architrave, capital and column shaft become an integrated unit, had to be meshed with aesthetic considerations involving all the parts of the building elevation as well as the building plan. The first of the analyses focuses on the the use of paint and metal to enhance intentions of design concept.

3.3.3 The making and ordering of form: The role of polychromy and appliqué in the articulation of capital form

The above analysis of tectonic rules inherent to the Ionic capital did not include the use of colour or metal applique, but this is deemed to be an integral part of the expression and definition of the capital - as was it for the total Order. It is not necessary to provide detail of all the instances of the use of polychromy in Hellenic glyptic art and architecture. The examples are well known. The use of polychromy also extends to the Ionic standard capital. Archaic Ionic capitals that still show traces of paint are Ion-21, -30, -35, -36, -62, -67, -68, -81, and Aeolicising capitals Iver-3 and -9. The capital of the Naxian *Oikos* (Ion-24) and the pre-standard architectural stone capitals from Delos (Preion-1) and Didyma (Preion-2) are deemed to have been painted (apart from possible intaglio grooves), and volute-angle spandrel palmettes could have been painted on the Aphaia sphinx column's capital (Ion-22).

Where one should view the use of pigment and metal on timber and stone artwork as traditive and endemic to Hellenic art, there should be exploration of the nature of their use in Ionic capitals. Whereas paintwork on smooth surfaces surely acts as the designated element, its use as overlay on a plastically formed element would designate something different. In a design context, should paint and metal overlays be read as mere ornament, or integral components of a decorative syntax? In terms of the design reasons for using polychromy, Martienssen had this to say regarding the Doric Order: "The architect has achieved by formal plastic means the degree of accent separation and structure that he deems necessary for aesthetic unity.", and "Colour.....has primarily an extended function in rendering this modulation independent of transient light conditions." (1942, p.74-5). The important aspect revealed by Martienssen was that [in the Doric Order] colour was not continued over differing units, and was never applied indiscriminately. Rather, specific colours were used for specific elements, in this sense accentuating the differentiation between the elements that was strived for through use of the chisel and of the decorative scheme. This conclusion has been affirmed by the interpretation of Carpenter (1962, p. 233). There is no study on the existence of a canonic manner of doing in the Ionic Order, and less so for the Ionic capital. From the examples above it appears as if colour was often used just to provide detail (Like leaf patterns on smooth *echini*, volute spandrel palmettes on an unmodulated plane, or volute channel line and the volute eye on flat capitals), in other words to differentiate form where this was omitted by other means of articulation like plastic execution or gravure. There are instances where meanders were painted on the abacus, and where the pattern is definitely to be understood as ornamentation rather than decoration. Piet de Jong (In Thompson, 1960, Plate 77.c) has reconstructed the colour of the Classical capital A2972 from the Athenian agora. (The article does not provide the colour, but the author has seen the coloured drawing displayed with the capital, on which traces of paint exist). Even though the concave volute- and canalis channels are defined by rectangular beading, the beading is accentuated in blue, leaving the channels of the capital in plain marble. The lines between the leaves of the modulated volute spandrel palmettes are likewise accentuated in blue and black.

However, similar to the other examples, the smooth abacus and echinus are decorated with painted ovoli in blue and delineated in black, and a black meander appears on the smooth vertical intermediary space between canalis and echinus.

Whereas one could understand the use of colour in the other less plastic examples as due to the lack of, or economy of sculpturally plastic detail, this example is very evocative of the interpretation made by Martienssen above. The colour in the case of the volutes and palmettes is definitely a double differentiation of the seperate elements that are part of the tectonic whole, and support the analysis of tectonic form that has been reached above. The use of colour on the Ionic capital, as may be shown for the columns (For example that of capital Ion-30), also reminds us that there was not the preciousness about the 'honest' or brutalistic use of material as has been expressed in Western Modern architecture.

Whereas the full covering of the volute by metal - like the Archaic metal applique volute from Olympia in Herrmann (1996, Fig.1) achieves the same effect as an unpainted volute, the use of elementaly separated metalwork seems to define the volute bead, channel and eye better, as with paintwork. Examples are capitals from Kavalla shown by Bakalakis (1936, Fig.101), the metal canalis decoration of the Propylaeon capitals from Athens, and others in Pedersen (1983, Note 76). This similarity in use of colour and metal helps to further underscore the achieved analysis of the tectonic rules inherent in the definition of the capital form. The occurence of metal and paint help in the evaluation of the probability of the existence of composite pre-forms for the Ionic capital.

3.3.4 The role of geometry and metricated design in the ordering and making of form

Koenigs (1990) has highlighted Hesiod's exposure of the ethical significance implied by the Hellene's voluntary subjection to a limitation of life-style, with a subjection to μέτρον being such a limitation. Numerical and geometrical order may be included in this sphere. Ionic plan form has always been seen as being of a more regulated modularity than the Doric, but overall Ionic architecture is seen as less 'modular' (Coulton (1975, p.70-1, Fig.1) in his definiton of the modular system involved in the Ionic Order, extending into the capital). Nevertheless, regarding early Archaic building elements, Ziegenaus (1957a, p.72-4, Fig.1) brought to light the use of metrication and geometry in one of the smallest parts of the South Building at Samos, namely in the design of the gable end tile decoration, and a recently found terracotta antefixa of the First Dipteral Heraion from before 550 BC also shows the use of modular design for a mass produced Ionic building element (See Kienast, 1992, Fig.6). How prevalent was the use of geometry and metrication design in Archaic Ionic capitals? The existence of the use of geometry and metrication in the <u>Classical</u> examples of the Ionic capital has been well documented, but whilst proof for the use of metrication in <u>Archaic</u> Ionic capitals is well documented in terms of the overall elevational proportions, it is less so in terms of the use of geometry. Also, few researchers have focused on the integrated and three-dimensional nature of the capital design. Here Gruben (1963, p.128-30, Fig. 20-21) has lead the way in putting forward items that may be included in the documentation of the total capital with his work on the capital of the Archaic Didymeion II. His work has shown the existence of proportional, modular (1 038 = 3 feet /2 ell) and geometric ordering of all elements included in the front and bottom elevations of those capitals. Additional to his analysis of proportional relationships, Vallois (1966b, p.199-200) also comments on the existence of plan geometries in the lay-out of Ionic capitals. Theodorescu (LCIG, p.142-59, Plate 4) has only focused on the geometric ordering methods employed in the design of the bottom elevation relationship between the two polsters and the echinus of various capitals. Apart from geometric devices, further work by Theodorescu (LCIG, Table 1, Matrix 0), Kirchhoff (EIV, p.236, Table 1, 3) and Koenigs (1979, p.198; 1980, p.66) show proportional relationships that may be used in analyses, and the author has compiled a comprehensive description model for the capital which includes these relationships and others. The comprehensiveness was deemed necessary to inquire into the *lacunae* posed by Theodorescu, but in the analysis it was found that some identified relationships are not productive in the sense of bringing greater understanding (they are still reflected in the capital description for use by others), and that other relationships are more useful in that they are the regulationg relationships from which others originate (these will be employed in the text). The author has gone further than other researchers till now in the sense that the capital's integral relationship to a bigger formal system, ie the votive column/building, is examined. Also, the existing guidelines put by Kirchhoff (EIV, p.236, Table 4) have been augmented by the author to take into account the work on column slenderness ratios by Gruben (1963, Fig.38), in order to enhance insight regarding proportionality within the Ionic Order. The endeavour in this work is to ascertain the earliest instances of rational ordering in terms of the use of geometry and metrication, as well as the evolution of certain of such design aspects.

3.3.4.1 The role of systematic proportioning systems and planning grids in the design of form

The work of Gruben (1963, Fig.21) clearly shows that the design of the capital of the Didymeion II incorporated the use of a proportional system and a design module. He (1963, p.129 note 83; 1960, p.89) mentions other groups of examples where the tripartite arrangement Volute length (D): visible echinus length (E): Volute length (D) follows a predetermined order (ie. 1:1:1, 1:2:1, 3:4:3, 5:6:5 and 6:7:6). Although he never expressly states this, one may come to the conclusion that a (at least rough grained) modular planning grid was employed in the design, and that this follows earlier progress in the use of planning grids in Hellenic glyptic arts from the early Archaic period, as is shown in Chapter 5. The first (Ion-1), was only ordered on the façade. Thereafter, the early Cycladic capitals (starting with Capital Ion-4 on Delos (*ex* Naxos)), non-monumental and monumental capitals were subjected to design with a three-dimensional planning grid, and they show clear signs of the use of both design module and a proportional system (See Tables 1.1 in Appendix 1). Haselberger's (1986, p.213) work on the 'Archilochos' capital (Ion-17) shows use of a design module and proportional ratios, eg D:E:D=3:4:3, A:Q=5:3, D:G:B=5:6:7, K:J:Volute distance below echinus = 6:7:5 all as stated by Haselberger (1986), and the author identifies that

B:G = 7:6 (With Q:B and Q:H = 3: [Approx] 2). It is of note that this capital's volute spirals are not yet as higly geometrisised as the modularity and proportioning would suggest. In the example of the Didymeion II mentioned above, similar to the Parian capital, the emphasis seems to be on the use the proportional system for clusters of elements of the capital (eg volute and echinus lengths, capital length and height, capital length and width, echinus and canalis height, etc) rather than linking or lining up significant parts of elements on a visual modular grid. Theodorescu (LCIG, p.4-5, Fig.2) comes to the same conclusion. One may also see this idea of clustering of building elements in Coulton's analysis of the proportional schema for the Ionic Order. The first method is a conceptually more difficult one, and was likewise employed in execution of the *kouroi* figures in Archaic Hellenic glyptic art. From the Didymeion II example it is clear that the complexity of the totality of the Ionic capital design (in contrast to the rather facile Doric capital) lead to exceptional achievements in this regard. (The reader is referred to the design of the Priene capitals, taking note of a reasignment of their positions and re-evaluation of proportions by Koenigs (1983)). The standardisation of the total capital form was only to come much later in the Roman era. (For the latest inquiry into Vitruvian metrication, geometric ordering and proportioning of the Ionic capital, Büsing (1987) and Frey (1992)). The conclusions made by Büsing are far reaching and should be revisited on the Archaic capitals in relation to their volute design - More about this in 3.3.4.2.3 below.

The interesting part of the use of the planning grid is that it provided order, an order which in a wider context of flux also could give stability in a design context - also see Onians (1988, p.9-11) in this regard - but that whilst the grid set certain limits from which artists and architects chose not to divert drastically and which provided a form coherence over time, this order also provided freedom, as the evolution of capital form clearly shows. We may also see that within this freedom of sculptural form there was an intense control of proportions, showing up the dialectic that exists in Hellenic art and architecture.

The effects of the use of the planning grid in the production of form is explored further in a later section on form execution below.

3.3.4.2 The use of geometry in capital design

3.3.4.2.1 The plan of the capital base

The works of Vallois (1966b, p.200), Theoderescu (LCIG, p.142-59, note 256-7, Plate 4) and Gruben (1963, p.128-30, Fig. 20-21; ie the capitals of the Artemision 'D' and the Archaic Didymeion) have shown how the polster extremities and the echinus diameter of a capital are brought into relation through the use of simple geometric shapes. Following on their work, the author has identified the geometric ordering devices employed in all the first generation Archaic capitals, together with some others from the late Archaic era. (Note: All the forms thus ascertained appear as Item 6 on those Tables indicating qualitative criteria).

Because it was found that the geometries are usually formed on the polster interiors on the moulding edge, it is suggested that in future capital descriptions the dimension between the inner edges of capital volutes, together with the dimension between polsters on the capital centre line, be included.

The square (in Ion-1, -24, -18, -19, -23, -27), and rectangle in the length of the capital appear in quite a few capitals up to 550 BC. Only after that the rectangle across the width of the capital appears (in Ion-45, 29, 25, 61, 58). This fact already indicates that the stretched out capital was more prevalent between 600-550 BC, with the exception of all the Naxian examples (Ion-24, 11, 18-9), and that a new compact capital type with volutes closer together than in the preceding phase follows after. The hexagon is first used in the second quarter of the Sixth Century BC (Ion-20), and in the third quarter (Ion-74, -30, -32). The octagon is only used as ordering device from the Classical era.

Apart from the square and the hexagon, rectangles (long or accross) with significant dimensions (eg 1:2, 2:3, 2: 4 etc) may be described as premeditated ordering devices. The long rectangle used in the first monumental example Ion-22, has a proportion of 1½ : 1. We may say that geometrical ordering devices for the capital bottom plan were used from the time of the monumentalisation of the Ionic capital, that all those ordering devices were premeditated, that the complex hexagon shape was already present in the second quarter of the Sixth Century, that apart from the early presence of the rectangle across at Paros it appears commonly in the third quarter of the Century. Furthermore it seems as if, apart from the earliest examples, that there was no preference for any shape relative to the capital's function (namely architectural or artistic). Even though the first capital (Ion-1) carried a sphinx and had a square as ordering device - the capital is relatively wide, its width : length being 1 : 2,26 - and one Parian capital had a rectangle accross, it is of note that all the earliest examples of long rectangular ordering devices were all employed for votive columns carrying sphinxes needing long capitals for the stretched out base (Ion-22, 4, 6). Interestingly enough the extremely slender length : width ratio of the capital of the first monumental example Ion-22 (ie 1 : 3,36), is not repeated in the following examples, which rather come closer to that of capital Ion-1 with the top plan ratio of Ion-4 being 1 : 2,38 and that of Ion-6 being 1 : 2,64. This last model was copied in an architectural example (Ion-7) even though an example (Ion-24) with square device and plan ratio of 1 : 2,54 was already in existence.

Whilst it is illuminating that the first architectural example, (Ion-24, Naxian *Oikos*) follows a new route by employing the square ordering device, it is clear however that, rather than the shape of the bottom plan ordering device, the capital top bearing plane proportion was the significant factor in terms of <u>structural</u> performance in the architectural examples

Further work regarding the metrological content of especially the rectangular ordering devices of the first generation Ionic capitals, but also of the hidden geometries employed in Classical capitals - where double squares and also the 'golden section' are evident - as well as the ordering devices used for the polster element as such, may lead to further insight in the extent of metrication employed in this era and is certainly a most fruitful study awaiting attention by an intrepid researcher. (There are examples of long capitals used for statues ([Ion-76 and Ion-36 [Alkimachos writer on chair], both presenting side profiles, and also Ion- 62 [Kalimachos statue rectangular due to the running figure being turned sideways to show breast/face front rather than profile], and it seems as only later capitals have a square abacus specifically for statuary [See Raubitschek, 1938, p.171; Also 1943, p.20]. Architectural examples of this are Ion-12 and -74)

This analysis illuminates the importance of the bottom elevation in the design, with resulting effects on the façade proportions. It is to be argued that, if façade proportions - in relation to column proportions - were cardinal in determining capital form, the plan proportions had to follow from there if there was premeditated use of a plan ordering device. This idea will be looked into further in the analysis of façade proportions and volute construction technique. Together with this, further analysis of the influence of the column top diameter on capital façade and plan design is required.

Gruben (1963, p.128-9, Fig.20-1) identified the diagonal line of the ordering rectangles of the capitals of the Ephesian Artemision 'D' and the Polycratian Heraion IV of Samos both complete a 3:4:5 triangle (the Didymeion II was very close to that), indicating a very simple but clear method of gaining a capital plan based on intentionally proportioned geometries which include the diagonal (also see Theodorescu (LCIG, note 257)). The author would like to venture the possibility that, in the design and execution process, the architects and sculptors of the time did not express these geometries only in the form of *paradeichmata,* but that the complexity of these geometries, as well as the scale of the capitals and the clumsiness of a huge cutting compass, required work on a writing surface in terms of drawn experiments or pre-constructions, and also written works - works that Gruben (1966, p.167) alludes to, and which Coulton (1977), Berquist (1967), Philipp (1968) and Wesenberg (1996) accept - in which the philosophical and 'scientific' reasoning behind this most interesting and amazing part of the total Ionic Order probably evolved, and was expounded and transmitted through the Hellenic era, as may be seen from the built examples.

With the insight gained above one may state that the metrication and geometrical ordering of the capital plan evolved in complexity throughout the Archaic era, that the evolution was not linear, that this aspect of the capital gained a great deal of attention, that certain examples may be seen as 'significant', and that the transmittal of 'non visible' knowledge surrounding the capital design seems to be indicated by the examples. Regarding the significant examples, further study needs to be done regarding possible differences in proportional design between peristyle and opisthodomos as part of the spatial experience of buildings, as indicated by Drerup (1954) for the capitals of the Athenaion at Priene. His misinterpretation of the placement of the capitals was borne out by Koenigs (1983; Koenigs sees the longer London capital as the ophistodomos, and the compacter Berlin one as the peristyle capital.

3.3.4.2.2 The use of geometrically generated angles on the capital façade

The angle of transition of the bearing load between bottom and top bearing planes is indicated as 'α' in the quantitative description, and is part of the decision making process involved in the making of the capital façade. The following trends are identified, and brought in relation with the ratio H:C:

Table 3.6 Relationship between angle of load transition α and ratio H:C.

In the period 600-550 BC in the chronologically put Table 1.1 in Appendix 1 both wide angle of transition up to 49°, as low as 12°, from 550 BC onwards tends to dwell between 20-30° with 15°, 17°, 33° and 40° occurring. One may discern a tendency towards smaller angles from the beginning towards the end of the Archaic era, with the angles being roughly in the 40°'s-30°'s before 550 BC, and thereafter in the 20°'s, but the trend is far from linear.
If one looks at the ratio *bottom bearing diameter : top bearing length* (H : C) for capitals up to 550 BC the ratio begins at 2,25 and ends at 1,25 but with many variations in between peaking at 2,5 and 1,0. Capitals between 550-525 BC show ratios from 2,3 dropping to 1,7, but with peaks at 2,5 and 1,1. The 525 -500 BC capitals begin at 1,7 and end at 1,6, with peaks of 2,0 and 1,0, and the 500-489 BC capitals show ratio beginning at 1,6 and ending at 1,5, with the most around 1,5, but peaks at 2,2 and 1,2. On the whole the ratio comes down from 2,5 to around 1,5 during the Archaic era, and that this reflects the tendency towards a smaller angle of transition over time (It is obvious that the angle of transition changes in relation to the distance between bearing levels).
If only architectural capitals are used in the analysis the following may be discerned. Between 575-525 BC the ratio dwells between 1,25 to 1,8, with peaks 2 and 1,1, and during 525-489 BC there is a very strong tendency around 1,5, but with peaks at 2,2 at the end of the period. It may seem as if the 1,5 ratio became the favoured ratio for architectural works during the Late Archaic era.

About 20% of capitals show angles originating from predetermined geometrical ratios, but there is no chronological pattern to be discerned in terms of a favoured angle.

3.3.4.2.3 The use of geometry and metrication in the design of the volute

Apart from ordering involving the relationship between the various components of the capitals, the ordering of single components may also be analysed. In the ordering of decoration on the echinus and polster components, symmetry is employed almost without exception from the earliest introduction of those decorations, be they painted, engraved or modelled. The examples speak for themselves. However, it is the volute element which as a single component seems to have engaged the attention of the designers from the very start. Whilst Constantinidès (1973, p.141) confirmed that nothing possibly written on this subject by Archaic or Classical designers has come down to us, his study of existing volute ordering methods showed the large amount of variations in ordering methods (about which very little certainty also exists). Whilst many theories for volute geometry construction have been put forward and just as many discredited, previous (eg Koenigs, 1979) and continuing painstaking work of documentation and interpretation (eg Korrés (1996) and others) is steadily increasing knowledge on the subject.

The succint work of Büsing (1987), where capitals are re-evaluated from the well-known Vitruvian (Book III.V.5-7) model, casts a completely new light on the system or logic contained in the volute design of certain well known Hellenistic capitals, which he terms 'additive' and 'duplicating' system-volutes, and also the 'pulsating' volutes, like those of the Classical Erechteion experiment which he shows to be part of the evolution in the direction of becoming system-volutes. Whilst expanding our current knowledge of the Vitruvian-based volute construction method, in his new analysis it is clear how the volute eye and the square ordering device (of eye radius length and width) contained in the eye centre, not only regulate the volute spiral construction of system-volutes but is also closely interwoven with the volute and capital façade size. Büsing (1987, p.338) points to the necessity of studying more Attic examples to trace the evolution towards the 'pulsating' and then 'additive/duplicating' types. This sentiment is echoed by Korrès (1996, p.97). His (1996, p.95-8, Fig.8-12) work shows that, whilst there was a high degree of standardisation in Classical volute design, the 'system volute' was as yet not a standard part of the Ionic repertoire. In order to complete the evolutionary train, the need to analyse the Archaic examples could be even greater, with the volute geometries of only a few capitals having recieved attention (eg Bakalakis (1936), Gruben (1963), Koenigs (1979), Ohnesorg (1993b, p.117), Gruben (1997, Fig.49), as shown in Fig.3.3a; Wherever geometries have been identified by others, the references are so mentioned in the catalogue in Chapter 2) .

The scope and limitations placed on this study precludes full analysis for all capitals as per Büsing's work (ie radii reductions and geometric ordering). Furthermore, it is only possible to accurately assess volute geometries from accurate drawings or corrected photogrammetric prints. Nevertheless, the author deems it useful to do a preliminary exploration of Archaic capitals - in the spirit of a reconnaiscance - towards assessing which capitals show geometric ordering in the volute design and which could possibly have foreshadowed the later system volutes so that they be identified for further analysis, to ascertain at which stage a more formal approach to volute design came into being, and to heighten current insight into the evolution of geometric ordering for the early Archaic Ionic capitals somewhat (Fig.3.3c). Due to practical reasons (eg lack of proper drawings/photos, distance from artefacts and administration involved in getting research access to capitals) this first exploration is on a level permissable by the state of the documentation available to the author - the varying levels of reliability of documentation are again indicated in the examples. Whilst analysis of 525 BC Late Archaic capitals is mostly excluded here, it is imperative that these examples together with the abovementioned Attic examples, as well as a more detailed analysis of the early Archaic examples than that attempted here, be undertaken to close the gap in knowledge opened up by Büsing, and to heighten understanding regarding the typological evolution of Ionic capitals as a whole.

All volute geometries of the examples analysed in Fig.3.3c below are as yet unpublished, except for four examples by others. The analytical drawings of the spiral constructions are to be read as sketches, as most of the author's drawn analyses of spiral constructions were done as overlays on enlargements of existing publications and photographs, rather than on tracings from the primary sources. Scale variations and distortions resulting from blowing up the sometimes small published drawings will lead to distortions in results. It is again stated categorically that this study shows up the necessity for other researchers to compile an inventary of volute spirals at a scale of 1:1 from the existing examples. The method used is here is merely an exploration for an inquiry into the possibility of major design patterns existing before the system-volute types of the Classical era. After the exploration of the Archaic examples, and referring to examples of volute construction published already, the author suggests that there are four different volute construction methods employed in the Archaic Hellenic period, namely:

Table 3.7 Types of volute construction employed in Archaic Ionic capitals.

A	The **involute scroll**, well used in Mycenaean times, is a spiral in which the distance between the spirals remain constant, and which may be constructed by unwinding a string from a cylinder resulting in the involute of the cylinder circle, but also by drawing 90° arcs originating from the four cardinal points of a circle at the volute centre. [called 'Involute'arcs in Appendix 1, Table 1.2]
B	The **free-system** [Freigeformte] **point-and-arc helix**, constructed from 90° arcs originating from more freely selected points ordered within a rectangle or square at the origin of the volute, or from both a rectangle and circle at the origin [called 'Circle arcs [90°]' in Appendix 1, Table 1.2], and which system could possibly be identified as the earliest progenitor of the system-volute,
C	The **random-system point-and-arc helix**, constructed from unmetricated arcs originating from points of unmetricated nature [called 'Random' arcs in Appendix 1, Table 1.2], and lastly
D	the **rastered square, additive-system point-and-arc helix**, constructed from 90° arcs originating from points on a rastered square inscribed within a circle at the origin of the volute (and some within a square at 45° angle within a circle), which leads to volutes similar to those eventually canonised as the Vitruvian 'system-volute' described by Büsing [called 'Square-arcs [90°]' in Appendix 1].

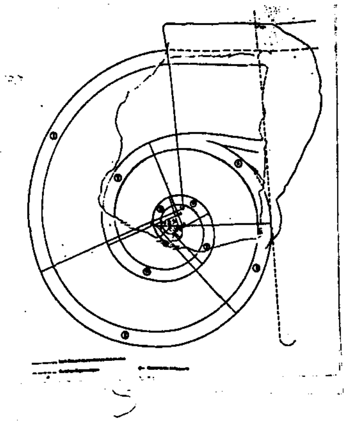
The initial exploration (See Table 3.8 below) shows geometrical ordering of various intensities and indicates a strong probability that there were various experiments with capital volute design [of the main types A-D] in the time up to 525 BC, and the few examples from after that show that this continued throughout the Archaic period. It is of note that there is use of ordering devices at the heart of the volutes, and that a few capitals [Ion-58, -23 {With Ion-12 having to be re-investigated from better source material}] move in the direction of method D, and that there is a capital following method D [Ion-50 from Kavalla] in the Archaic period. The examples also show that method D came about through a series of experimentations with pre-existing methods. It is argued that the geometrical method of constructing the involute scroll (Method A) is the early root of method D, although it could not provide the helix. The ordering device of the geometrically constructed involute scroll is a circle at the volute centre, bisected horizontally and vertically, and with the volute arcs originating from the cardinal points on the circle situated on the line where the arc terminates. The evolutionary process through method B provided the transition to arrive at the simple method of volute construction which again used the circle as ordering device. Whether one accepts Constantinidès's (1973, Fig.4) 'Goldman type' volute ordering device for the Erechteion east hall capitals, or the system volute of Büsing (1987, Fig.28), it is clear that Method B went through a process of evolution, and that both methods are refinements of a pre-existing, geometrical method. Whilst there are many Archaic capitals (Ion-12, 20, 23, 26, 27, 30-2, 35-42, 46, 48, 50-56, 66-7, and -74) with volute eyes which may, and should, be analysed within Büsing's (1987) method, the volute construction geometries of all the Archaic capitals should be brought into relation with the main façade lay-out lines in a graphical way in order to ascertain the relationship between volute construction and total façade design. This analysis will identify the relationship between volute design and the capital proportioning system employed. As mentioned, addressing the full spectrum of capitals in this manner is presently outside the scope of the study, but there will be further exploration. Because capitals Ion-6 - whose missing canalis does not hamper the investigation - and Ion-50 (which has slight volute damage but, due to the sharpness of detail of the capital, allows for reliable reconstruction work of the volutes bottom and outer side) are well documented, they may produce useful and reliable results. Using Büsing as guide, their volute geometries, relative to their façades, are analysed as examples of capitals without and with volute eyes (Fig.3.3b). In Ion-6 we see that diagonals of the centre of the square formed by the volute height seem to be lines on which r^1 and r^2 are situated. Also, the bottom of the echinus seems to be formed by the intersection of the vertical line on the inner volute edge and the diagonal of the square formed by the volute height. A 1:1 drawing should be made of capital Ion-6 and this geometrical co-incidence, as well as the volute construction, redetermined. It nevertheless does seem as if the volute design is closely related to greater concerns regarding façade proportion. In Ion-50 there is a remarkable co-incidence with the 'duplicating' system-volute construction method identified by Büsing (1987), with only the inner reduction of the volute lay-out square being slightly larger than one volute eye diameter. The volute channel of the first quadrant is two eye diameters high, and the volute channel distances on the main arc quadrants are as the duplicating system-volute type. The distance between the volutes of Ion-50 are four eye diameters, and although less than the later standard system-volute capitals of the Hellenistic era, this still proves that the volute eye was used as module. The top of the echinus lies on the midline of the volute square, and the space between the volutes are made up of two squares on top of each other. It is proposed that this capital is an ideal candidate for further analysis in terms of the progression of radius lengths, and correlated with the sytems identified by Büsing (1987) as well as with the standard base dimension identified.

Regarding the geometrical content, this remarkable example not only indicates that volute geometry and capital layout are very much interlinked, but that there were Archaic examples where the system-volute was invented, most probably following up from earlier experiments towards it. It shows that Büsing's analysis should gain a lot more attention and generate more research. The author has included the dimensions from the volute extremities to the volute origin in the manner of Theodorescu (LCIG), namely I^1, I^2, I^3, I^4, and as Gruben (1963, Fig.21) did for the capital of the Archaic Didymeion.

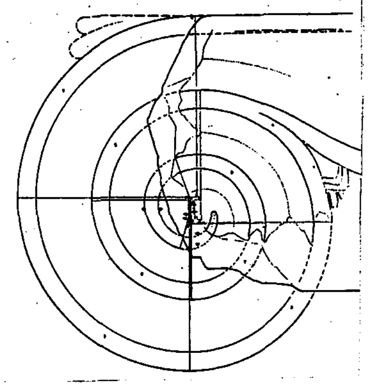
Fom the insights brought by Büsing there is a realisation that for those Archaic capitals whith volute eyes this identification of the volute origin is not required, but that this system is really useful only for volutes following ordering method B. For methods B and D there should also be an indication of the first four quarter circle radii (Which should rather read r^1, r^2, etc to fall in line with accepted nomenclature). The author identifies as necessary future activity that the geometries of volutes using ordering method B be brought in relation with their capital façade planning grids to ascertain if a significant point may be discerned in every capital - per example Koenigs, 1979, Beilage 2 - which is related to the overall proportional system and which governs the planning grid like the centre of the square around the volute does in the volute-system capitals.

Table 3.8 Exploration of volute ordering methods for selected Archaic Ionic capitals.

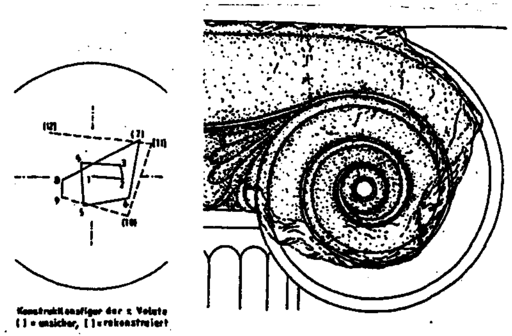
Capital No + reliability	Volute type	Description of construction method
Ion-22. Sphinx column, Aphaia	A	The Aeginetan capital shows the beginnings of a helix in the first 1½ turns, where after it becomes an involute spiral.
Ion-1. Votive Sangri, Naxos.	B with circle	The first 90° arc is followed by a 90° arc with a r^2 being 1/5 less than r^1, followed by r^3 and r4 with radii both consecutively less 1/10. A circle is described around the point of origin of r^2, the radius of the circle outline bisecting the point of r^3. Lines resulting from the intersection of the geometries of these forms are constructed in the circle, resulting in a vertically long rectangle of 2:10 with its centre at the origin of r^3, and neatly centred within the circle which becomes the eye of the capital volute, and with all the arc originating points following a rectangular grid pattern described in the rectangle.
Ion-4. Votive, Naxos.	Bwith rectangle	The reduction of the r^1 to r^2, and to r^3 are 1/5 and 1/10 , resulting in the formation of a horisontally long rectangle of 4:10 within the radius line and on the origin of r^1, with arc points ordered on a grid within the rectangle, and with the volute origin coinciding with the centre of the rectangle.
Ion-24. Naxian oikos interior	Bwith rectangle	The capital is damaged. Although nothing final may be concluded, Kaster's reconstruction (Ohnesorg, 1996, Fig. 1) allows the first three arcs of the capital volute outline to be examined. From the reconstruction method B is used for the volute spiral construction, with r^2 ca 1/20 less than r^1 and the r^3 *ca* 1/10 less than r^2, forming a vertical rectangular ordering device of 1:2 [ca 6,3 x 12,6 mm]. Martin's reconstruction with obtuse outline is not accepted.
Ion-6. Naxian sphinx column, Delphi	B with square	The second arc does not originate from the edge of arc one, but is shifted downward to create a deeper volute. After this the normal pattern of Method B with a rectangular ordering device is followed for arcs three and four after which arc five is moved into arc four, but with arc six coinciding exactly with arc two. There is no apparent reason, untill one sees the diagonal lines from the volute origin, on which $r^{1,\,22,4\text{ and }5}$ seem to lie.
Ion-7a. Dionysos temple IV, Iria, Naxos	B with square	The reduction of the arc radius from r^1 to r^2 is ¼, also resulting in an ordering device in the form of a gridded <u>square</u> (at rest) on the volute origin, but the arc points fall on different parts of the grid than that of Ion-6. The inside border of the volute tangentially meets the 45° line described between the bottom bearing plane's extremity and the point where the top bearing level starts its descent as a volute.
Ion-16 Artemision 'D'	B with rectangle	The reduction of r^2 is 10%, and of r^3 is 15%, with the resulting ordering device being a vertically long rectangle of 3:4, but with the volute origin falling below the rectangle centre.
Ion-20. Capital from Delos	B with arc shift	The radii of r^2 and r^4do not originate from the boundaries of the first and third arcs, but are rather shifted away (ie r^2 downward and r^4upward), as in capital Ion-24.
Ion-14. Kyrene sphinx column	B with arc shift	In the vertically long volutes the reduction of r^1 to r^2 is 16,6%, but thereafter the arc points do not fall on the boundaries of preceding arcs, but the vertical lines of arcs are rather shifted over that of the preceding arc, resulting in the vertical emphasis of the volute.
Ion-15 Lower Temple at Myus	B with arc separa-tion	This capital is a theoretical reconstruction. From analysing the model the first quadrants r^1 to r^4 are all separated from each other , together forming an upright ordering rectangle of *ca* 3:4. From r^5 onwards the originating points fall on the lines of the first four quadrants.
Ion-45. Temple, Miletos- Yeniköy	B with arc shift	The volute geometry was established by Koenigs (1979, Beil.2). It is similar to Ion-15 , but there is an attempt to shift the originating points of $r^{5\text{-}7}$ closer to the capital centre.
Ion-28a. Archaic Didymeion	B with arc shift and rotation	Whilst the originating point of the capital is placed within a proportional system, Gruben (1963, Note 70) says the volute contains no mathematical/circle ordering. [Check his Fig.16 again]. The author has found that for the construction of the volute an additional arc was drawn (with a radius of r^1 + 1/9 of arc one, the addition then being 11% of the length of the radius of the additional arc) against the vertical boundary of arc one in the capital inside on the spandrel palmette/canalis space. This ensemble of two combined arcs was turned by 26,565° <u>away</u> from the capital axis by means of constructing a triangle of 1 : 2 against the outside face of the additional arc [Tan 26,565° = 1÷2 = 0,5; It is clear this was a geometrical construction resulting in a specific angle]. Here after method B is employed in so far that the r^1 is reduced by 11% to gain the r^2, and r^3 thereafter follows the set pattern to form a rectangle (almost a square) around the volute origin. Some of the originating points of the following arcs are shifted towards the centre as for Ion-45.
Ion-58a Heraion IV, Samos	Bwith rectangle with arc shift and volute increase	The enlargement of the first turn of the volute is gained by increasing the horizontal edge of arc one by 1/6 past the originating point of the arc, from which point a bigger arc is drawn towards the top of the capital, and a tangent is drawn on that arc upwards to the bearing level, so creating the capital bearing offset. Both a section of the arc and the tangent become the new outline of the volute. The rest of the spiral ordering follows method B, with r^2 being 1/10 less than r^1, r^3 1/6 less than r^2, r^4 1/7 less than r^3, r^5 1/6 less than r^4, and so on. Some of the originating points of the arcs are also shifted closer to the volute origin. The originating points are plotted on the rectangular grid formed by all the radii . The points follow a rotationary movement from outside to inside the grid, almost describing a diagonal cross. It is believed that an early version of ordering method D may be seen at work here. Furthermore, Gruben (1965, p.87) relates that the relative position of the volute origin [here given for the left volute in anti clockwise order from the top] is 10/8, 9/8, 8/8 and 6/8. Because the rest of the capital also follows the module of portions of eighths, it might be possible that, during the volute design, a fixed point is found for the volute origin within the given block proportion apportioned to the volute. If the reduction in the radii of only the first two arcs is decided upon beforehand, it is quite easy to space the first three originating points around the chosen volute origin.
Ion-64 Votive, Sangri, Naxos	B with arc shift	The arcs are constructed in order to emphasise the horisontality of the volute.
Ion-74. *Enneakrounos* in Athens	B with arc sepa-ration	The first four arcs are separated from each other, more so in the vertical direction, resulting in a very long volute with oval eye.
Ion-43. Miletos [Milet city area]	C	Volute construction was identified by Koenigs (1979, Beil.4). There is addition of various circle segments of differing sizes, both greater and less than 90°, in the construction of the volute, definitely indicating that the block outline dimensions of the volute element were <u>predetermined</u>.
Ion-10 capital Katapoliani,Paros	C	No comment.
Ion-32 Delos	C	<u>The random placing of the arc points is shown on the drawing by Gruben (1997, Fig.49). The existing volute of the corner capital was used, not the reconstructed hypothetical standard capital.</u>
Ion-78 Milet	C	No comment.
Ion-25 Naxian stoa on Delos	B+C	Methods B and C with the first arc rotated downwards by 18,4° (tan 18,4° = 0,3333 = 1½a + radius of 4½a). The capital top bearing plane has been extended by adding a bigger curve with radius 1/5 larger than that of r^1, and r^2 is 1/5 less than r^1.
Ion-17 Archilochos capital, Paros	B+C	Haselberger (1986, p.213) indicates that it has a free formed volute, but the author finds a mix of methods B and C using his excellent drawing. The first and fourth and seventh arcs are quarter circles [The use of the first arc as quarter circle is as is the norm in method B], with arcs two and three as well as five and six having angles less than 45°, and arcs two and six springing from the sides of the quarter arcs. This capital also clearly shows the predetermined nature of the volute block outline, showing that in this phase the main elements were first fixed within an overall proportion system (here <u>a module 18,44 dactyl large) after which the volutes were constructed.</u>
Ion-50a. Artemis Temple, Neapolis	D	Bakalakis (1936, Fig.13) identified the construction method. It shows how the origin of this method derives from method B in that the position of the volute origin is also <u>geometrically</u> constructed. It differs in that r^2 is r^1 reduced by an amount, after which r^3 and r^4 are reduced by the <u>same</u> amount, thus forming a square (Position at rest). The square is divided into a raster of 6x6, with the points on the diagonals in clockwise rotation inwards becoming the points of origin for $r^{5\text{-}n}$. The back side differs from the front in that it has a spiral without eye, whilst the method of ordering remains the same <u>(See Bakalakis (1936, Fig.13β)).</u>
Ion-23. Votive, Thasos	B+D	The ordering device is a vertical rectangle and a square described within the volute eye, and with the arc originating points occuring on the corners of the 1:5 rectangle and square, as well as inside the square, following an orderly, rotational motion around the forms (Radii r^2 and r^3 were formed by reductions of 1/8 and 1/6 of the preceding radii). This hybrid pattern is definitely a precursor of the <u>later method D, and can be seen as a first tentative step towards it.</u>
Capitals of which the form and detail are not re-liable. Further research in terms of documentation is suggested, and suggested geo-metries are to be verified.	Varies	The volute constructions of the following capital;s cannot be ascertained correctly, but are deemed to fall within the following categories (These capitals are identified for redocumentation of volutes): Method B: Capital Ion-9, Votive, Naxos [It seems as if the vertically long rectangle within which the arc points are ordered falls inside the radius line but not on the origin of r^1]; Capital Ion-30 from Athens; Capital Ion-68, Paros; Capital Ion-76, of the Ameinias column, Athens [it seems as if r^2 is *ca* 1/6 shorter than r^1, and r^3 *ca* 2/15[?] shorter than r^2]; Capital Ion-5, *Prostoön* Naxian *Oikos IIc* [It is possible that the horizontally very long capital results from a new innovation where the reduction of r^1 to r^2 1/5, and where a circle is inscribed around the originating point of r^1, with its diameter coinciding with the originating point of r^2. The horizontal median of the circle is subdivided into quarters, and vertical lines inscribed through them, forming a rectangle in the circle. The originating points of the onfollowing arcs possibly follow a grid pattern originating from the intersection of the geometries of both forms]; Ion-29 [The first two arcs are almost identical]. Method C: In Ion-54, of the Megaron at Larisa-o-t-Hermos, this method seems too have been used even though the capital has a volute eye; Capital Ion-69. Method D: Capital Ion-12 [a few of the arcs on the badly damaged volute clearly seem to originate on the 45° lines diagonally crossing the centre of the circle, with the centre point of this eye seemingly situated on the line where the column top and capital bearing meet].



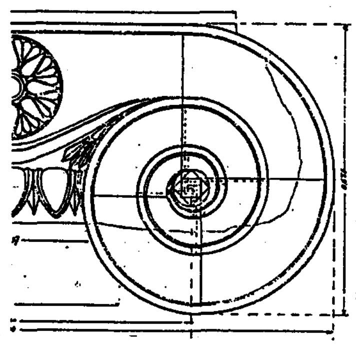
Ion-43 (Koenigs, 1979, Beil.4)



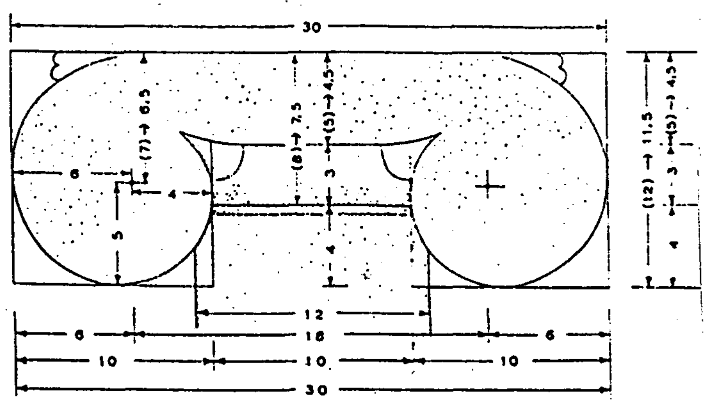
Ion-45 (Koenigs, 1979,Beil.2)



Ion-32 (Gruben, 1997, Fig.49 [portion])

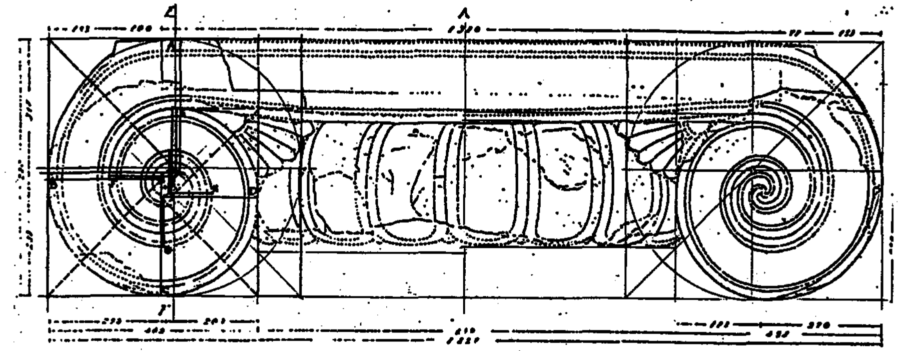


Ion-50 (Bakalakis, 1936, Fig.13)

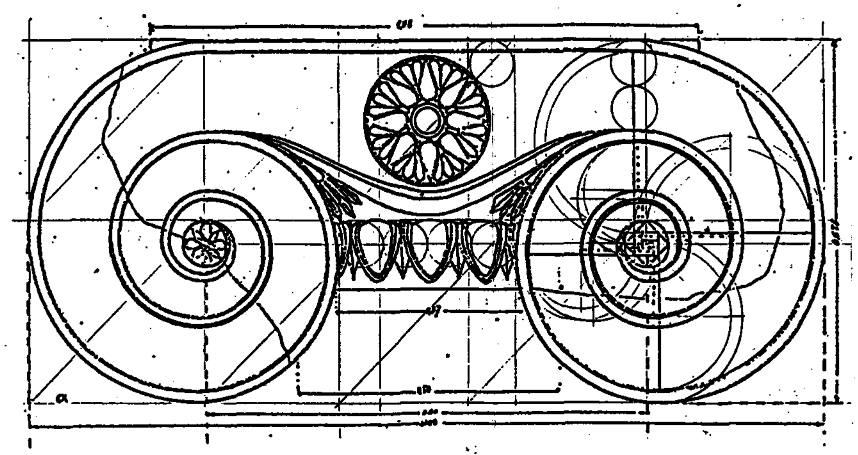


Ion-28a (Gruben, 1963, Fig.21 [top left])

Figure 3.3a Volute construction diagrams of Archaic Ionic capitals by various authors (Also refer to Table 3.8).



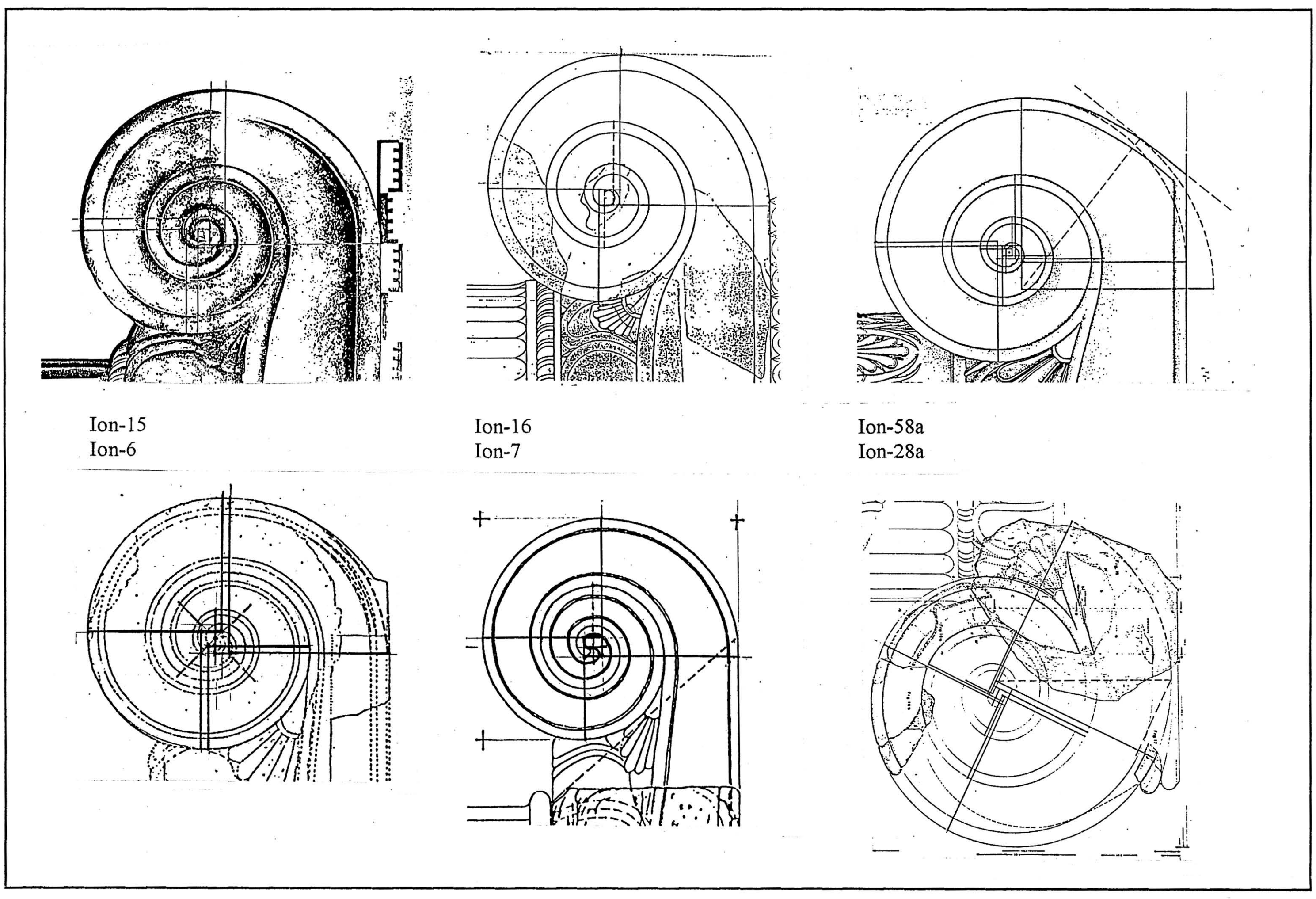
Ion-6 (Using Amandry, 1953, Plate 11)

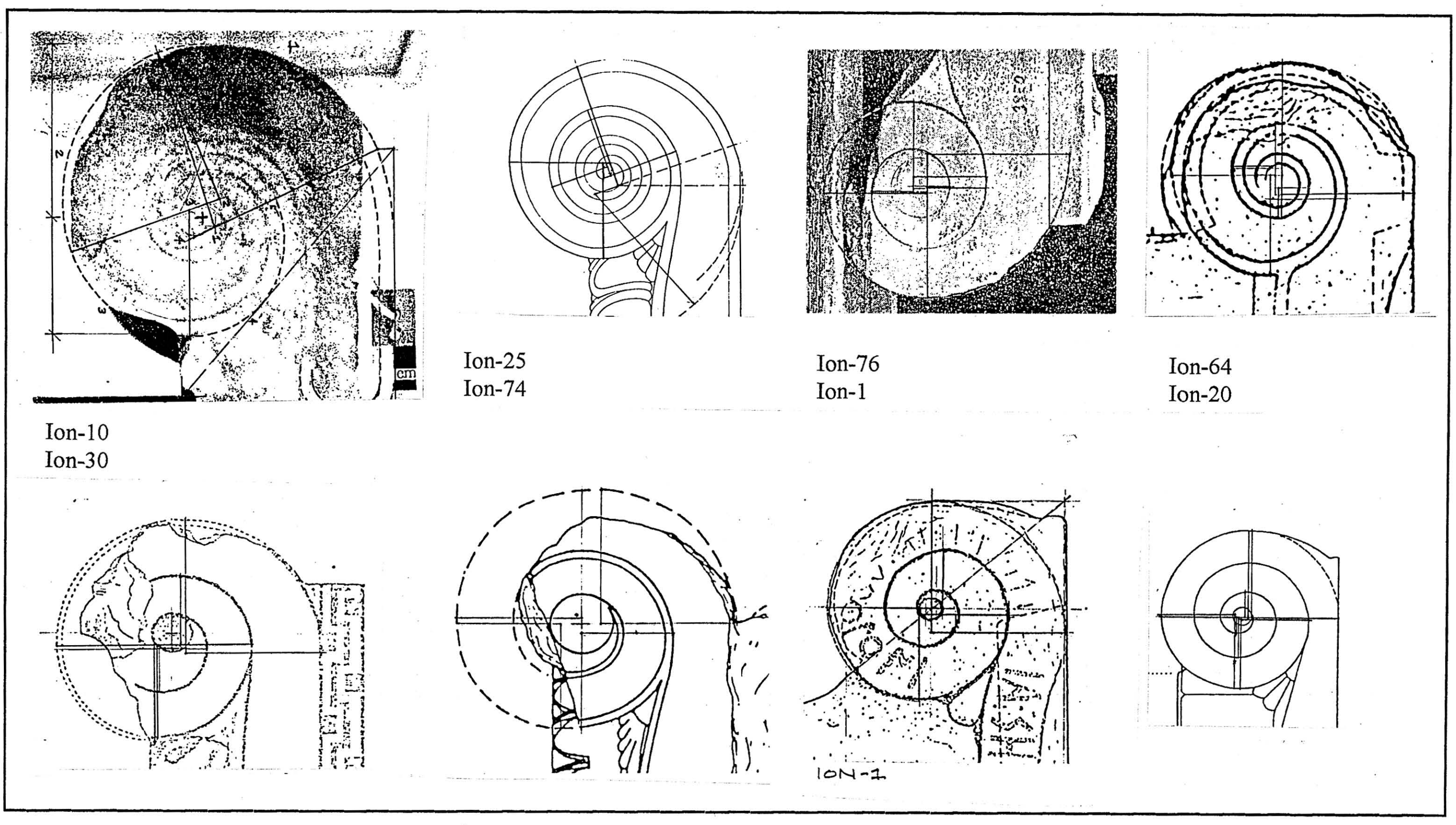


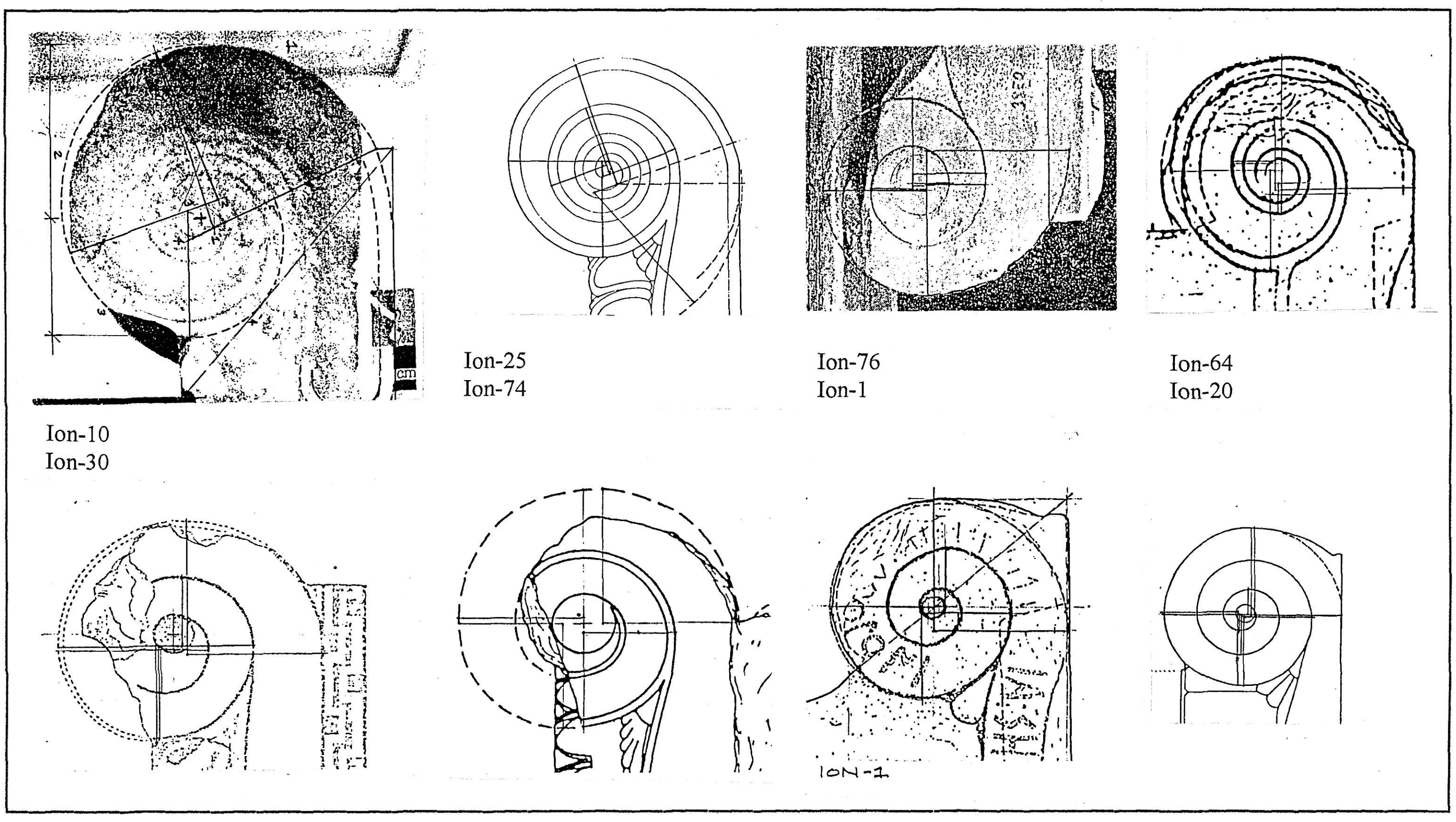
Ion-50 (Using Bakalakis, 1936, Fig.13)

Figure 3.3b Explorative fascade analysis of capital Ion-6 and Ion-50 using Büsing's (1987) method.

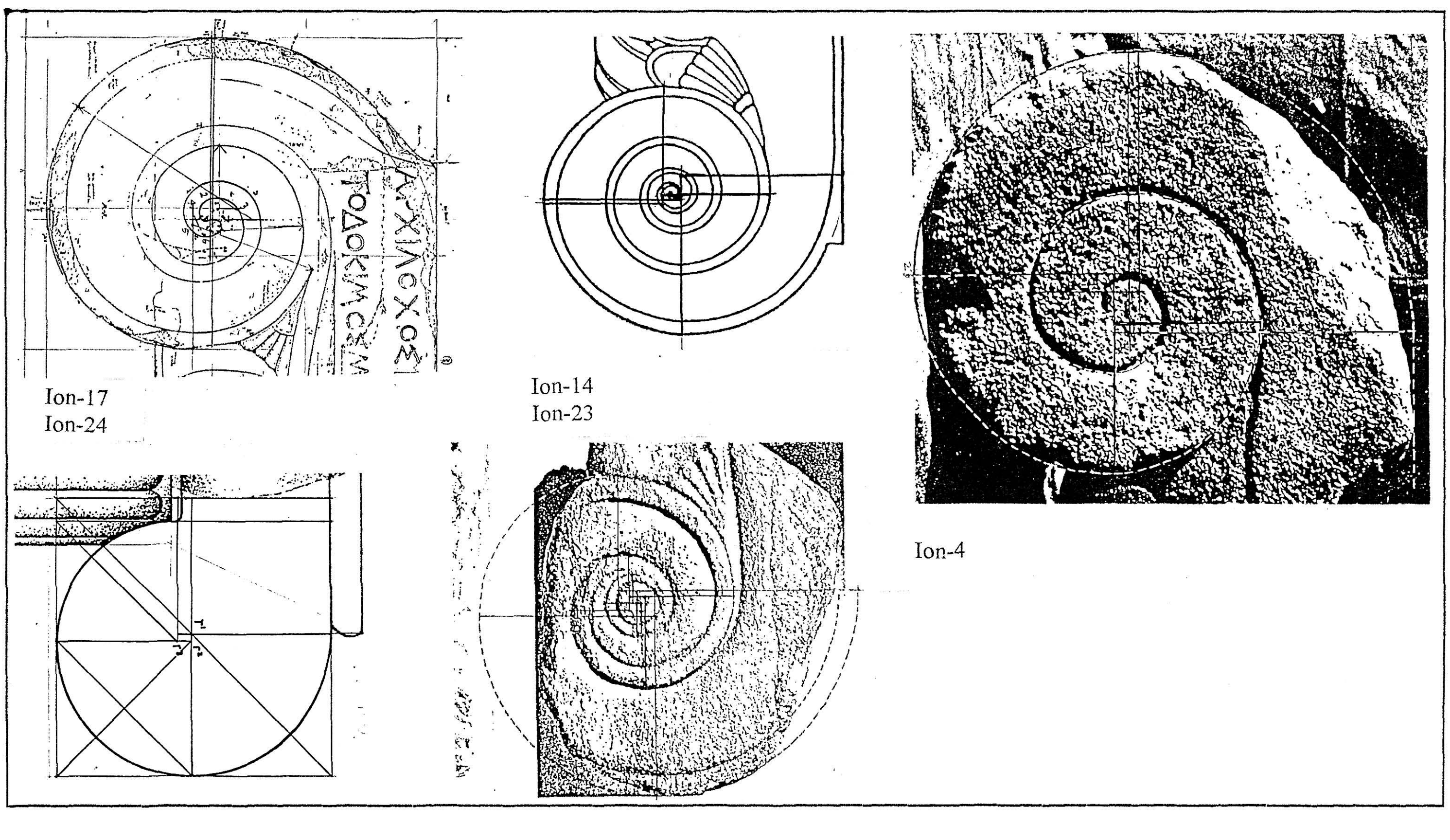
Figure 3.3c Explorative diagrams of volute ordering methods of selected Archaic Ionic capitals (Refer to Table 3.8).







Ion-10
Ion-30
Ion-25
Ion-74
Ion-76
Ion-1
Ion-64
Ion-20
ION-1



To conclude, the first generation examples, together with some others (Seen as representative of Archaic examples) show that volute construction was an area of intense concern for the designers of the Ionic capitals from the very beginning. The very first stone example of the Ionic volute shows a degree of ordering through metrication together with the use of simple geometric forms mainly arrived at through the use of the compass. This conclusion vindicates knowledge and use of the cutting compass in Early Archaic sculpture, corresponding with the later Vitruvian ideal of architectural reliance on the ruler and compass, as mentioned in Constantinidès (1973, p.137).

It has been shown that the design evolution was not linear, that cross lending of method occurred, that any canon was subject to adjustment due to refinement on the work itself, and that a greater amount of standardisation occurs in the later Archaic examples. The designers's concern with the volute was sustained throughout the Archaic period in terms of the continued employment and refinement of the four distinct volute ordering methods, with method A being a very shortlived archaism, and with methods B and D eventually being canonised in their refined form in the Classical to Hellenistic era in the manner suggested by Büsing, ie standard capitals with system-volutes.

3.3.4.2.4 Desing co-ordination between volute centre and echinus bottom bearing and -side

Analysis of this aspect should be included in the re-evaluation of volute geometries and capital planning grids, but the author has, through analysis of the relationships of the capital dimensions pertaining to the position of the eye or (a supposed) originating point of the spiral, in vertical relation to the bottom of the echinus (Item N in quantitative descriptions) and in horizontal relation to the side of the echinus bearing surface (our item P in quantitative descriptions). In reality the volute centre cannot be related to the column top and side because the tops of columns are not readily available for analysis. For volute centres of capitals using volute ordering method B, the centre of the ordering device was used. Without going into detail, the analises show that in the design of many capitals there seems to be a premeditated relationship pertaining to the both values (A few examples where the credibility of dimensions may permit a conclusion would be capitals Ion-23, -28, and -58. That of Ion-12 does not permit such a conclusion, and is identified for further scrutiny. Nevertheless, just a visual inspection shows clearly that the Halkipinar capital's eye is on the line defined by the capital bottom/column top. There may be many more, but due to the fact that not all the base dimensions of capitals are known, this relationship cannot be deciphered. It is still possible to state, however, that co-ordination of this kind does not seem to have been a groundswell trend in the Archaic period. The work by Büsing (1987, Fig.27) does however show the co-ordination of volute eye and capital bottom for the later Didymeion. It is identified that further work in this area would be fruitful for both Archaic and Classical/Hellenistic capitals.

3.3.4.3 The role of standard dimensions as base dimensions in the design of form

Standard units of measure like the foot (πούς) and dactyl (δάχτυλος) are mentioned in Greek building inscriptions (See Bankel (1983, p.67, 94); Koenigs (1990, p.124)), and were used as base dimensions for modular setting out of the main parts and in proportioning the Orders in Hellenic buildings. Whilst there is direct reference to Fifth Century Classical works, our most well known reference claiming such application in the Sixth Century remains Vitruvius, who ultimately refers to sources referring to the works of Theodoros and Chersiphon and Metagenes (See Wesenberg (1996); Philipp (1968)).

Much research has been done regarding the use of base dimensions based on standard units of measure in Archaic Ionic temple design. Lately Bankel (1983, p.95-9) tests existing interpretation, and Koenigs (1990, p.126) indicates the range of those variations of which certainty exists.

Table 3.9 Existing research indicating standard units of measure, variations and their use as base dimensions in Archaic Ionic buildings.

Base dimension	Unit of measure	Ionic building examples	Author
347-9 293-5 325-8	Certain variations in Ionic foot standard Certain variations in Attic foot standard Certain variations in Doric-Pheidonic foot standard	- - -	Koenigs, 1990, p.126 ditto ditto
293,66-296,4 326,74	Ionic foot standard in Attic buildings Erechteion foot base dimension now seen as Doric foot standard	Nike, Parthenon Erechteion	Bankel, 1983, p.94 Bankel, 1983, p.93
326-8 327 [esp Attic] 328 [esp Attic] 328	Doric-Pheidonian foot standard Doric-Pheidonian foot standard Doric-Pheidonian foot standard Doric-Pheidonic foot standard	- - - Temple 'A', Histria	Mertens, 1979, p.114 Gruben, 1972, p.325 Drerup, 1937, p.234 Theodorescu, 1980 [LCIG]
346	East Ionian foot standard	-	Gruben, 1972, p.324, note 11
349-50 349,5 349 349 350	Samian foot standard Samian foot standard Samian foot standard Samian foot standard Samian foot standard	- First Dipteral Haraion and IV - Didymeion II Temple, Miletos	Gruben, 1972, p.321 Mertens, 1979, p.114 Gruben, 1963, p.127 Koenigs, 1979, p.198
Ca 330	Delian foot standard	Naxian stoa, Delos	Hellman & Fraisse, 1979, p.111
294-5 296 294,8	Solonic-Attic foot standard Solonic-Attic foot standard Solonic-Attic foot standard	- [Statuary] Apollo Temple, Palati	Gruben, 1972, p.321, 324 Guralnick, 1996, p.520 Gruben, 1972, p.323
291,4 295,5 293-4 293 293,5 294	Cycladic variations of Solonic-Attic foot Cycladic variations of Solonic-Attic foot Attic-Cycladic foot standard Cycladic variations of Solonic-Attic foot Cycladic variation of Solonic-Attic foot Cycladic variation of Solonic-Attic foot	Dionysos temple, Iria, Naxos Temple 'A', Paros - Temple 'D', Metapontum Building 'B', Paros Building 'C', Paros	Gruben et al, 1987, p.595-7 Gruben, 1972, p.323 Mertens, 1979, p.114 Mertens, 1979, p.114-5 Gruben, 1972, p.323 Gruben, 1972, p.323
523-525	Ell of 1,5 x 349 [Samian ft]		Gruben, 1972, p.321

The base dimensions of many variant examples may be regional variants of the standard units of measure, or may merely be singularly used base dimensions. (Koenigs (1990, p.128) indicates remaining uncertainty surrounding the discernment of these). From examples pertinent to this thesis, shown in Table 3.8 above, it is clear that there are many attempts in current archaeological research to come to grips with the eccentricities of local variations on the mainly employed units of measure. The earlier attempts by Dörpfeld, Riemann and Dinsmoor are not included here (See Bankel (1983, p.65-7, Notes 1-20)). Similarly, researchers have already established many of the standard units of measure used as base dimension for the setting out and proportioning of specific Ionic capital designs. Table 3.10 below shows existing known and speculated base dimensions of relevant Archaic Ionic capitals. Whilst most of these identified base dimensions are established on sound research principles (Even that of Ion-58, where Gruben desisted from starting with a proportion system but rather followed from dimensions shown up in the column design analysis, and where the error range is kept within acceptable boundaries), further analysis of other Archaic capitals can definitely extend knowledge in this area. Drerup (1937, p.234) ascertained the prevalent use

Table 3.10 Standard dimensions used as base dimensions in Archaic Ionic capitals.

Base dimension	Unit of measure	Ionic capital	Author
87,25	[¼ of] 349 Samian ft standard	Ion-28: Reconstruction capital, Didymeion II, Didyma [known bldg base dim 349]	Gruben, 1963, p.127, 129, Fig.29
82	[¼ of] 328 Doric-Pheidonian ft standard	Ion-37: Reconstruction pronaos capital, Athenaion, Paestum	Krauss, 1959, p.43-8
whole fractions of 502	A job specific, reduced ell of 502, used in column design	Ion-58: Reconstruction capital, Heraion IV [See discussion at capital description Chpt 2]	Gruben, 1960, p.86
82,0	[¼ of] 328 Doric-Pheidonian ft standard	Ion-39: Partial reconstruction capital Temple 'A', Histria	Theodorescu, 1980 [LCIG]
dactyl = 21,87	[1/16 of] 350 Samian ft standard	Ion-45: Capital, temple (?), Miletos (Milet-Yenikoy)	Koenigs, 1979, p.198
inch of 27,5	[1/12 of] 330 Delian ft standard [qt ft 82,5]	Ion-25: Capital, Naxian Stoa, Delos [Known bldg base dim of *ca* 330]	Hellman et al, 1979
73,25	[¼ of] 293 Cycladic Solonic-Attic ft standard	Ion-46: Capital, Temple 'D', Metapontum	Mertens, 1979, p.114-5
dactyl = 18,44	[1/16 of] 295 Solonic-Attic ft standard	Ion-17: Capital, votive column, Ag, Tris Eklesies, Paros	Haselberger, 1986, p.213
dactyl = 21,87	1/16 of 350 Samian ft standard	Ion-43: Hypoth standard capital, Temple, Miletos (city area, Milet)	Koenigs, 1979, note 350

of the 328 Pheidonic foot standard as design module for most Attic Ionic capitals. Gruben (1963, p.129, Fig.21; 1960, p.86) identified the use of a module based on a foot standard in the design of the capital of the Didymeion II (A ¼ of the foot standard) and, in the case of the Heraion IV (Gruben, 1960, p.85), the use of fractions of a reduced non-standard ell of 502, as employed in the column dimensioning (Being unsuccsessful in establishing a foot standard as base dimension, he links the module used in the column to the capital design. Although theoretical, the established base dimension points the way towards possible metrication). Koenigs' (1983, p.150) latest work on the Athenaion of Priene identifies the foot standard of 294,4 (+/-10 with V:E:V = 6:10:6) as base dimension. The discovery by Gruben *et al* (1987, p.595-7) of a hitherto unknown foot standard used as modular dimension at the Dionysos temple at Iria, Naxos, is one example of local variations of standards used during the Archaic period.

Bankel (1983, p.68) illustrates the necessity of not starting a search for base dimensions in the large overall dimensions of buildings. It is especially in the smaller repetitive dimensions (like the column centres and other) that a certainty may emerge. His (1983, Fig.1) comparative table also shows how the base dimension with the greatest number of incidences may emerge from the analysis. Because we have seen that other researchers have already established that foot standards were used as base dimension for the design of Ionic capitals, as well as for the other elements of building design, it is accepted that other Ionic capitals may be made subject to such inquiry. Bankel (1983, p.67-68, 92) indicates the use of the dactyl, ½ dactyl, ½, ⅓ and ⅛ foot. The above inquiry has shown that the ¼ foot was also used, as was the $^{1}/_{12}$. The author, very much in the spirit of an exploratory metrological search, uses the guidelines by Koenigs (1990, p.129) to indicate the possible design modules of the first generation Archaic Ionic capitals (Up to 525 BC). In this process existing research by others is taken into account. As shown in the metrological *skala* by Bankel (1983, p.69), pertinent peristyle dimensions may be used to come to a discovery of a base dimension. The author uses the dimensions of the First Generation Archaic buildings in Chapter 2 to ascertain possible base dimensions of buildings, for which these have not already ascertained in existing research, which can act as guide in defining base dimensions (Due to space restrictions, arguments cannot be entertained in the text). For every capital these possible foot standard base dimensions are tested on the possible main capital dimensions, and the most responsive candidate is mentioned in Table 1.1 in Appendix 1.

Neutral metric capital dimensions were used as a starting point. Capital dimensions were subdivided by the known foot standards in a search for simple, subdivisional units, being either whole numbers or 'true' fractions like ½, ¼, ¾, ⅓, ⅜ etc. Gruben's (1960, p.86) analysis of the Heraion IV capitals, with the base dimension described in a fractional sense, and Drerup's (1954, p.5) identification of the ⅛ part of the Attic foot of **294** for the capital of the Athenaion at Priene, and with all dimensions expressed as *n*/8, show the type of clarity that comes forth. If these did not apply, further exploration proceeded, keeping in mind to find simple fractions, which will however have to be tested to other works from the regions in question, to ascertain any prediliction for their use. The author has restricted the search to the use of ¼ foot units and in some cases dactyls, and it is accepted that further work must be done with dactyl dimensions (whole and half). As in the analyses by Gruben and Drerup, the initial search by the author finds that fractions of the base dimensions were used, already indicating a strong sense of proportional refinement in the execution of the final products.

During this process one remains mindful of the type of capital element dimensions that would probably have been subjected to modularisation, depending on the logic in capital design and construction/sculpting. Further work on finding proportions follows from this, keeping in mind the type of resonation between elements inherent to, and the inner logic present in, Greek built work (These aspects are taken up below). In all this, knowledge of the the exactness of dimensions plays a governing role: Obviously only those modules gained from well preserved capitals where all dimensions may be measured physically - for pre-525 BC capitals they are rare, ie Ion-6, -11, -69, 45 - and are trustworthy. Even in the good cases one should take note of the known occurence of differences in dimensions of capital groups which are supposed to be of similar size - for instance the variations in dimensions for a group of the Athenaion at Priene (See Koenigs (1983)) and the Naxian stoa (See Hellman *et al* (1979)). In such cases base dimensions are identified as being representative of a varying sample group. Also, most artefacts have undergone wheathering, resulting in diminished dimensions, or have been manhandled, resulting in missing elements that cannot be physically measured. Gruben's, Drerup's and Koenigs's work also show that in eventually deciding on a base dimension, one must take into account the discrepancy between the conceptual dimensions applied on the unworked block and that of the the finished product. The analyst must rather try to come into tune with the underlying reasoning involved in the capital design, than to get bogged down with his/her calculator - one thinks of the difficulty in dimensioning stonework to extremely fine tolerances (See Guralnik (1996). The approach throughout the analysis has been that the pattern must stand out clearly before a design base dimension module is proposed.

Whilst the quality of many of these capitals has allowed theoretical reconstruction to a high degree of probable exactness by the archaeological fraternity, many are in such a state that their reconstructions are in actuality merely inexact representation sketches. In order to provide understanding of the level of exactness of those dimensions we are dealing with, the author employs the evaluation of the reliability of capital dimensions already discussed in Chapter 2 (Green (Dimensions accurate and measurable from the artefact), Blue (Responsible and accountable reconstruction), and Red (Too fragmentary or impossible to reconstruct to any degree of probable accuracy). From this further evaluation of the propobability of modularity was achieved. Those capitals where dimensions are within an acceptable range of accuracy (Green and Blue), and where the evaluation of modular content proves to be Good to Fair, may identified as probably having been designed with the base dimensions that are identified. As Bankel (1983, p.92) also admonishes, these should however be further confirmed through closer scrutiny of measurable dimensions on the capitals themselves. Such action could be followed by the compilation of ideal capital dimensions as based on the base dimension, the ascertaining of standard deviations from the ideal, interpreting the Z-scores and finaly evaluating the existence of the base dimension - here refer for example to Guralnick (1996, p.521) and, to an extent, Gruben (1960). In the case of the buildings where base dimensions have not been confirmed through archaeological means, but where base dimensions correlate with those provisionally identified for the other elements of the buildings, both capital and building base dimension

Table 3.11 Evaluation of the occurrence of probable base dimensions in pre-525 BC Ionic capitals.

Dimension accuracy status	Capital No.	Building/Votive column	Possible base dimension	Standard unit of measure	Probability of modularity
Blue Blue Blue	Ion-1 Ion-14 Ion-15	Votive, Demeter and Apollo Sanctuary, Sangri. Kyrene sphinx column [Theoretical reconstruction] Lower Temple, Myus [base dim [Possib base dim 295,5 or 293,75]	73,875 73,95 73,875	295,5 295,8 295,5	Good Very good Good
Blue Blue Green Blue Blue	Ion-4 Ion-22 Ion-6 Ion-7 Ion-23	[Reconstruction] Naxian votive, Delos Sphinx column, Aegina Naxian sphinx column, Delphi Dionysos temple, Iria [known base dim 291,4] [Reconstruction] Votive, Thasos	72,85 72,85 72,85 72,85 72,85	291,4	Fair to good Good [Main dims] Fair [Few defin] Good Fair
Blue	Ion-16	Artemision 'D', Ephesos [Possib base dim: Ell 523, ft 293,75]	73,4375	293,75	Good
Blue Blue	Ion-24 Ion-20	Naxian *oikos* Naxian (?) votive column, [theatre] Delos	87,5 87,5	350	Fair
Blue Blue Green	Ion-69 Ion-64 Ion-18	Votive, Paros Votive, Demeter and Apollo sanctuary, Sangri [Reconstruction] Naxian sphinx column, Artemision, Delos	87,25	349	Good Fair Good
Blue Red Red Blue Blue	Ion-10 Ion-29 Ion-32 Ion-27 Ion-48	Parian votive [Katapoliani] unidentified Ephesian building Hypoth std capital Propylon II, Delos In-antis façade Propylon II, Delos [Nieborow] Prostyle façade Propylon II, Delos [Pheia]	86,5 86,5 86,5 86,5 86,5	346	Good Poor Poor Fair Fair
Blue Red Green	Ion-74 Ion-30 Ion-11	Athenian Enneakrounos Athenian memorial column Erzats capital, Competaliast agora, Delos	82,0	328	Good Poor Fair
Blue	Ion-5	*Prostoön* of the Naxian *Oikos* [base dim 286]	71,5	-	Fair

should be confirmed by further investigation. The reader will note that many base dimensions are of the non-standard types. Further investigation is needed to identify whether such base dimensions used are regional variants of the main foot standards or singularly used modules.

The explorative analysis is deemed to have been successful in pointing the way towards further research, and it is also deemed as having been adequate to show that Ionic capitals were subject to noetic control in terms of modular design from the start, with a few exceptions where dimensions are not trustworthy or not obtainable, or in capitals of a possibly more whimsical nature. It is significant that the earliest standard capitals (Ion-4, -24, -6, -7, -10) already show the application of a design base dimension in most elements. Whilst the capitals analysed by Gruben, namely that of the Archaic Didymeion (Ion-28) and the Heraion IV (Ion-58), show its use for every element, one clearly sees that in most capitals only a few of the main dimensions were regulated by the base dimension, and that many dimensions approach or just overshoot some ideal dimension. The reasons for this could be manyfold. Also, it is clear that most capitals use ¼ foot fractions based on foot standards, but also the dactyl, in the designs to the Hellenic design sphere - the excellent work by Guralnik (1996, p.520) on the Isches *kouros* from Samos has borne out the transference of a ¼ foot (One Royal cubit = 6 palms, and one Egyptian foot equals 4 palms), and the dominance of ¼ foot modules regarding to capital design in the Ionian sphere - indicates the direct transference of the method, with obvious acknowledgement of the local variations in terms of the length of the standard foot applied. As an aside, the large number of different modular systems applied by the Naxians on buildings, votive columns and their capitals on Delos, give reason for further research regarding detail surrounding the use of foreign modular systems, apart from those mentioned in this study.

In terms of post-525 BC Archaic Ionic capitals, using the same process of exploratory evaluation, the preliminary exploration has identified the following application of base dimensions: 72,85: Ion-52, Anta capital of a temple, Thasos [Green, fair]; 72,85: Ion-53, partial reconstruction of capital of a temple, Thasos [Blue, fair]; 72,85: =Ion-38, capital of votive, Thasos [Green, fair]; 72,85: Ion-12, capital [Red, fair and worthy of theoretical reconstruction and re-evaluation]); 21,87: = Ion-43 [Blue, good]; 87,25: Ion-59 [Green, good]), 82: Ion-67, votive 135, akropolis, Athens [Red, poor]; 82: Ion-35, votive No.3853, akropolis, Athens [Red, fair and worthy of redocumentation and re-evaluation]. Other post-525 BC Archaic capitals must be subjected to the same analysis. To conclude, it is indicated that the design base dimension was used in the conceptual phase of design, with certain proportional rules being applied, but that the artists/architects did not hesitate to alter the dimensions of certain elements if they did not 'feel' right - for example Gruben (1963, Note 70) where he indicates freedom of execution, regardless of the chosen module. This freedom to change canonic proportion systems and of artistic expression within the predisposed schema, is mirrored in the glyptic arts of the time.

3.3.5 Integrating the idea with the execution - making the capitals

3.3.5.1 The total capital

From the analysis of the tectonic rules inherent to the capital form it is clear that the capital was seen as being made up of different form elements. In practice these form elements were not assembled and fixed together, but had to be drawn out of a cubic stone form. We have also shown the use of the modular planning grid. It is necessary to understand how the grid was used in the process of making capital form. The same law of frontality (Schäfer, 1974 [1919], p.316) that would apply for the grids used for statues, would apply for the capital in the setting out process on all six the faces of the blocked out stone form. With the bottom plane as starting point - where in architectural capitals there first had to be proportional co-ordination with building elements in terms of column diameter and in terms of distance between columns - the relative size of the capital length and echinus were determined relative to the volutes (and later the volute eye position), and also the capital width. The main lines were then also projected on the front, back and side elevations of the stone block. Here the bottom plan's ordering device came into play in tying the capital form to the column, and to a great extent setting the trend for what was to follow in a design. From here the detailed setting out and further proportioning of elements of the capital façades could follow. The decision of capital height gave the general proportion of the front façade, and from this decision the upper extremities of the vertical face could be projected around the block, and the excess material be removed outside the bordering lines. The importance of the volute design at this point of the execution is dealt with below. Even though they were determined, any decisions regarding volute type, spiral type, quantity of windings of the spiral, the position of the eye and the ordering technique used were not necessarily applied to the stone block initially, because the volute surface is inside the echinus's outer extremity.

The volute : echinus proportion already decided the the length of the canalis, but the next decision regarding the top to bottom capital bearing height set limits to its possible proportion, due to subsequent vertical subdivision. This height had a great effect on the appearance of the capital's overall proportion and set the trend in terms of its squatness or slendernes. The required angle of load transition also had a lot to do with these decisions. The next subdivision was the echinus height relative to canalis height. The next decision that had to be marked on the block was the required length of the top bearing surface. The bolster fascade, the width of which was initially determined from the bottom plan lay-out, had to be constructed. There were the decisions on bolster form and vertical subdivisions of the form. The width of the capital's bolster had a huge effect on the experience of the echinus disc on the front façade, and the place where the third quarter arc of the vertical volute face would meet the horisontal arc of the echinus side. Next followed the placing of elements like the volute angle palmettes and bolster palmettes, ordering the echinus parts on the bottom plane and, depending on the echinus's relationship with the volute, designing the connection between bolster and echinus where it dissappears from sight under the bolsters. Final adjustments to proportions followed. The dressing of the vertical façades of the stone to the volute surface could then proceed. By now the planning grid had dissapeared, new detail had to be drawn on the façade, and volute spirals had to be cut with the cutting compass from the constructed or marked setting out points. The execution of detail could then proceed.

From this analysis there is the realisation of the possible existence of design on a smaller, more controllable scale before the realisation of the project, followed by the enlargement of scale and detail with the help of the planning grid and easily repeatable geometrical patterns. Although no examples of rough capital blocks with planning grids and carved outlines exist, in the case of architectural capitals there is sure to have been a *paradeigma,* in order that a model or specimen that could be re-measured by calipers to ensure conformity and likeness, was present on site. The *anagrapheos,* from evidence meant to be a template (Coulton, 1977, p.55), was most probably used for difficult contours (like abacus leaf patterns - and maybe even bent templates for difficult cyma leaf outlines), devised by a master artist to be followed by lesser skilled artisans. The same has been demonstrated for the volute form.

Within this process there obviously occurred experimentation and in-process proportional adjustment, as well as insights into new, easier or more logical ways of reaching certain goals. From a chronologically based inspection of capital form the earlier forms clearly show an adherence to the outline and surface level of the basic form of the block, and over time it appears as if the planes of the block forms, which as was shown were always the starting point, disappear and the capital form is animated, with a life of its own, just like the earlier *xoanon* sculpture type was in later work freed from its stereometric form to expressive plastic form.

3.3.5.2 The volute

It is necessary to linger on the design and construction sequence involved in making the Ionic capital volute. From Büsing's (1987, p.326, Fig.20-2) work it is clear that in capitals with system-volutes, the volute extremities are mainly predetermined by the distance between the volute eyes relative to the capital size, and further regulated through the modular workings of the eye. In the making of such cases only the square which bounded the main volute lay-out was necessary as guide for chiseling down the block form of the capital face, after which the four subsquares, volute eye, and volute *radii* could be applied. However, in the face of less systemised volute construction shown above for Archaic capitals, one must explore how the more cumbersome technique of volute construction impacted on the construction process.

Because the volute face is deeper into the rough capital block than the outer edge of the echinus, it seems quite improbable that a cumbersomely constructed and detailed volute spiral outline would be dressed upon the outer skin of the blocked out surface, only to have that whole surface chiseled away in order to reach the eventual volute face surface. It is clear that it was in the best interest that the design had to very simple to apply, in order that it could easily provide a blocking out guide before the block's surface was chiselled down towards the eventual volute face surface. One could think that a rectangular form of certain proportion was used, on which a known spiral form could have been constructed at the time of reaching the volute surface in the block. It has been shown that the proportion of such a rectangle would be dependent on the chosen total modular coherence of the three-dimensional capital form, as well as the type of volute required (For example vertically long, horisontally wide and so forth). It might also not be unreasonable to think that basic guidelines regarding the reduction ratio of consecutive volute arc *radii,* required to achieve certain volute forms, could have been stock-in-trade patterns of design studios. Examples of capitals with an unfinished back façade, like that of the Monopteros II at Samos (See Ziegenaus [1957b, Beil.108.2] and Ion-59) and a possibly 'unfinished' capital like Ion-78 from Mengerevtepe, Milet (See Weber [1995, Fig.34-6] - Lately Weber [1996, p. 86] believes its smooth surface to be intentional), clearly show that no volute spiral construction had been attempted even though the volute outline had been completed. There may still have been further refinement of this idea.

The analysis above shows that once decisions regarding overall capital proportions had been defined, including decisions about the volute form, the rectangle within which the volute had to be described could easily be devised in terms of the ordering device resulting from the progression of the first four quarter circle volute arcs (Method B). The author proposes as an idea to be tested that, for multiple architectural capitals, the outline of the volute, as well as the form of the ordering device and the cardinal volute arc points, could have been made in the form of a master template with little drilled holes, in order to easily transfer the essential basis for the volute construction on the block surface. In terms of the volutes devised from circle segments of various sizes (Method C), it is obvious that the rectangle for the volute, or even the volute outline itself, followed a far more willful schema. With Method D, the centre point used for the construction of the rectangles and later diagonals used for the originating points of the volute arcs definitely needs to be positioned before construction of the total volute may proceed, and this was indeed possible, either on the block surface as shown above or through use of a template, as indicated in the analyses above.

The author has shown that a geometrical method was at the heart of Archaic volute design, which method eventually evolved into the design canon which was later to become universally applied (The mentioned use of a very simple composition of rectangular forms, systematic proportioning and a planning grid in the Vitruvian schema for the Ionic capital demonstrated by Büsing (1987), but also by Frey (1992, Fig.2, 6, 8)). Based on the techniques used in constructing an involute scroll, one might argue against the predetermination of the volute ordering rectangle in Method B. It is however a simple matter to increase or decrease the diameter of an involute scroll. In order to fit the involute scroll into a pre-determined square if the string method is used, the diameter is easily increased or decreased by manipulating the diameter of the cylinder one uses to unwind the string with cutting tool attached. If the geometric method is used (See Penrose (1902, Fig.6)) the central circle taken as originating point for inscribing the increasing quarter arcs with the cutting compass might just as easily be inreased or decreased. The above reconstruction of the volute spiral lay-out sequences further emphasises the reliance on a simple system of proportioning and the use of the planning grid, which devices were used in monumental sculpture at the time of the appearance of the first Ionic stone capital.

3.3.5.3 Lifting and placing the completed capital

Due to the intricacies of capital design and execution the capitals are deemed to have been finished on the ground before being lifted and placed in position. The lifting process must have proceeded after the final dressing of the column shaft or the final drum, due to the difficulties the volutes would present for working on the column neck and top after placement of the capitals. From research by Coulton (1977) we should assume that, up to the architectural use of hoist with compound pulley by *ca* 515 BC, major building elements like capitals were elevated through use of earth ramps, mostly due to the weight of the massive capitals which were beyond the capabilities of the simple hoist - there is proof of this for the Artemision 'D' epistyle. The intricacies involved in not damaging the bolsters and fragile volute edges, just in dragging the capital up a ramp, must have been very great, unless if it was taken up on a sled. One could argue that the echinus of the capital could simply have been moved over the column top bearing, but the smaller volute distance would have prevented this. With a monumental capital where the echinus bottom and volutes were at the same plane (Like the Aphaia sphinx column) this would present less of a problem, but at the Artemision 'D' for example (Like most other capitals), where the space between volutes was less than the column's diameter, where the echinus bottom was well above the volute bottom, and where the capital fitted on top of a cylindrical joining element projecting from the column, other methods must have been used for the final positioning. The earth bank may have been constructed slightly higher than the column top, and the capital lowered by removing sand in between the bolsters first and then under the bolsters. Alternatively the capital may have been slid from a sled, onto a sandbag on top of the column's top, after which it was let down slowly, the last section supported by levers in order that the empty bag be removed. However, capitals show no U-holes on top or holes on the sides required for this action, and none of the known uncomplete capitals have been found with handling bosses present. The most probable method would have been that of lifting the capital bottom with a fulcrum lever positioned in a hole under the capital, lifting and swinging the capital over to its final position with the bolsters resting on a raised sand section, and slowly letting it drop into position. There is some doubt in the author's mind about the ability of the *naos* wall to withstand a bending moment caused by earth being placed right up to its top level, unless if it was temporarily braced or if the opposite side was also filled in (Usual in Egypt), not a bad idea if one thinks that the inner columns also needed capitals. One may think that scaffolding could have played a part in the placing stage. If the earth bank did not completely surround the column up to the *naos* wall, in order for the column to withstand the forces applied during the shifting and placing of the capital, it would have had to be braced, and scaffolding may have been used to connect with the earth bank as well as to provide a point of leverage for swinging the capital, with the capital's bottom hole on the peg of a rotating lever on a fulcrum, temporarily higher than the support platform in order to lift and drop the capital into position through various means available. The sheer weight of the capitals however make such arguments less probable if one thinks of the stability and strength of scaffolding. However, history has shown the inventiveness employed in such instances, with the scaffolding and support structures often being more innovative than the building structure itself.

Smaller capitals were most probably hoisted with a simple winch, with two ropes passed through V-shaped holes at the top of the capital at equidistant points from the axis (Coulton, 1977, p.3), or fixed to lifting tongs positioned in the volute eye opening where they occurred (See Ion-42), or even with ropes slung under the capital at the meeting point of the volutes and echinus, leaving the capital bottom bearing plane almost free Whilst the possible damage to the fragile edge of the volutes may logically count against this idea, the lack of lifting holes for wedges and tongs in the drawings or photographs of Archaic capitals make it seem feasible (apart from fixing holes for statuary, most holes are of the type used for pouring in lead-filling for the capital-to-column connection). The whole aspect of lifting and placing is here identified as topic for further research on the artefacts. Ionic capitals show a relative decrease in physical size over time. Whilst previous analyses has shown this is probaly rather due to aesthetic adjustment, recognition of the advantages of using smaller blocks that may be used with compound pulleys could likewise have reflected in the general trend towards using smaller building blocks.

3.3.6 A search for synchronisity in sculpting of capital detail and sculpture technique

Shiloh (1979, Fig.9-10) shows Phoenician sculpting techniques like blocking out, dressing the capital outline and smooth dressing the surface before the capital relief was carved from the relief pattern outlines. His analysis indicates that all the elements were defined by grooves and/or beads, and that no beads projected out of the block surface, indicating that only incision was used. These methods were available to the early capital makers, and is indeed very similar to the early Naxian/Samian capitals where only incision and abrasion (with emery from the island Naxos) was used to define elements, a sculpture technique apparently endemic to the Cyclades.

The use of the claw chisel - invented from 575-50 BC; Also see Gruben (1997, Note206) - is speculated for the manufacture of a deep concave flute and canalis. However, the first really deep flutes on a bolster appear at the capitals [Ion-16] of the Artemision 'D' of just before 550 BC. The capitals (Ion28) of the Didymeion II of *ca* 540 BC had slightly deeper bolster flutes. The deep concave canalis only appears by 510 BC in capital Ion-53, an anta column capital from Thasos. Really deep examples appear after 500 BC, like capital Ion-54 from the 'Megaronbau' at Larisa. The use of the claw and flat chisel is speculated for volute mouldings with a rectangular borders, like the first instance at capital Ion-74 of 550-25 BC. Archaic Hellenic sculpture shows a predilection for surface decoration from after 550 BC. One finds the use of scales on the abacus of the Athenian memorial column capital Ion-67 of 520 BC and on the bolsters of capital Ion-31 and Ion-46 after 500 BC; Plant forms appear from 520-10 BC on Athenian examples, and on the bolsters of capitals Ion-58 of the Heraion IV which only went up after *ca* 500 BC.

The above shows that evolving sculpting technique is closely followed by evolution of new execution detail in the Ionic capital. Further research in synchronisity in capital typology and sculpture types is recommended.

3.3.7 Aspects relevant to a contextual analysis

Even though Hellenic architecture and memorial columns had their own functional and aesthetic design programmes, there is already indication that there was much cross fertilisation and even possible simultaneous experimentation. Whilst one can argue that the architecture, having had a tradition of timber brackets (decorated or not) and entablatures in the Geometric and Early Archaic periods, had its own independant development towards a stone Ionic capital through a stone voluted bracket capital and /or a (decorated or undecorated) timber- bracket-with-stone-torus capital, the chronology shows that the stone Ionic standard capital in the votive column was a major event towards achieving the standard capital form. It seems to be advisable to jointly look at votive column and building design up to the achievement of the first known architectural standard capital.

In terms of the memorial column capital, from work by Jacob-Felsch (1969), there is knowledge of the design interaction between sculpture and memorial column, in terms of aesthetic aspects like balance, proportional relationships between elements and overall proportion, both indicating that the capital must also have played an important role in this. From others like Raubitschek (1938, 1940, 1943), we understand the functional demands posed by the form of the statue and methods of fixing, which were necessary to prevent side forces from letting the statue tilt. In this sense one understands why the canalis would rather not be a loose element on the echinus, as it sometimes was - and could have been structurally sound - in the architectural timber bracket *cum* stone torus experiments, and why the male-female cylindrical, slotted joint between capital and column would have evolved. The early Aphaia capital shows this understanding in another way, because even though appearing to have been made of two pieces, the canalis was fixed to the domed echinus, itself a very stable form which was well fixed to the column. In any event, there is need for further exploration of the relationship between the capital and total column.

The architectural *scenario* is different. Even though an architectural trabeated system is relatively more static than the memorial column type, and the additive composition of column, capital and epistyle is relatively simple and results in a stable composition, there are complexities forthcoming from other sources. Apart from the noetic control in terms of proportions, modularity and tectonic rules, we may realise that the major architectural considerations of performance of materials, the relationship between material performance, element size and possible span lengths or resistance against load, were important factors that had to be brought towards an empiric understanding of what a capital should and could do in the ensemble of the Order.

Analysis of the Ionic buildings and Ionic Order will show up the intricacies of the architectural design and the capital's integration therein.

3.3.7.1 Formal aesthetics and the Ionic Order and -votive column

The founding process will be discussed in the following chapter. Here there is an inquiry into the aesthetic content of what may be termed a nascent Ionic Order with base, shaft, standard Ionic capital of various variations, epistyle, optional frieze strip, dividing elements of various kinds between last two, and a concluding cornice. In terms of the votive column, it would be similar excluding the entablature, but including the sculpture. Van den Berg's (1972, p.269-325) analysis of monumental Hellenic sculpture provides the guidelines for criteria that may be employed in terms of the nature and content of the artifacts. These are scale, form, proportion, rhythm, pattern, symmetry, connections, articulation and proportions. Only form, pattern, symmetry., articulation and connections are dealt with in the analysis of the tectonic rules of the Order below.

The Ionic Order employs a scale that is anthropometrically based, but which is of a monumental order. This is similar to the achievement of the monumental *kouros*, which elevates the work of art to a godly dimension. From study of proportions included in Hellenic minor arts and glyptic arts, the use of simple proportions within a regulating system like a planning grid is indicated (See Curtius, 1923, p.218, Fig.159-60; Schäfer, 1974 [1919], Fig.323, 327, Robertson, 1975b, Fig.13a; 17b; Boardman, 1978, p.20-1, 77, Fig.250, Lambrinoudakis, 1980, Fig.1-3, Kienast, 1985, p.381; 383; 391, Hübner, 1994, p.341; 347; Fig.20-1). This is similar in the early examples of the Ionic Order, as may be seen of an analysis of noetic content. Rhythm in the horisontal dimension of the Order is mostly repetetative, like for column spacing and fluting, but complex rhythms are set up in the vertical dimension of the hierarchical progression of the elements contained in the Order, in terms of the relationships between the elements (from the base to architrave rabbets and entablature elements). Much archaeological detail is still required to fill in the achievement of the Archaic period in this regard. Even though detailed information is included in the references in Chapter 2, the detail is not complete enough to unlock these specific relationships. More is said of the quantitative aspect under 3.3.7.3.

Syntactically speaking, what is important is that the Order is horizontally layered like the capital, with most elements - apart from the early unrabbeted epistyle and undecorated frieze - being vertically non-reversible, but horizontally so, similar to the capital. Symmetry is employed in the total composition of the Order, in terms of the existence of a vertical centreline around which all vertical elements are symmetrically placed, and around which the horizontal elements are centred, also as the capital. This frontal symmetry is very prevalent in most Archaic Hellenic artworks, from earthenware to *kouros* statues - but not in the *kore* type, and also not in the *kouros* type where a god carries an attribute, like the Apollo statue at Delos. The columns are symmetrically composed around a vertical axis running down the column centreline and which regulates the form of the capital, echinus and column flutes (and plinth if present). Other than the flutes, echinus decoration and plinth, axial symmetry is differently expressed in the capital, having two similar long front and two similar short side faces, resulting in a very strong 'frontal' impression - the equisided Ionic capital only becomes a reality much later - which is extended to the other elements and façade composition. This idea of frontality is similarly present in the sphinx statue votive column type, as well as in the *kouros/kore* types - even though there is no symmetry in terms of front and back - but not in the Doric column which is equisided. This specific nature of the Ionic capital is one of the factors which is identified as providing for much of the complexity within the Ionic Order. In terms of these aesthetic aspects, it may also be said that the Ionic Order takes up the existing themes of Hellenic artworks.

Close scrutiny of the first monumental votive columns (the Ionic Aphaia sphinx column and the Naxian sphinx column at Delphi) and the columns of the first total stone examples of Ionic architecture (the interior columns of the Naxian *Oikos,* Delos, and the columns of the Dionysos temple, Iria), shows that there is a great deal of similarity in the morphology and syntax of the constituent elements. Due to this, the author deems it unnecessary to duplicate the analysis of formal aesthetic content achieved for early Ionic architecture. For all practical purposes the columns are deemed to be homologue, with the important difference that the epistyle with its continuous horizontal bottom line is replaced by a sphinx statue base which ends at the point of descent of the volutes. From the achieved chronology, the author identifies as hypothesis that the functional demands of the long form of the base of a sitting sphinx (rather than the idea of enlarging the bearing plane of the architectural capital), as found in the Sangri column, must be seen as instigating the evolution of ways of dealing with enlarging the capital's top bearing plane without enlarging the total capital, a design aspect not yet visible in the known Late Seventh Century stone voluted architectural capitals. In a sphinx column the sphinx is shown from the side, together with the front of the capital - this may be understood as using the image of the sphinx that had evolved in the two-dimensional representations in the minor arts. In the examples of sphinx columns before total stone Ionic architecture, the length of the top bearing plane of the capital was extended in three ways, namely with rectangularly edged additions to enlarge the horizontal bearing area for the sphinx base, by bolster spandrel palmettes and by volutes which were enlarged by meeting the top bearing plane with an obtuse angle rather than on the tangential. These early examples had to deal with the problem of meeting the horizontal plane in exactly the same manner than the later capitals of the Ionic Order, but within another visual form syntax. Similar to the sphinx statues which showed their side profile, the early votive column sculptures depicting humans - *kouros/kore* types, *Nike* figures and representational depictions of citizens of the *polis* - could not be placed in such a way that they showed a frontal view due to the demands that the long capital form placed on the positioning of the feet of the sculptures (Ion-76 and Ion-36 [Alkimachos writer on chair] presented side profiles, and also Ion- 62 [Kallimachos statue] with a running *Nike* figure, interestingly with turned torso). Raubitschek (1943, p.20) states that the transverse placement of sculpture feet only happened in the Fifth Century BC - where the square abacus is commonplace - but the author's analysis has shown that capital Ion-12 from Smyrna could have had a frontally directioned statue, possibly the first example of a non-architectural capital to have a square top bearing plane.

The homologue form relationship shown to have existed between early memorial column and columns of the Ionic Order, is taken as being an indication of the existence of a shared heritage and continuous conceptual 'fit' between Ionic architecture and votive column aesthetics. The validity of this statement will be further looked at in terms of tectonic rules below. Nevertheless, the analysis of detail on capitals shows that there was more chance for individual expression in the 'once of' votive column designs than in architecture, where design considerations encompassed a far greater problematic. This problematic will be explored in the a following section.

3.3.7.2 Abstract tectonic rules of the Archaic Ionic façade and votive column

Gruben gives a very apt description of the dualistic tectonic nature of the Ionic Order as he finds it in the Archaic Didymeion. He points at a tendency in Ionic architecture where the static framework of a building may be decorated with plastic forms - for example the sphinxes and lions on, as he believed, the architrave corners, now known to also be on the frieze section - and where stereometric elements like the epistyle, column, wall, cornice and raking sima are transformed into organic liveliness through the medium of vegetative ornament (leaf moldings, volutes and palmettes), plastic friezes, swelling, richly profiled bases and powerful capitals - to him unrelated to structural performance in terms of form - in direct contrast to the rationality of the extreme metrication and schematism of the building plans, which to him indicate "einer letztlich unlösbaren und .....unbewältigten Antinomie." (1963, p.176). It is deemed useful to inquire into the formal tectonic rules of the early Ionic architectural façade (Following Howe's [IDO, p.93-113] useful analysis of the tectonic rules underlying the Doric Order, as followed from conclusions of his similar work on MG II pottery and Early Archaic *kouroi*). From this, the role which the Ionic capitals had to perform in a wider architectural context may be more clearly defined, after which a statement will be made regarding the artistic counterparts in votive columns (See Table 3.12 below).

Firstly the analysis of the tectonic rules included in the Archaic Ionic façade show an amazing correspondence with those rules formulated for the Doric Order by Howe. This indicates that on the whole the Doric and Ionic architects worked from the same tectonic framework and shared a similar abstract vision of how to express a physical reality in the abstract terms of architectural morphology and syntax. The analysis indicates that Ionic architecture (In terms of façade), far from being undisciplined or 'decadent', showed the same rigorous adherence to predetermined rules, and tried to resolve the same tectonic issues. In this attempt, the Ionic capital as single element in the façade (see the analysis of tectonic rules), follows the same rules showed to be inherent to the Ionic façade and very strongly so, even if the form did allow for much experimentation. Secondly, the main differences between the Doric and Ionic façade ensembles come about in the allowance of decoration on 'functional' elements rather than only in 'non-functional voids', in the allowance of subdivision of elements - rarely applied on the corner capital inside volutes - and most importantly in the allowance of a wide range of proportional latitude for specific forms.

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Table 3.12 Synopsis of the tectonic rules present in the Archaic Ionic façade.

Morphology nature allowability proportion	* Every element of the Archaic façade elevation consists of compact, convex elements (horizontal capital element, tapering shaft, krepis) and discrete connecting elements between them (moldings, echinus, abacus, spira and torus base elements). Known concave elements like the conical echinus and the outward flaring leaf-cyma column base appear very sporadically. * Each structural element is an individual visual element * Different forms in elements indicate differing character properties * The elements are horizontally reversable due to their symmetry but vertically irreversible due to differences of top and bottom. * Open spaces are seen as voids (space between entablature moldings, tympanum, capital bolster). However, some of the structural elements like the architrave corners, the column bottom and top ends, as well as the capital canalis and volute origin are also used for decoration. * Variation is allowed in functionaly identical elements and in voids * Elements are sometimes subdivided (corner capital volute inner corners; canalis middle section) or superimposed (in one instance a double cyma) * There is wide variety in proportion of specific elements
Syntax position connection ordering	* Each element type only occurs within its own horizontal band * Only molding elements are repeated in various positions within the façade * Horizontal connections between elements are emphasised * Curved forms do not only occur at connections, but they do occur there and indicate elasticity * Elements become progressive lighter from the bottom up * The vertically layered ordering accentuates any vertical axial ordering * The vertical irreversibility of elements emphasises the direction of vertical axial ordering. * The elements are co-ordinated in the vertical which creates the illusion of supporting lines * An hierarchical ordering of connections exists, of which the connection between column and architrave [ie capital] is the most important through the strong downward curve of the volute. In the large scale of the total ensemble of the Ionic façade the cyma acts as connecting element between canalis and column shaft, and the abacus [where it occurs] acts as connecting element between capital and architrave/sculpture base. In the case of the capitals with obtuse angles and without abaci, the connection is emphasised through extreme contrast of angle. * The connection between column and crepidoma shows an evolution over time, ie from strong conical base elements for early columns in which contrasting angles play the major part, towards strong accentuation through use of multiple convex elements divided by concave elements. Here there is another evolution towards an interplay between the concave and convex elements which culminates in the Attic base form. * A hierarchical ordering of the horizontal bands exist, and their proportions do not remain constant
The formal tectonic rules formulated also show an attempt, as is the case with the Geometric pottery and Archaic *kouroi*, at creating a visual fiction which represents the architects understanding of the physical, in this case architectural, reality, and as in the Doric Order through the use of the morphology and syntax of the colonnade. However, there is much more experimentation in terms of possible form elements, the overall content of every individual building's 'Order', as well as in terms of the the positioning of decoration. The process of attaining the final canonic form of the Ionic Order took place over a period of over 100 years, and even in the Classical era much experimentation is evident.	

The evolution of Doric capital form, which shows a wide latitude in terms of proportions, and similarly the column slenderness ratio, happened in a very short span of time. Due to this, the Doric Order is perceived as more static in this regard. In the Ionic architecture, the evolution towards canonic form evolved from the Seventh Century right into the Classical period, leaving the impression of freedom and uncanonic design. It is clear that the base and capital of the Ionic column are more complex than any form included in the Doric Order, and allowed for far greater experimentation and manipulation. Far from being unprincipled, the analysis of the First Generation Archaic Ionic façades shows a steady increase in noetic control, lots of experimentation with horizontal and vertical proportions, but also, at least in terms of the base and capital element, the achievement of interim, regionally bound canonic form and proportion. Due to the fact that the Ionic column and capital were similarly used as memorial column element, even more experimentation occurred outside the strictures of the demands posed by systematic building.

The allowance of decoration on 'functional' elements definitely lead to less abstract form than that of the Doric. Nevertheless, this decoration was always controlled and bounded within the outline of permissable areas, definitely decoration rather than ornamentation. In terms of the subdivision of elements, this happened so seldom, like at the inner volutes of the corner capital, that it is almost of no importance. Finally, a major difference between the Doric and Ionic is that whereas the Doric became more rigid and contained within stark, pure geometric form outlines over time, the Ionic started of like that, and evolved into ever more independent forms that defied the three-dimensional stone forms from which they originated. Rather than this being seen as a flight from rational order and control, the study has shown the simultaneous increase in noetic control of form, echoing the Doric evolution but in a radically different way.

This vision of the Ionic Order shows the simultaneous existence of freedom and control within one overarching idea, but rather than an being an irreconcilable antinomy as interpreted by Gruben above, there exists a dialectic that is indicative of interrelatedness and mutual supportiveness rather than exclusiveness and discord, a complex but coherent dialogue between two poles rather than mere opposing co-exisisting elements. It is deemed of importance that the Ionic capital is a very important and active element in this total dialectic, rather than merely a non-structural, decorative element. This interpretation of the Ionic façade is in contrast to the prevailing descriptions, and may serve to place Ionic architecture next to the Doric in terms of the achievement of a coherent tectonic vision.

3.3.7.3 A synoptic view of architectural standardisation of dimensions and systemised planning

Because the use of standardised dimensions is well covered in the analysis of the capital, a more cursory mention suffices here. The common ordering device for the long hall type Geometric temple was the 100 foot length (Similar to Syria and Cyprus). In suddenly dealing with a large scale stone architecture the Ionic architects also had enough access to architectures where the problems of co-ordination of walls and colonnades had been adequately dealt with. Nevertheless, the first examples of Doric architecture were not flawless, with irregularities in dimensioning occurring in the entablature, in column spacing and in the crepidoma form (The Heraion of Olympia is the commonly put example). Coulton (1977, p.64) indicates that the strictures of Doric entablature design was a new dimension that had to be grappled with, in other words three-dimensional co-ordination, because it did not exist in such complexity in foreign architectures. This aspect of three-dimensional co-ordination is dealt with later in terms of the Ionic Order. Coulton (1977, p.71) also says that there is little evidence of Ionic design method before the Hellenistic period, apart from close co-ordination between column axes and *naos* wall axes. The validity of this statement is taken in hand below, and replied to.

From the interpretation of information related in the description of buildings in Chapter 2, there is an indication of the prevalent use of the (regionally bound) foot standard, fractions of the foot standard (¼ foot or palm, ⅓'s and ⅙'ths of feet) and ell modules for many of the elements of the Order, but they are not always applied consistently for all elements of the different examples. (Due to the limitations placed on this study the detail analysis of dimensions cannot be displayed). Where the stylobate, walls, column base, column shaft, column top and bottom diameters, capital height and architrave height are most often described in terms of base dimensions or modules based on foot standards, the total column height is most often rather expressed as multiples of the column diameter, but also sometimes in foot and ell modules. The column interaxis is often expressed in ell modules, and sometimes the column base height and width - but at the Artemision 'D' the plinth width which becomes the regulating module in horizontal and vertical dimensioning (despite Gruben's (1996, p.76) and Wesenberg's (1983a, p.44 flw) difference in interpretation of what constitutes the column 'base' in this specific case). Wesenberg (1983a, p.103-4, 179) has recently indicated the bottom of the column [*UD*] rather than the shaft diameter just above the apophyge [*ud*] and total Order height [*SH+GH*] as determinant of much of the façade relationships (See also Gruben (1963, p.158) re the round 50ft figure for the Didymeion's Order height). Unfortunately the entablature dimensions are lacking for most Archaic buildings in this study, making further such calculations impossible. Regarding the column diameter, one notes Gruben's (1996, p.74, 76) acceptance of *vestigia* meaning bottom bearing - in the case of the Artemision, being the spira rather than the column bottom - together with his plea for the use of measured dimensions rather than Roman text. Koenigs (1985, p.448) clearly indicates the sequence of setting out the column from the shaft diameter above the apophyge (*ud*) towards the bottom extremitiy of the apophyge [*UD*], as shown by Haselberger's (1983) work on the technical design drawings found at Didyma. In this study the shaft dimension is still used.

If the particulars of this inquiry are then brought in relation with the similar inquiry regarding the Archaic Ionic capital above (Taking into account that a detailed inquiry not part of this particular study), it may be generally said that there was in use a system of three-dimensional, modular dimensioning which used the ell - mostly - for the stylobate, base and interaxial dimensions, and for the vertical dimensions of the Order the column diameter was (Most often) used to determine total column height. Within this broad framework, all the remaining dimensions were expressed in feet and ¼ feet (sometimes also the dactyl), the base dimensions more often than not being standardised foot dimensions. Through this system the capital was integrated in the dimensional system of the Order and the plan, seemingly most importantly through the workings of the column diameter at the top (due to the lack of extant members in analyses often only to be deduced from the capital bottom). There is no space for detailed inquiry into the history of these standardised dimensions, but the use of standardised foot dimensions as base dimensions before the emergence of both Ionic and Doric Orders may be indicated by the early Archaic use of the foot and quarter foot (a palm) module in Archaic monumental statuary, especially for the *kouros*, which was similar to that of the Egyptian manner of application and subdivision of the reformed Seventh Century four palm foot standard (see Guralnick (1996, p.516-20)). In Hellenic architecture we find the additional use of ell standards, directly relatable to the use of the 525 Royal cubit in Egyptian architecture and a similar dimension used in north Syrian architecture (ie the long Royal cubit of 520 as in Ugarit, shown by Wright (1985, p.118)). Archaic stone Ionic architecture follows firmly in the achievements of the pioneer generation before its founding, and ultimately on preceding foreign architectures, but it makes its own mark. Within the Archaic Ionic architecture of the First Generation, dimensional standardisation and modularity takes on a specific character demanded by the rapid evolution of the Order and regional idiosyncrasies.

From analysis of the building plans of Ionic buildings from 600-525 BC it is clear that there was noetic control of the Ionic plan form from the start, especially in terms of the use of standardised base dimensions as modules, and also in terms of co-ordination between elements, and that this control intensified in general, but dramatically in certain buildings, especially at the Artemision 'D' at Ephesos, the Lower Temple at Myus and the dipteral Archaic Didymeion at Didyma. In Delos, as in the first examples of Doric architecture - like the Heraion at Olympia with its irregular spacing of columns and the skew *crepidoma* - there seems to have been very little concern with modular co-ordination of the elements on plan. In Naxos, and soon after also at Ephesos and Myus, the jump is far and clear. In the Archaic Didymeion the supposed achievement of clear modular co-ordination is not certain yet. Despite the huge advances regarding our knowledge of the plan of the First Dipteral Heraion from the work of Kienast, with only uncertainty around some of the intercolumnation dimensions remaining, there is certainty that the early modular regularity of modularity apportioned to this building by Buschor (1930) is under review. At the Samian Heraion IV and its Monopteros there isn't the clear and concise modular design as exists in the eastern Ionian examples.

When the Ionic Order reached Athens, there was no clear vision of the use of modular design in this Order there - in contrast to the highly sophisticated capital design. Analysis of plans (not shown) demonstrates the evolution of and the increase in use of the planning grid, square in some instances. In this regard the above statement by Coulton is valid. One may see that the temple plan came about by the use of plan conventions rather than from detailed drawings of the whole. Importantly, the modular ordering of the *naos* portion of the temples become more readable, showing the simple but significant proportions wich were co-ordinated with the outer column arrangements. The similarity in proportion of the main interior space of the *naos* of both Artemision 'D' and the Archaic Didymeion, namely 1:3, and the 1:1 proportion of the *pronaos* of the Archaic Didymeion - still using Gruben's (1963) plan - is notable. It seems as if there is a definite correspondence in the manner of ordering building plan forms and capital form. There was however much more. Apart from the use of significant proportions regarding relationships between column diameters and column interaxis and intercolumnation, analysis of the First Generation Ionic Order has shown that the noetic control went far beyond the simple use of a planning grid for co-ordination of columns and walls, but transcended the plan into the third dimension.

3.3.7.4 Integration of the Ionic capital in the proportional syntax of the first generation Archaic Ionic Order - A quantitative analysis

In order that the relationship between the Archaic Ionic capital and the Order in which it appears may be elucidated, the author deems as adequate for the purposes of this study the inquiry into quantitative relationships between elements of the first generation Ionic façades only. (Not included is the identification of typological developments within distinct morphological developmental stadia). Mention will be made to documented examples of Archaic Ionic buildings after 525 BC, but as mentioned before the analysis of all Archaic Ionic buildings still requires a lot of attention in the archaeological domain: A synopsis of all Archaic buildings including all relevant dimensions, along the line of Wesenberg (1983a, p.105), is a necessary tool and is identified as a future research goal. The building dimensions included in Table 1.5 in Appendix 1 is initially used for calculating the relationships.

In Gruben's (1963, p.89,127, 138, Fig.21, 38) work on the proportioning of a few elements of the Order of the Archaic dipteral Didymeion (Bld-6d) together with its capital, the interaxial and intercolumnial proportions of a few other Archaic buildings are also dealt with in terms of column diameter (which results were revised in his [1996, p.74, Fig.17-8] later work). Furthermore, the relationship between the Didymeion's capital and Order, as well as the integration of the epistyle in the ordering system of the total building, is demonstrated in his work. Due to the loss of the epistyles of most of the first generation Ionic buildings, a similar interpretation which includes epistyles cannot be performed for all Archaic examples, but inquiry into the nature and chronological tendencies of proportional relationships between the elements of the Order below the epistyle, and the capital's role therein, is still possible. The First Dipteral Heraion (Bld-1d) with a torus capital from column group 'E' (shaft length hypothetical) is added for interest due to its important role and position in the chronology - the timber bracket's role cannot be included. The Demeter Temple at Sangri (Bld-29) is excluded due to its lack of Ionic capital, but with due acknowledgement of its importance in terms of transference of Ionic design principles.

Table 3.13 Discernable proportional relationships in the façades of pre-525 BC Archaic Ionic buildings.

Building	**1d**	**12b**	**3d**	**12c**	**2d**	**21**	**6d**	**22**	**23**	**1e**	**26**	**27**	**28**
	Heraion	Oikos W	Dionysos	Oikos E	Artemision	Myus	Didymeion	Nax Stoa	Palati	Hera IV	Phanai	Enneakroin	Temple A
Y/R	0,96	72	86	88	76	83	79	73	not measrb	0,79	87	86	0,81
OSLM/R	6,51**	12,25*	1048	779	12,0**	12,00	1180	893	not measrb	10,54	1200	not measrb	9,23
Z/R	3,26 [E]	67	530	609	332	425	320	667	271	250	370	456	3,12
T/R	2,26	592	430	475	232	325	220	550	171	150	270	356	2,12
Z/OSLM	**0,5**	**0,4**	**0,5**	0,78	0,27	0,35	0,27	**0,75**	not measrb	**0,24**	-	not measrb	**0,33**
X/OSLM	0,32**	41	35	63	0,17**	20	13	60	not measrb	0,11	18	not measrb	not measrb
U/A	2,14	273	129	240	70	65	60	234	not measrb	0,55	70	204	not measrb
X/C	2,37	419	220	411	154	124	91	425	not measrb	0,88	150	349	not measrb
Z/A	N Appl	373	229	340	170	165	160	334	not measrb	1,55	170	304	not measrb
Z/C	N Appl	519	320	511	254	224	191	525	not measrb	1,88	250	449	not measrb

The proportional relationships derived from Table 1.5 in App. 1, together with the key to the symbols of building elements used, are chronologically put in Table 3.13 above as decimal values (the demands of the calculations, as well as space limitations, prohibit display of the relationships as fractions as would have been used in the founding context originally, but those fractions that are whole are easily discernable. Graphs showing all proportional trends visually are similarly precluded through space limitations). A few aspects need to be highlighted. It is very important to note that all proportions are from outer colonnades - including the new *Oikos* west prodomos reconstruction - in order that comparative deductions are possible. The exterior west façade columns of the Naxian *Oikos* show an extremely slender start for Ionic columns, emulated - in the range above 1:10 - by most of the other buildings apart from the First Dipteral Heraion (Bld-1d, included for illustrative reasons only, and out of its chronological order), and also the three profane buildings, ie the *prostôon* of the Naxian *Oikos* (Bld.12c), the Stoa of the Naxians at Delos (Bld.22 - using the dimensions of Hellmann *et al* (1979)), and the *Enneakrounos* at Athens (Bld.27) where the ratios fall far outside a pattern that seems to emerge for the temples.

Due to the realities of the *prostôon* addition of the Naxian *Oikos* the slenderness ratio [R : OSLM] is far less than the other first generation temples, and is not very suitable to use in determining trends. Therefore one may say that the Stoa of the Naxians and the *Enneakrounos* building seem to follow a similar pattern, indicating the use of a proportioning system for profane buildings quite different to that of temple buildings. The author early on realised that the inner colonnades of Archaic Ionic architecture were quite more slender than the outer ones, a fact also mentioned by Gruben (1996, p.74; 1997, p.347). The column diameter : column height ratio [R:OSLM] of 1:13,27 of the *Oikos* (Bld-12b) interior column, as opposed to the exterior of 1:12,5* (* so designated by Gruben (1997, p.348) whilst his dimensions give a result of 1:13,25), should be seen in this light, and we should not forget the known, more daring interior columns - the extreme being at Sangri, Naxos (Bld-29, not included above because of its style characteristics) - when looking at the nature of Ionic column design. The chronologically placed R:OSLM ratios in Fig.3.4 below, are discussed to illustrate the amount of experimentation in first generation buildings. Note - 'Others' refer to dimensions from Table 1.5 in App.1, and stated as relationships in Table 3.11, and 'Gruben' refers to new work in Gruben (1996, Fig.17) and (1997), as provided in App.1, Table 1.6.

The ratio starts at 1:12,5 [*13,27] and would hover between 1:10 and 1:12 for the temple buildings - except for the First Dipteral Heraion (Bld-1d) - seemingly close to a canon, and a with daring approach to column slenderness at that. However, from latest research of the Dionysos IV temple (Bld-3d), shown - but not fully published - in Gruben (1996, p.74, Fig.17), and from re-evaluation of the Artemision 'D' (Bld-2d) column height - using the spira rather than plinth as *vestigium a la* Gruben (1996, note 40) [or column below the apophyge, *a la* Wesenberg (1983a)] - as well as the other revisions of column height in Gruben (1996, Fig.17), all shown in Appendix 1, Table 1.6, our Fig.3.6 below clearly shows a more experimental curve in the ratios, and there almost being two distinct column types. These are the very slender and the rather squat, but with the whole being very 'uncanonical' (Wesenberg (1983a, p.105) reached a similar conclusion for both column diameter types [ie *UD* and *ud*]).

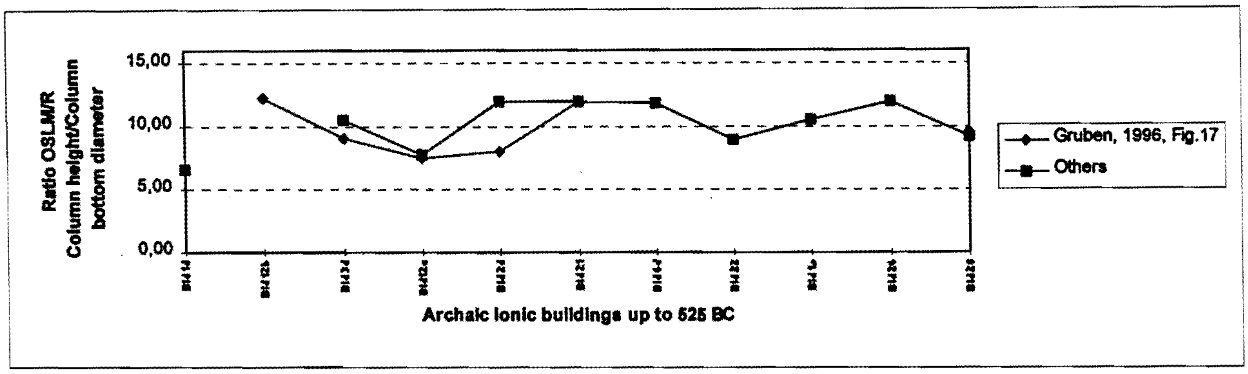

Figure 3.4 Chronological trend of column slenderness ratio of relevant Archaic Ionic buildings up to 525 BC.

If the relevant early, monumental votive columns are added to the list in Fig.3.5 below, it may be seen that

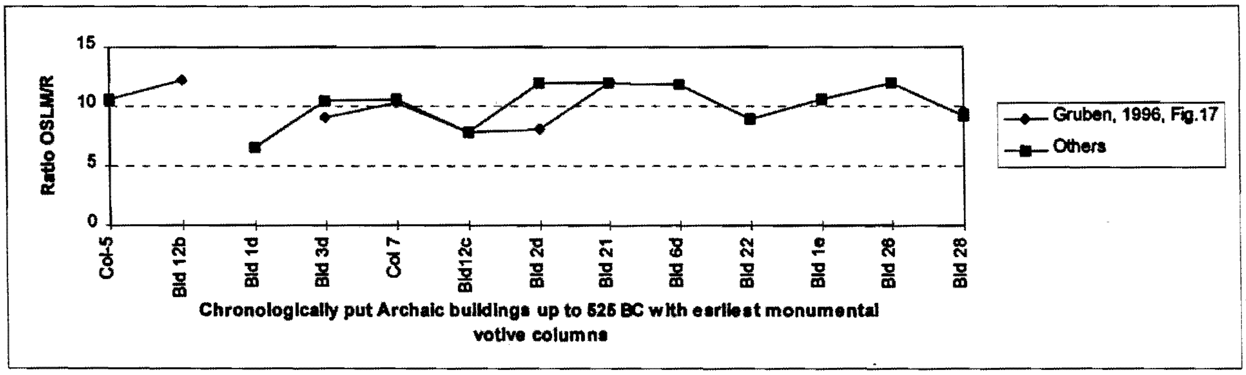

Figure 3.5 with Chronological trend of column slenderness ratio for Archaic Ionic buildings up to 525 BC together the earliest Ionic monumental votive columns.

they remain in the higher group of over 1:10, possibly indicating in the artistic *scenario* a lesser anxiety regarding bearing failure due to constructional forces, or alternatively the aspiration towards greater visual effect in the *temenos* space. The reader may peruse further trends for other ratios in Table 3.13 or App.1, Table 1.5-6. Looking at the role of the capital in the façade proportions in Table 3.13, the temple buildings show that the proportions of Capital length : Distance between capitals (A:U), Capital bearing length : Distance between capital bearing lenth (C:X), Capital length : Column interaxis (A:Z) and Capital bearing length : Column interaxis (C:Z) all show a relative decrease over time, again the profane buildings excluded. In order to shed light on the technical versus aesthetical, form-related nature of the design decisions involved in the design of the Ionic capital, one has to look at the relationship between Capital length (A) : Interaxial column spacing (Z) together with the relative capital length from ratio A : H (see Chapter 3, Table 3.1, Fig.3.1) in order to gain an integrated answer. (Even though there are still many other variables that come into play in the design of the Ionic Order, like inclusion of aspects like roof weight, architrave sizes and so forth, evaluation of these are not possible due to the lack of evidence). The author's analysis of Archaic capitals as a whole and more specifically the Archaic architectural capitals in terms of the ratio of A : Z and A : H indicate that, in Archaic Ionic architecture, the biggest factor influencing the declining ratios is the columns that come relatively closer over time (ie decreasing beam spans!) rather than the decrease in relative capital length, within a very limited range. Conversely, the approach towards the dimensioning of relative capital length is concurrent with evolution in terms of structural understanding, but with a realisation of the boundaries of propriety in terms of proportion. The interesting aspect of the evolution is that there is a definite predeliction to the demands of an aesthetic programme taken into account, showing that one cannot define an Hellenic building only in terms of structural performance. The juggling act that the Ionic capital had to perform in its architectural format comes to the fore.

When one looks at the given examples of proportional relationships in Table 3.13 above, or on Gruben's revised work (shown in Appendix 1, Table 1.6), but in terms of fractions rather than decimal values - fractions may be easily discerned - it becomes clear that many of the proportions show that they had been premeditated and were devised to fit into a wider aesthetic schema. This is particularly obvious for the proportion Column diameter : Column height (R:OSLM). In Table 3.13 the relationship Column total height : Column interaxis (OSLM:Z) there was a very high incedence of simple ratios, but in Gruben's revised work shown in Appendix1, Table 1.6 this simplicity does not appear any more. In terms of the relationships Column total height : distance between capitals (OSLM:X), Column diameter : Column interaxis (R:Z) and Column diameter : Intercolumnation (R:T) - Bankel (1983, p.92-3) again stresses the importance of the use of simple proportions here - as well as Capital bearing length : Distance between capital bearings (C:X) and Capital bearing length : Column interaxis (C:Z), there are frequent significant relationships in both versions of the work. This indicates a high degree of interrelationship between elements of the Order which includes the capital, and from the early examples of Ionic architecture. Buildings where this interrelationship seems to have been applied most are the Artemision 'D' (Bld-2d), the Lower Temple at Myus (Bld-21)and the *Enneakrounos* (Bld-27). However, the still hypothetical nature of some of the dimensions on the façades of these buildings asks that these conclusions be reviewed in future. The tentativeness of façade design (below the epistyle) on the Dionysos IV temple (Bld-3d) and the Archaic Didymeion (Bld-6d) is curious, given the rigour found in the execution of the plan and elements of the first, and in the full Order height and the plan of the latter, as found by Gruben (1989; 1991; 1963).

From the analysis of capital proportions earlier, it may nevertheless be shown how the complex sets of proportional groupings present in the Ionic capital are brought into relation with the total Order by means of manipulation of the proportional sets which include the dimension of the column top diameter. From this interpretation, as well as the interpretation above relating to both modular dimensioning and proportioning of the Order, it is indicated that the capital element was fully integrated in the design of every example of the Order from the conceptual design stage. The reader will follow that, with the new slant Gruben (1996; 1997) has placed on the issue, revisions to the above deductions will have to be made in due course. Whilst the column lengths (OSLM) and column diameters (R) are provided by Gruben, he does not revisit the other façade dimensions - whilst he does so for the Dionysos IV temple [Bld-3d] column spacings - which brings the analysis in question. Furthermore, revised dimensions of many others are still in the process of being readied for publication. With this in mind, the author desists from further work in this regard, whilst reiterating Gruben's findings that the early Ionic buildings were definitely uncanonic when seen as a whole. This is likewise reflected in the capital design.

The documented examples of full façades [ie Order and pediment], namely the Archaic Didymeion (Gruben [1963, p.158] including Schattner's [1996, p.1-23] contribution), as wel as Temple 'D' at Metapontum (Mertens [1979, p.114-5, 130]), show the amount of pre-meditation relative to in-process adjustment, and fully expose an extent of noetic control in Archaic Ionic architecture that was previously not deemed to be there (eg by Coulton [1977, p.71]). The present study has shown that the intricacies of proportioning in the full Ionic Order are not revealed so easily. Future testing of Coulton's (1975, p.71, Fig.1) graphic explanation of the design framework underlying the proportional relationships inherent to the Ionic Order, from the combined information compiled in this study (and augmented by work on the other post-625 BC Archaic examples as are available, as well as that of Fifth Century examples like Mertens (1979, p.138-9)), and further re-examining the role of the Ionic capital within that framework, is herewith identified as a fruitful field of future research. This work should also be extended to test, from a fuller sample, the format now devised for the columnar portion of the Order by Wesenberg (1983a). Such a study will make a great contribution to the understanding of the early Ionic Order and its evolution in the early Classical examples. For now one may say that some of Coulton's conclusions seem to be corroborated from the contribution made in this study, like his - well known - indication of the prevalent use of the column diameter to determine the column height, but his statement that "the rules for Ionic temples are far from being modular" (1975, p.71) does not seem to do the first generation examples justice. One may also refute Coulton's (1977, p.71) statement regarding the lack of design method (apart from close co-ordination between column axes and *naos* wall axes) in Ionic architecture until the Hellenistic period. From the discovery of detailed working drawings of the columns of the Didymeion III on the *sekos*'s interior walls - one refers to the drawing and photographs in Tuchelt (1986a, Fig.2-3) and also Haselberger (1983) - the later sophistication of premeditated design is now clear to see in another graphic dimension, and the author has come to the realisation that this method of design had its precedents in the Archaic period, which included capital design.

Both the Ionic and Aeolic architectural capital had as task the transference of weight from a linear horizontal epistyle to a vertical round column, in a way explaning their shapes. Was the one shape more driven by structural efficiency than the other? In terms of the relationship between structural performance of the Aeolic and Ionic capitals, Betancourt (TES, p.131) aired the opinion that the earlier Aeolic capitals had to carry a lighter timber entablature than the early monumental Ionic temples. In his analysis he finds that, possibly to be able to carry increasingly bigger loads, Archaic Aeolic capitals become increasingly longer (at the top), in other words more horizontal in nature. Kirchhoff (EIV, Table 1.5, 2.5, p.205) has found that the converse is true for the Ionic capital, namely that capital lengths actually decrease over time. It is apparent, from studying the Ionic and Aeolic buildings involved, the immense differences in form types, of scales employed and of materials used for the columns and entablatures for different building projects, that a simple analysis like the above is meaningless if any insight is to be gained re the relative length and structural role of capitals. Both these analyses do not relate capital length to any portion of the buildings. It was decided to test Betancourt's findings again, but in a contextual sense, and to relate it with newer analysis of Ionic capitals as derived from this study. The author's analysis of trends of Ionic capitals in Chapter 3, using the relationship Capital length : Capital bottom bearing diameter (A: H [Used because of a lack of column top diameter dimensions]), tries in a simple way to relate capital size to their built context. As mentioned, they indicate that this relative Ionic capital length decreases over time. Within this framework the decrease may be seen in two phases: The pre-550 BC relative capital lengths remain constant around 2,5 x column top diameter, and the post-550 BC relative capital lengths remain constant around 2,0 x column top diameter. Similarly, the decrease also occurs for the relationship Capital bearing length : Capital bottom bearing diameter (C:H). In terms of the relationship A : Z (Interaxial spacing) it was shown that it was actually the column spacing which became increasingly inefficient in a structural sense, rather than the capital design.

According to the author's similar analysis of the ordered group of Aeolic capitals in Table 3.14 below, the

Table 3.14 Ratios H:A and H:C for chronologically ordered Aeolic capitals.

Aeolic Capital	Date	Ratio H:A	Ratio H:C
Aeol-3 Larisa building	575-50 BC	1: 3,05	1 : 2,07
Aeol-2 Neandria temple [Larger front capitals]	ca 550 BC	1 : 30	1 : 1,26
Aeol-4 Larisa Old Palace	550 BC	1 : 3,17	1 : 1,89
Aeol-5 Klopedi temple	530-500 BC	1 : 2,8	1 : 1,83
Aeol-6 Klopedi/Mytiline temple	Late 6th Cent BC	1 : 3,2-5	1 : 2,0-17
Aeol-7 Eressos building	550-500> BC	1 : 1,88	1 : 1,52

finding was made that capital lengths, relative to column diameters - again expressed as capital bottom bearing diameters due to the reason stated before - remained fairly constant in the Sixth Century, and rather getting smaller to the end of that period. There is a definite correspondence between the trends in Ionic and Aeolic capital design in this regard, refuting Betancourt's finding. In terms of the relationship Capital top bearing length : Capital bottom bearing length (C: H) for Aeolic capitals, there is also a decline, but much more visible and steady than the previous analysis - however with the Neandria temple showing a temporary experiment with carrying the epistyle only on the middle spandrel, rather than using the volute palmettes as well as elsewhere on the top level. Again Betancourt's finding is refuted. Sadly there is not enough material evidence - even with the new plan of the Temple at Neandria by Wiegartz (1994) - and detail to repeat the façade analysis, using the proportions A:Z and A:H to look at efficiency evolution of Aeolic structural design and its relation to aesthetic predelictions. It is therefore at this moment still not possible to state whether, structurally speaking, the Aeolic and Ionic capitals functioned differently in the two systems, and whether the Aeolic was more structurally efficient than the Ionic, which became more aesthetically efficient in a stylistic system where the structurally efficient form and size of the capital, relative to other elements in that system, had been relatively fixed at a quite early stage - at least as far as the capital's relative length was concerned, but not the top bearing to bottom bearing height - but where column spacing was structurally less efficient over time.

3.3.8 Recapitulation

The typological analysis increased knowledge on capital form design and manufacture. There is more insight into the tectonic nature of the capital and its context which meshes with other previous studies, as well as the manner in which capital design was achieved by rational means on the originating block form. There is more clarity about the subproblems that every side of the block presented and the resolution that was required before the execution of the work could start, for example the size and proportions of the volutes and the geometry of the spirals, the inner diameter of the bolster and its co-ordination with the echinus, as well as the diameter of the echinus and its co-ordination with the volutes. Coupled to this, there is an increase in understanding of considerations of a three-dimensional character, like the co-ordination of the angle of transition (called α) from the capital top to bottom bearing surface with the overall capital proportion, together with the size of the individual elements that make up the capital element. The study considerated the formal collision of two façades at the corner of a building, as defined by the corner volute. There is greater understanding of the importance of the considerations that spring from Ionic capitals' functional contexts: In votive columns the considerations being the resolution of the size and proportion of the capital relative to the size, proportion composition and weight of the artifact that was carried, as well as to the size and slenderness ratio of the column that bore it, and in architectural capitals the integration within the total Order. From this analysis it becomes amply clear that the capital should be seen as an element that was fully integrated in the total design of the column from the time of the conceptual phase of the design, and in terms of proportions, that it was a very active partner in the aesthetic presence of the totality of the column. The typological analysis also provided new insight into the relationship between Ionic and Aeolic capital proportions.

3.4 CHAPTER CONCLUSION

The aim of gaining typological understanding of the relevant artifacts was achieved through interpretation of an ordered *corpus* of early Ionic capitals from a typological and contextual perspective, and current interpretation has been altered and increased.