CHAPTER VII.

THE MORTLAKE CIRCLE AND ELIZABETHAN ENDEAVOUR (1564-1583).

I. Dee settles at Mortlake — his household — connections with Sydney family — with the mathematician Thomas Allen — attacked with Allen, Lopez and Julio in Leicester's Commonwealth — friendship with Dyer — attempts to engage Dyer's influence in his political schemes.

II. Mystical works on triangle and circle (n.28 & 29) — edition of de Superficerum Divisiorum with Commandine in Italy — Dee's identification of the work as Euclid's.

III. The English Euclid published — Dee, Billingsley and Whitehead — its novelty — thesis of the Preface, the three levels of mathematics — reflections of this in introductions to the separate books — Dee's defence against charges of conjuring — his appeal for wider mathematical instruction and for dissemination of scientific works in the vernacular — parallels with Gilbert's proposal for founding Academy on new educational principals and for scientific research.

IV. Concern of the Preface and Dee's annotations with the new artisan and technical classes — the appeal Dee's work had for them — their conscious independence, experimental approach and increasing respect for mathematics.

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VI. Connections with the voyagers and general exploration — and Frobisher's Black Stone company (n.101) — views on the N.W. Passage and Gilbert's treatise — instructions to Hall and Frobisher — to Jackson and Pott — interest in Far East — associations with Gilbert's last enterprise — its historical importance — plans with Davis and Adrian Gilbert to colonise and convert America — receives a grant of greater part of Canada.

I. Some time after his return from the Low Countries, where he had overseen the printing of the Monas, Dee established himself at Mortlake, in what is described in a survey of 1617 as being then "an ancient house," and which after Dee's death was converted into — certainly its grounds became the site of — the Royal Tapestry Works (1). Despite increasing financial difficulties Dee enlarged the original premises and estate from time to time, by the purchase of adjacent tenements. Here he housed his vast library (2), his collection of scientific instruments, and objects of antiquarian interest — he mentions a collection of ancient seals he possessed, as well as a body of Welsh and Irish records, and a large and increasing family and numerous assistants and servants. Some thirty years later, in 1597, in the depths of his poverty, his household still numbered eighteen, which he estimated as the minimum possible for maintaining the normal essential routine of daily life (3). He also erected, or converted to this use — as his Diary jottings reveal — at least three separate "laboratories" — or still houses, and elaborately equipped them. Mortlake was of easy access from London by land or water (4). The Queen rode out here on occasion, and Dee received frequent visitors from Court and city. Here, among others (several more regular resident pupils are mentioned in the diaries (5)). Sir Philip Sydney came to him for instruction in Chemistry (6), and for him Dee drew up a sixty-two page horoscope, full of golden predictions of talents and success (7). Indeed it is probable that Dee retained some intimacy with the whole Sydney circle, for Philip's mother was the daughter of Northumberland to whose household Dee had been attached, and his sister, Mary Countess of Pembroke, employed Adrian Gilbert, who was a close associate in various of Dee's activities, and was even admitted to the sittings with Kelly when angelic correspondence was established. Aubrey records of this countess "In her time Wilton house was like a College, there were so many learned, and ingeniose persons. She was the greatest patrenesse of witt and learning of any lady on her time. She was a great chymist and spent yearly a great deale in that study. She kept for her laborator in the house Adrian Gilbert (vulgarly called Dr. Gilbert), halfe brother to Sir Walter Ralegh, who was a great chymist in those dayes....She also gave an honorable yearly pension to Dr. Mouffet, who hath writt a booke De Insectis. Also one Boston, a good chymist....who did undoe himselfe by studying the philosopher's stone."(8) Dee's circle, which had as its centre at Mortlake, until his departure for the continent in 1583, has been ascribed a place of high importance in the development of English scientific thought by F.R. Johnson. After examining various learned societies of the latter part of the sixteenth and early seventeenth centuries he concludes "Of far greater import, however, was the success of John Dee....in gathering about him a group of friends and pupils which in effect constituted a sort of scientific academy," and this group must be ranked as the earliest ancestor of the Royal Society to contribute significantly to its patrimony (9).

Among Dee's acquaintances of this time deserving of particular mention was Thomas Allen (1543-1632). From the fragmentary information surviving, Dee and Allen seem to have been of very similar temperaments and inclinations, though unfortunately few of Allen's writings remain, and those scattered and neglected in MS. Their names are sometimes coupled in contemporary writings; they both accumulated extensive libraries, each of which boasted a manuscript of Chalcidius commentary on the Timaeus (10); and on Dee's death various of his books and manuscripts passed into Allen's hands (11); Allen's collection containing these was presented to the Bodleian by Kenelm Digby, an intimate friend of Allen's, and who was termed by him "The Mirandula of the age."(12) Allen is reported to have rivalled Dee in mathematics, for he is described as "not only the prince of Coryphaeus, but the very Soul and Sun of all the mathematicians of his time."(13) Like Dee he was suspected and accused of being a "conjuror" and engaging in diabolical practices; in Fuller's well-known phrase he "succeeded to the skill and scandal of Friar Bacon,"(14) and his servants, says Aubrey, would alarm the country folk by announcing that they frequently "met the spirits coming up the stairs like bees."(15) He was also, according to Wood, much courted by Northumberland "whereupon spending some time with him he was infinitely beloved and admired, not only by that Count, but by such artists who then lived with, or often retired to him, as Tho. Harriot, John Dee, Walt. Warner, Nath. Torperley, etc. the Atlantes of the Mathematic World." After leaving Oxford in 1567 he seems to have shared his principal patron with Dee. This was Leicester, who apparently made him similar offers of ecclesiastical advancement as he had once made to the elder philosopher for, says Wood "he would have conferr'd upon him (Allen) a Bishoprick, but for the sweetness of a retired life, he denied that also."(16) The scurrilous Leicesters Commonwealth (1584) to which Sydney was engaged to write a refutation in 1585, couples Dee and Allen once more — as magicians; proclaiming "His Lordship doth alwaies covet, to be furnished with certaine chosen men about him, for divers affairs: as these two Galenists in the University: Dee and Allen (two Atheists) for figuring and conjuring: Julio the Italian, and Lopas the Jew, for poysoning, and for the art of destroying

children in women's bellies; Verneis for murdering: Digbies for Bauds: and the like in occupations which his Lordship exercises."(17) They were closely associated during the affair of Frobisher's Black stone, Allen succeeding Lock as treasurer of the company — he was later receiver for it — formed to exploit the stone after Frobisher's third voyage (18). Just as Dee on occasion kept close conference with the Queen to reassure her at the appearance of comets and the new star, so Aubrey says of Allen: "Queen Elizabeth sent for him to have his advice about the new star that appeared in the Swan or Cassiopeia (but I think the Swan_ to which he gave his judgment very learnedly."(19) Laski, whom Dee and Kelly accompanied on his return to the continent, seems, previously, to have extended a similar invitation to Allen; while it is possible that Kelly came to Dee after service with Allen — it was perhaps from him that Kelly picked up those scraps of abstruse learning by which he was able to impress Dee and lend colour to his "visions" which were undoubtedly in part calculated deception and imposture — for Wood states that Kelly served as Allen's amanuensis at the time when he was instructing Sir John Davis in mathematics (20).

This period of Dee's life also probably marks the beginnings of his friendship with Edward Dyer (b.1543) — also a close friend of the Sydneys (21) — who thereafter continued one of Dee's most intimate disciples, and an associate in his various speculative or practical ventures, geographical, political and occult. Dyer's father had died in 1565, leaving him, according to Aubrey, L4,000 p.a., and L80,000 in moneys, and then came straightway to Court and took service under Leicester (22). It was in this same year that Dee wrote his Reipublicae Brittannicae Synopsis in English, a lost work which may perhaps be identified with one written for Dyer, spoken of in later writings, and if so from the nature of its contents there indicated, it may not be unreasonable to conjecture that "by this date Dee had already begun to dream of England as Mistress of a Northern Empire, based on the command of the seas."(23) For, discussing a possible English discovery of a North West passage and its importance for such a project, Dee wrote in General and Rare Memorials that he had previously treated of the matter in his "old Atlanticall Discourses to the selfsame purpose (at the sayd M. Dyer his request) almost ten years sins set down in wryting."(24) Dee attempted continually to engage Dyer's political influence (25) in his various schemes for English aggrandisement, those of his works addressed specifically to Dyer have this as their chief theme; unfortunately perhaps for the success of these, Dyer seems to have been primarily interested in the alchemical side of Dee's researches, and in encouraging him in further efforts in this field (26). Nevertheless, Dyer's wide patronage of the arts and sciences, and his generosity towards scholars (27) probably proved useful to Dee; who was from now on through the rest of his life in chronic need of financial assistance.

II. In the same year as he addressed his "Atlanticall" treatise to Dyer, Dee composed De Trigono circinoque analogico. Opusculum Mathematisum et Mechanicum lib. 4. From the surviving fragments of it, it may have been intended for publication, as this is a fair copy, with scribbled directions in the margin in English relating to the placing of the figures of the text. But its mathematics are of a kind comparable to those of the "Monas" and one suspects therefore that it was largely designed to illustrate the mystic properties of the triangle (28), a figure Dee held in high esteem, employed as a personal monogram (it is used invariably to indicate himself throughout the "Spiritual Diaries"), and later, by a grant from Rudolph II incorporated into his arms. The probable purpose of the book is reflected in a long letter he addressed to Camden ten years later on the virtues of this figure (29).

A more important mathematical achievement was the edition he produced, in conjunction with Federigo Commandino (30) of de Superficierum Divisionibus (31) tajeb from a manuscript in Dee's possession, of a Latin translation by Gherard of Cremona from the Arabic, which attributed the work to Machumetus Bagdedinus. It was printed in 1570 at Pisa and reissued there the same year in an Italian translation (32). That, as in the case of the Monas and Aphorisms, Dee should publish abroad may be an indication of difficulties encountered in the production of abstrusely learned works in England, and perhaps accounts in some measure for the small proportion of Dee's writings that arrived at publication. Dee had been staying at Urbino (33) with Commandine, since the latter who describes Dee as "Vir praestanti ingenio, atque eruditione singluari," says addressing Frederic Maria in the dedication, that he "Illustrissima vestrae aule fama compulsus maxima itinerum difficultate superata sese huc contulit."(34) The most probable date for Dee's visit would seem to be 1568 or 1569 (35) for there seems to have been little delay in the publication. Dee proceeded to Rome for the summer, concluding his preface: "Iam conficiendi itineris ration me avocat, ne maiorem horum, qui nunc nos circumfundunt aestuum tolerare, cogar iniuriam antequam in umbris romanas hinc me recipere quea" and directed Commandine to send copies for him to the "singluar patron of all good arts but especially of the mathematical," Sir William Pickering at London from where they could be most readily conveyed to his own library (36) which seems to indicate that he did not anticipate that he would have returned to England by the time the work appeared. Dee presented a transcript he had made and not the original, to Commandine on leaving, for he refers to the author's name as found "ia ipso, unde descripsi uetustissimo exemplare" (37) and left Commandine to do the detailed editing and preparation for the press. For Commandine writes "Cum Joannes Dee....libellum huc...mihi discendens amoris ergo me sui testem relinqueret" he expressed a wish that it could be made generally available to students of mathematics; "Itaque ego & honestissima amici hominis, ac doctissimi voluntate commotus, & mira libelli utilitate allectus," proceeded to rearrange its contents and publish it (38).

Dee contributed a prefatory letter in which he declared that his major preoccupation for many years had been the discovery and preservation of the monuments of the ancient philosophers. The present MS was extremely difficult to decipher and he seems to have employed artificial aids to better his sight: "libellus, charactere quidem scriptus deformi nimis et ab ipsam etiam vetustatis inuriam vix legibili. At oculos ut videre effeci; lynceos: & frequenti meditatione, usuqz lectionis sum consecutus facilitatem."(39) After he had made it out he realised its extreme importance. He was certain that the author was not Mahomet Bagdadicus but wondered for a long time if it might not be Albategnus, whom he says Copernicus often mentions "as a very considerable author in astronomy." But he is now fairly confident that it was written by Euclid and equates it with the lost work mentioned by Proclus in his commentary on the Elements , which seems to have been concerned with the division of figures into like — as triangles into triangles — and unlike regular figures — Dee adds that he has some skill in such attributions, as a number of friends of his can testify that he has restored a work "in Philosophia occulta, mysticaqz incomparabilem," by most sure proofs to its rightful author, Anaxagoras, though it had long falsely passed under the name of Aristotle (40). In the present case the work soon became well known, and Dee's attribution was generally accepted (41); as far as the substance of the work goes, this is so today and the equation of it with the work of which the title is cited in Proclus' commentary is judged correct. It was translated by Leke and Serle in their Euclid of 1661 (42) and was included in Gregory's Euclid of 1703. In the present century it has been reissued accompanied with a full discussion on its problematic authenticity and with notes on its considerable influence (43).

III. 1570 also saw the appearance of the English Euclid, one of the most outstanding monuments in English scholarship, educational work and book production of the sixteenth century. The translation, more accurate, felicitous and easily comprehensible than many of its successors, was made from the Greek (not the usually employed later version of Campanus) by Henry Billingsley, later Lord Mayor of London. Of him Wood writes that he "did spent some time among the Muses in this University (i.e., Oxford) as others did who were afterwards traders in London...but before our author Billingsley had continued there three Years...he was taken thence and bound Apprentice to an Haberdasher as it seems in London (44). But though Billingsley may also have been at Oxford for a time his university education was not so restricted as this account implies, for he matriculated at St. John's Cambridge — 150, and became a scholar there the next year. Wood goes on to assert that much of the work was done by an Augustinian friar, Whitehead, who sheltered in Billingsley's house, after expulsion from Oxford, and who instructed his benefactor there and left him at his death all the notes "which he had with great pains drawn up and digested upon Euclid." Wood's information, despite the impressive dignity of the manner in which he delivers it, which lends a spurious air of authority to his pronouncements, is too often only a recasting, and often a quite inaccurate one, of the miscellaneous gossip with which Aubrey supplied him. The present story is usually discounted. However, in this case, Whitehead's cooperation is testified to, by a more nearly contemporary witness (1582), who declares "Great pains were taken at the time of the impression by M. Doctor Whitehead a profound learned man, and Mr. John Dee, who is accounted of the learned mathematicians throughout Europe ye prince of Mathematicians of this age: as Cicero named Cratippus ye prince of Philosophers in his age. This M. Dee hath put unto these englished elements many scholies, annotations, corollaries and expositions which give great light and facilitie to the understanding of them."(45) Dee also corrected or redesigned many of the more complicated diagrams to assist a more ready comprehension, and was perhaps partly responsible for the device (not wholly an innovation, there are traces of it in the works of Durer, Cardan and others), which excited much admiration of supplying additional figures, offered as illustrations — they are carefully distinguished from true geometrical procedure — appealing to the intuition which were possessed of moveable parts, or which when cut out in pasteboard, could be folded into three dimensional representations, as for instance of the regular solids. Dee also contributed a lengthy Preface of some fifty folio pages addressed generally "To the unfained Lovers of Truthe, and constant Studentes of Noble Sciences" and more particularly "framed" "to Plato his fugitive scholers."(46)

The Preface, the work for which Dee was chiefly remembered, until Casaubon's publication of his "spiritual diaries," threw his other achievements into the shade — and of which a Latin translation was being urged nearly a century later (47) is an eloquent and forceful exposition of a neo-Platonic "numerical" philosophy, based on the assumption of three cognitive levels reflecting three levels of "being" subsisting in creation. The rise of mathematics is traced from abstract principles innate in the mind, and a multitude of arts and sciences are catalogued and examined which are from the "Mathematicall fountaines, derived into the fieldes of Nature, are refreshed, quickened, and provoked to grow, shote up, floure, and give frote infinite, and incredible."(48) Dee rises to lyrical heights of enthusiasm in his pleas for a recognition of the proper dignities of this neglected science of mathematics. "O comfortable allurement," he exclaims, "O ravishing perswasion, to deale with a Science, whose Subiect, is so Auncient, so pure, so excellent, so surmounting all creatures, so vsed of the Almighty and incomprehensible wisdome of the Creator, in the distinct creation of all creatures: in all their distinct partes, properties, natures, and vertues, by order, and most absolute number, brought, from Nothing to the Formalitie of their being and state."(49)

The summaries and comments which precede the various books, are possibly Billingsley's but they reflect what is a uniform tone pervading the whole production, and range over, and mingle with no sense of disparity the purely mathematical, the utilitarian, the "metaphysical" and matter of natural philosophy. Thus it is pointed out how book II provides a geometrical foundation for the theory of the equation (50); and the extreme logical importance, as an example of a self-contained deductive system independent of figures and paralleling arithmetical reasoning, of Book V which was a book usually omitted from normal instruction as too difficult, and abstract, or extraneous to geometry as a whole, until the late nineteenth century, is admirably brought out (51). Similar pains are conscientiously taken to render Book X comprehensible and to dissipate the legend of its extreme obscurity, difficulty and uselessness (52). Or again, Book VI is recommended to special attention because "On the Theorems and Problems of this booke, depend for the most part, the composition of all instruments of measuring length, breadth or deepness, and also the reason of theuse of the same instruments as of the Geometrical Square, the Scale of the Astrolabe, the

quadrant, the staffe, and such other. The use of which instruments beside all other mechanical instruments of raising up, of moving and drawing huge things incredible to the ignorant, and infinite other ginnes (which likewise have their grounde out of this Booke) are of wonderfull and unspeakable profite, beside the inestimable pleasure which is in them."(53) Book III it is noted, treats of the circle "whereof it is much more to be esteemed than the two bookes going before" (which dealt with right lined figures) for "of all figures the circle is of most absolute perfection whose proprieties and passions are here set forth" and "sciences take their dignity from the worthyness of the matter they intreat of."(54) Apropos of Bk.XI, the editors explain why the heavenly bodies are necessarily of spherical form, for they were designed to be in continual motion and "a sphere is a figure most apt to all motion, as having no base whereon to stay," and so on (55). Throughout, the Platonic mathematicism of the Preface is recurrently stressed. A clear example is the introduction to Book VII. where Euclid's consideration of number is used as an excuse for exhibiting the superiority of Arithmetic to Geometry, since it is more self-sufficient, and the subject it deals with "cannot be judged by any sense but only by consideration of the mind and understanding. Now things sensible are far under in degree than are things intellectual and are of nature much more gross than they, wherefore Number, as being only intellectual, is more pure, more immateriall, and more subtile, farre than is magnitude and extendeth itselfe farther....The wisest and best learned philosophers that have bene, as Pithagoras, Timaeus, Plato and their followers found out and taught most pithely and purely the secret and hidden knowledge ofthe nature and condicion of all thinges, by nombers and by the proprieties and passions of them....Yea it hath been taught of the chiefest amongest philosophers, that all natural things are framed and have their constitucion of nomer....Timaeus in his booke, and also Plato in his Timaeus following him, show how the soule is composed of harmonicall nombers and consonantes of musicke. Number compareth all thinges, and is (after these men) the being and very essence of all thinges, and ministreth ayde and helpe as to all other knowledge."(56)

The contents, sources and influence of the English Euclid, forming the subject of the complementary study to the present, it is only necessary here briefly to notice its appearance. One or two features however may be more particularly noted. Towards the end of the Preface, Dee forsakes his theme to burst into an impassioned rebuttal of the charge of "Conjuring" that rumour had raised against him, it is the first of several "Apologies" that we have from his pen, and as a personal record part of it maynot improperly be reproduced here. It also exhibits in a striking manner the qualities of Dee's English prose at its height; at once cumbrous and nervous, headlong, and superficially involved, but rhetorically effective and generally clear as to underlying sense. "Should I" he demands, "for my xx or xxv yeares Studie: for two or three thousand Markes spending: seven or eight thousand Miles going and trauiling, onely for good learninges sake: And that, in all maner of wethers: in all maner of waies and passages: both early and late: in daunger of violence by man: in daunger of destruction by wilde beastes: in hunger: in thirst: in perilous heates by day, with toyle on foote: in daungerous dampes of colde, by night, almost bereuing life: (as god knoweth): with lodginges, oft times, to small ease: and sometime to lesse securitie. And for much more (then all this) done & suffred, for Learning and attaining of Wisedome: Should I (I pray you) for all this, no otherwise, nor more warily: or (by Gods mercifulness) no more luckily have fished, with so large, and costly, a Nette, so long time in drawing (and that with the helpe and advise of Lady Philosophie and Queene Theologie): but at length, to have catched, and drawen vp, a Frog? Nay, a Devill? For, so, doth the Common povish Pratler Imagine and Jangle: And, so, doth the Malicious Skorner, secretly wishe, & bravely and boldly face down behinde my backe. Ah, what a miserable thing, is this kinde of Men? How great is the blindness & boldness, of the Multitude, in thinges above their Capacitie? What a Land: what a People: what Maners: what Times are these? Are they become Devils, themselves: and, by false witnesse bearing against their Neighbour, would they also, become Murderers? Doth God, so long gave them respite, to reclaime themselves in, and from this horrible slaundering of this giltlesse: contrary to their owne Consciences: and yet will they not cease? Doth the Innocent, forbeare the calling of them, Juridically to aunswere him, according to the rigour of the Lawes: and will they despise his Charitable pacience? As they, against him, by name, do forge, fable, rage and raise slaunder, by Worde & Print: Will they prouoke him, by worde and Print, likewise to Note their Names to the World: with their particular deuise, fables, beastly Imaginations, and unchristenlike slaunders? Well: Well. O (you such) my unkinde Countreymen. O vnnaturall Countreymen. Why oppresse you me, thus violently, with your slaundering of me: Contrary to Veritie: and contrary to your owne Consciences: and I, to this hower, neither by worde, deede, or thought have bene, anyway, hurtfull, damageable, or iniurious to you, or yours?"(57)

The Preface also embodies a call for more general education, especially outside the

Universities, in mathematics and its derived sciences which may prove of infinite commodity and service to the commonwealth at large. Dee, following the tradition of Recorde and others, advocates the wide circulation of scientific work in the vernacular, and the translation of ancient and foreign scientific books into English (58). Among his additions to Euclid's text, many of which are concerned with logical method, he looks to the evolution of a uniform style of exposition which shall present its matter clearly and indisputably, since in form it will be modelled upon procedure of mathematical proofs; it should, he declares, follow that method taught by Plato to Leodamus; i.e., to begin by initially assuming the truth of the hypothesis to be established, and, arguing from this to certain and recognised truths, and returning from these again, deductively to the original hypothesis: and thus demonstrating the hypothesis since it will have been shown to be necessarily implied by accepted data (59). (Galileo and other mathematicians similarly advocate this Resolutive-Compositive method.)

Dee's views on education that are to be found in the Preface and elsewhere, find a curious reflection in the proposals for the establishment of an Academy laid before Burleigh and the Queen this same year by Sir Humphrey Gilbert. Gilbert was a close associate of Dee's in this period of his life; in most of the ventures of each the other's name may be found conjoined; Gilbert is praised in the Preface itself where it is deplored that service in Ireland prevented the fruition of his plans for a voyage of discovery some years previously (60), and another of Gilbert's schemes, a political project he laid before the Queen in 1577, seems also probably to have stemmed in part from Dee (61). In Gilbert's proposals (62) much stress is laid on teaching in English, all practice in Rhetoric is to be in the vernacular, since "in what language soever learning is attayned, the appliaunce to use is principally in the vulgar speech," moreover great "ornament will thereby grow to our tonge" — and the authority of Cheke is invoked in support of these views (63). Mathematics figures largely in the curriculum, for two lecturers with assistants are to be appointed, one of which would concentrate on the application (much as described in the Preface), of these sciences to "imbattelinges fortificacios, and matters of warre, with the practice of Artillery and use of all manner of Instruments belonging to the same....and trayne his Auditorie to draw in paper, make in modell, and stake owt all kinds of fortificacios."(64) "The other Mathematician shall reade one day Cosmographie and Astronomy, and the other tend the practyces thereof only to the arte of Navigacion, with the Knowledge of necessary starres, the making use of Instrumentes appertayning to the same....Also there shall be one who shall each to draw Mappes, Sea Chartes etc. and to take by view of eye the platte of any thinge, and shall reade the groundes and rules of proportion and necessarie perspective and mensuration belonging to the same." Greek, Latin and Hebrew were also to be taught, and there should be a Reader in Physic who, it is strictly laid down, "shall never alleage any medicine be yt of simples, salves, saltes, balmes, cycles, spirits, tinctures, or otherwise but that he shall declare the reason philosophicall of every particular ingrediente for such operacion: and shew his hearers the mechanicall making and working thereof."(65) This insistence not merely upon the utility of knowledge but on the carrying back to first principles of what is taught, in order to inculcate a thorough comprehension rather than a more pragmatical ability, is also strikingly present throughout the English Euclid, and represents a markedly superior view to that of the succeeding century, when this aspect of instruction, markedly in mathematics but also in other subjects, was increasingly neglected or cried down. Thus Snell in The Right Teaching or Useful Knowledge in 1659, warns "care shall be taken that no unprofitable learning shall bee taught," and that "In teaching of necessarie Arts there shall bee no superfluous and overteaching which is a grievous losing of time, but everie knowledge shall bee taught so far onely as the learner shall have occasion to use it."(66)

The Academy was intended to become a centre of learning and research such as Dee later hoped to establish on a small scale at St. Cross. Thus it is directed that the Physician "shall continually practise together with the naturall Philosopher, by the fire and otherwise to search and try owt the secrets of nature as many waies as they possiblie may: and shall be sworne once every yeare to deliver unto the Treasurer his office, faire and plane written in parchement without equivocations or enigmaticall phrases, under their handes, all these their proofes and trialles made within the forepassed yeare: together with the true events of thinges, and all other necessary accidentes growing thereby, to th'end that their successors may knowe both the way of working and the event thereof, the better to follow the good and avoyd the evil which in time must of force bring great thinges to light, yf in Awcomistrie there be any such thinges hidd, for whose saffetyes I would wish the Statue of the 5th of Henry the 4th touching multiplication to be disappeared at large."(67) At least every three years the Academy was to produce and publish translations of scientific works that might serve useful purposes, and there is perhaps an echo of Dee's proposals to Mary in the suggestions that are made for the establishment of a library for it: a grant of L2000

to be made towards it initially, and thereafter all books coming into England to be first offered to the Academy and "all Printers in England shall for ever be charged to deliver unto the Library of the Academy, at their owne charges, one copy well bownde of every Booke Proclamcacion or Pamflette that they shall printe."(68)

The proposals end with a defence of the principle of the proposed Academy, and a criticism of the older universities. "Both Plato and Lycurgus" it states, in a tone similar to that with which Dee usually speaks of the commonwealth and its overriding of private interests, "with other great Philosophers having bene of opinion that the education of children should not altogether be under the puissance of their fathers, but under the publique power and aucthority, because the publique have therein more Intereste than their parents," and it claims to represent an educational reform for "whereas, in the Universities men study only Schole-learnings, in this Academy they shall study matters of action meet for present practize both of peace and warre," and ends hopefully "by erecting this Academe there shall be hereafter, in effecte, no Gentlman within this Realme, but good for somewhat whereas now the moste parto of them are good for nothinge...whereby your Majesty and your successors Courtes shall be for ever, insteade of a Nurserie of idleness, become a most noble Academe of Chevalerie, Policy and Philosophie."(69) Though Gilbert's scheme came to nothing, yet it is interesting to observe that a flourishing academy under Royal patronage was established by Sir Francis Kynaston in 1634 in which the constitution is in many points practially identical with the Gilbert-Dee proposals (70).

IV. Another feature of the Preface (and English Euclid) that may be mentioned is the immense appeal this had for the new, explanding classes of artisans and technical craftsmen. Not only did they find it a practical guide clearly laying down a method they themselves had been gradually and falteringly compelled towards, but it provided also a welcome defence of the dignity and theoretical importance of their pursuits, and it is not infrequent to find even the metaphysical preoccupations of the Preface reflected in their writings (71). The work was sometimes spoken of as if it contained an adequate and complete education in itself. Thus, Robert Norman declares that mechanicians although they know no dead tonges will find all the knowledge required for their great feats in the work of Recorde and the English Euclid (72). Dee openly professing his wish to present his knowledge in a form in which it might prove advantageous for the public good, and most widely useful (73), abandons all the secretiveness and obscurity which at times, and on other topics he appeared to cultivate and addressed himself largely to this class in the Preface and annotations, he thus exhorted them to "esteme one Drop of Truth (yea in Naturall Philosophihe) more worth, then whole Libraries of Opinions, vndemonstrated: or not answering to Natures Law, and your experience" (speaking of the use of the balance for experimental investigation) and in consequence of such passages was sometimes looked upon as the exponent of a new and radical empiricism, totally foreign to the vain speculations of orthodox academic learning (74). It has been very properly observed that in the Preface Dee displays "a clear understanding of what we mean today, by the experimental method — that is the continual alternation between the collection of data by observation, the mathematical elaboration of these data, and by the devising of new experiments to check the validity of the theories deduced mathematically as probable consequences of the original observations."(75) Dee is moreover fertile in suggestions, clearly distinguishing them from geomertical method, for illustrating theoretical conclusions by sensible results, to be reached by various experiments, in the workshop, with the double effect of rendering his subject matter more familiar and comprehensible, and persuading his readers of the correspondence between mathematical abstractions known a priori and explored by logic, and the phenomena experienced in the physical world. One of his chief objects is to propound methods which will produce "workable" results, so he describes for instance various mechanical devices for doubling the cube or squaring the circle, which feats may be thus performed to any degree of accuracy desired by the operator, within the limits permitted by the actual instruments he employed. Methods of approximation are consequently given an important place, after the theory of ideal computation has been properly expounded. Thus Dee explains how to extract cube roots by a series of successive approximations: "And where those numbers are not by logisticall consideation accounted Cubick numbers, ye may use the logisticall secret of approching nere to the precyse verytye: so that the roof most easily you shall perceave that your fayle is of the sence, never to be perceived: it is to wete as in a lyne of an inch long not to want or exceede the thousand part: of farther you may (infinitely) approche at pleasure. O Mechanicall frend, be of good comfort, put to thy hand; Labor improbus omnia vincit."(76)

Dee's contacts with these new "Mechaniciens" (77) as recorded in his diaries and elsewhere, and their own laudatory references to him would form a lengthy catalogue. Prominent amongst those he directly influenced were Eden the navigator, John Davis the Compassmaker, Adrian Gilbert the chemist, John Bourne, gunner and general "inventor" and Thomas Digges, who surveyed a wide variety of applied sciences, in fullfilment of the ambitious intention he announces in Pantometria "so meane I, god sparing life, to imploy no small portion of this my shorte and transitorie tie in storing our native tongue with Methamaticall demonstrations, and some such other rare experiments and practical conclusions, as no forraine Reelme hath hitherto beene, I suppose, partaker of" (78) making it his beast that he had "spent so many of my years in reducing the Sciences Mathematicall, from Demonstrative Contemplations, to Experimental Actions, for the service of my Prince and Countrey."(79) The objects of such men were in the main utilitarian, their methods largely empirical. The spirit of their investigations, and the direction of their interests, is that which informs Purchase's proud affirmation "I had rather have the meanest of Ulysses his followers relating his wanderings, than wander from certainty with Homer, after all his reading and conjectures," (80) and it is well conveyed in the enomium of Pancirolli's commentator on the forgotten inventor of the mariners' Compass: "Whoever he was that was the first Discoverer of this noble Invention, 'tis pity he should lie hid in so neglected an Obscurity; and that so great a Benefactor to the World should want a Lapidary, when the Disturbers of it have so precious a Memory. And this unknown fellow...hath deserv'd more than then thousand Alexanders, and as many Aristotles. And this single Art hath improv'd knowledge and done more good to the World, than all the Niceties of the subtle schools."(81) Failure of experiment drove these men to a thorough re-examination of statements relating to principles or data, long accepted

as authoritative. It was a laborious process and such accounts as Thomas Fales gives (1593) of his own efforts anare perhaps typical. He had believed, he declares, that his books was complete seven years previously, but he had had to revise the whole with empirical checks at every stage when he had discovered that he had been misled in an important point, by reliance upon traditional authority. "For after we found some precepts in Witekindus to be false, we were enforced to trie and examine with great care each figure and exaumple in the Summe."(82) Authority after authority failed inthis same way when their verifiable statements about the natural world were tested. A spirit of independence, not unmixed with pride, evident in the many proclamations of the novelty and originality of their procedures, informed the activities of such men, which although still at this stage grateful for the assistance and encouragement offered by theoretical philosophers such as Dee, and willing to gather a demonstrative method from their teachings in a later age, was to deny all connection between the flourishing science it claimed to have generated and the metaphysical tradition which had once been of perhaps inestimable value in legitimising, rendering reputable to current thought, and supplying a coherent formal framework to the new procedures. Robert Norman's remark in 1581 is typical and significant; that although many in the past have written of the magnet and its properties "yet I meane God willyng, without derogatyng fro them, or exalting myself, to set down a late experimental truth found in this Stone, contrary to the opinions of all that have heretofore written thereof," therefore he will pass them all over, giving them no consideration "founding my arguments onely upon experience, reason and demonstratio which are the groundes of Artes." He can even contemplate with equanimity the possibilities of an apparent conflict arising between abstract reason and observation in natural philosophy, but has no doubt which is to be preferred, for "Nevertheless by experience in all things, wherin consisteth truth and reason, of necessities reason must yield when truth is present."(83) What have been held to be the three most definitive characteristics of the "New Philosophy" as it flourished from the middle of the next century (84) — that it ws experimental in method, quantitative and mathematical in its theorising, and consciously independent of authority — are all found to a pronounced degree among these late sixteenth century "Mechanicians," with many of whom Dee is to be found closely associated.

V. Dee was particularly concerned with promoting the development of navigation and discovery; he refers frequently to two inventions he has made, which he considered important contributions to progress in this field — his "Paradoxall Compass" and Compass of Variation. There is evidence of Dee's longstanding interest in the magnet — he used it as an example in the Aphorisms for the secret influence fromthe stars acting at a distance through interposing matter (85), and his copy of Peregrine's De Magnete survives, heavily underlined and annotated (1562) (86) — but it is not possible to fix the exact period when he devised these instruments. On the title page and in the preface to General and Rare Memorials (1576) he speaks of them as invented by him 20 years past, but he was possibly predating these inventions to rebut more thoroughly a counter claim to the invention of the paradoxall compass, advanced by James Alday perhaps, Professor Taylor suggests — some little while previously and which Dee, aggrieved, notes among the other manifold injuries done him by his countrymen (87). Of the exact nature of the paradoxall compass we have no knowledge, for Dee though he promised to append a full description of it to General and Rare Memorials failed to do so. It seems likely however that it was designed to overcome certain difficulties connected with sailing in the polar regions (88) where the considerable dip of the needle and the convergence of the meridians resulting in a close spiralling of the thumbs, made accurage navigation almost impossible. Professor Taylor suggests that "This Paradoxall Compass enable the master to lay a course along a successio of rhumbs which would make an approximation to great circle sailing," and that it was a practical development of certain teachings of Pedro Nunez (89). It is possible that it embodied an adjustable rose (90) to be used in conjunctions with the compass of variation. From some papers of Dee's bearing on his invention, it might appear that it was as much a new method of computing data, by the aid of sets of tables, as a mechanical instrument, and was perhaps intended as a way of achieving the same advantages, while employing the standard charts of the time, as Mercator's charts on which loxodromes could be drawn as straight lines, later offered, though only for fairly low latitudes. Whatever its details, it apparently came into fairly general use as John Davis' list of instruments essential to a "Skilful Seaman" in 1595 runs "Sea Compasse, a crossestaffe, a Quadrant, an Astrolabe, a Chart, an instrument magneticall for the finding of the variation of the compasse, an Horizontall plane Sphere, a Globe and a paradoxall compasse." "By which instruments all conclusions and infallible demonstration, hidrographicall, geographicall, and Cosmographicall, are without controlment of errour to be performed."(91)

Of Dee's compass of variation we can form a more exact idea, since chapter two of Wm. Barlow's The Navigators Supply (92) is devoted to a description of it. In essence it consists of the attachment to a compass of an upright style which will cast a shadow, from whose length and direction the sun's altitude and azimuth from the magnetic meridian, denoted by the needle, may respectively be determined. If two readings are taken before and after noon when the sun is at equal altitudes, and thus equidistant from the geographical meridian, half the difference between the observed azimuth gives the variation of the compass. Barlow describes it as an ordinary seaman's compass having two additions; on the inside of the Box is a circle divided into 360 divisions, and "athward the upper face of the glass a Ruler of Latten" as long as the diameter of the box and half an inch broad. On each end are fixed vertical metal sights 3" high, one with a narrow slit down the middle, the other a mere frame with a central lutestring on which is strung a bead; the lutestring stands at the southern point of the compass. The box is turned to the East in the morning until the shadow of the lute string falls along the central line on the ruler and the division on the ruler where the shadow of the bead falls is marked. The operation is repeated, with the box turned to the West, at that time in the afternoon when the shadow of the bead again reaches the same division on the ruler. If the readings, on the degree divisions on the outer circle, pointed to by the compass wires attached to the magnet needle at these times, are identical, then there is no variation, otherwise it is equal to half the difference between the readings. Barlow remarks that this compass can also be used for taking distances and "to set the land" better than any other compass (93). Dee's compass and his view of variation probably lies at the base of his assertion in 1576 that he had devised a method for the determination of longitude even "without sight of sunne moone or star."(94) It was a commonly entertained hypothesis that variation remained constant in time over the whole earth and that therefore a determination of its value would give an accurate indication of longitudinal position. Thus Guillaume de Nautonnier's enormous work La mecometrie de l'Eymont ou l'art de trouver la longitude par le declination de l'Eymont (1601) contains complete tables of variation (largely supplied conjecturally, of course) for every degree of latitude and longitude, for this purpose. So also does Stevins De Hovenwindung which appeared in 1599 and of which an English version was made in the same year (95).

VI. A full account has been given by Professor Taylor (96) of Dee's influence on contemporary navigation and exploration and a detailed recapitulation of information there available is superfluous though abrief sketch of this, with a little additional information, will not be out of place here. Dee acted as instructor and technical adviser at various times to Richard Chancellor, Stephen and William Boroughs, Anthony Jenkinson, Hall, Frobisher, Humphrey and Adrian Gilbert, John Davis, Ralegh, Jackman and Pett, while the evidence is "cumulative" (97) that he was the directing spirit behind Drake's voyages. He contributed to Hackluyt's collections (98), several items he lists among his works at this period (up to his departure from England in 1583) consist of maps or instructions to seafarers, and he himself was a frequent recipient of reports and narratives of seamen's voyages (99) some of which survive with his marginal comments, and many of which he embodied in his Famous and Rich Discoveries throughout which, as also in private correspondence (100) he shows himself generously anxious to publish as widely as possible the substance of his personal collection of geographical materials. His name figures with those of Philip Sydney, Hatton, Leicester, Burleigh, Sussex, Sir Thomas Bromley etc., in the lists of the "Merchant Adventurers," and with Gresham, Dyer, Lok, and others he took a prominent part and was a heavy financial loser in the unfortunate episode of the Black stone brought back by Frobisher (101), indeed there is some evidence to indicate that Dee sailed himself with Frobisher on this voyage (102) the only occasion on which it appears that he may have taken such an actively personal part in exploration.

Dee's chief preoccupation in matters exploratory was the discovery of a N.E. or N.W. passage (103). He encouraged and helped to plan the arctic expedition of John Davis, though this was not actually made until 1585 after Dee had left England; and his diary records in June 1583 a conference he held with John Davis, Adrian Gilbert and Walsingham at "Mr. Beale his house, where only we four were secret, and we made Mr. Secretarie privie of the N.W. Passage and all charts and rutters were agreed upon in general." He speaks more frequently of one to the N.E., a belief "based on a faulty interpretation of the Arab geographer Abulfeda."(104) Dee in his General and Rare Memorials quoting Abalfeda Ismaelis cosmography, to the effect that the coast of Asia tends to the N.W. until it reaches the confines of Russia, proclaims this "a record worthy to be printed in gold." He states in the same place (105) that his own views had been set out in his "old Atlanticall discourses," but they are perhaps fairly accurately reflected in a pamphlet he had read some months previously that Dyer had brought to his notice which he here praises, and in which, he says "no small piece of Credit (for the attempt to be liked of) was ascribed to M. Dee his judgment." This work of which Dee gives no further details except that Gascoigne had written the preface — is Sir Humphrey Gilbert's A discourse of a discouerie for a new Passage to Cataia dated April 12, 1576, and to which Gascoigne contributed a preface in which he declared "it treateth of a matter whereof no man hath heretofore written particularly, nor showed ani approved reason for the same." Gilbert boasts of Dee's support in it, writing that "a great learned man (even M. DEE) doth seeme very well to like of this Discoverie, and doth much commend the author, the which he declareth in his Mathematicall preface to th english Euclid. I refer thee (Reader) to peruse the same and think it not strange though I be encouraged by so learned a foreleader to set forth a thing which he so well liked of." Gilbert undertakes to demonstrate the existence of a passage to the N.E. by four lines of argument, based on Authority, Reason, Experience and Circumstance. He equantes America with the "Atlantis" of the Timaeus and Critias (Dee also invariably calls America by this name), and points out that since Plato describes this as an island, it must be surrounded by water; moreoever coins of Augustus Caesar are to be found in the mines of South America (his witness is Marinus Siculus' Chronicles of Spayne) and Red Indians are cast away from time to time on the coast of the Baltic, after having sailed off their course and drifted down the passage (107). His copy of this work, Dee declared, he has heavily annotated and the same day he read it, immediately wrote out eighteen further considerations of his own to justify a similar voyage of discovery (probably one to the N.W.).

Dee was in close touch with Muscovy House and lent his influence there to the encouragementof this discovery. He records in the same passage of General and Rare Memorials in which he refers to Gilbert's work that he was requested by Frobisher and Sir Leonard Duckett to instruct Frobisher and Christopher Hall at Muscovy House for a voyage in 1576. They found him he states "(above their expectation) skilfull, and (more than could be wished for) Carefull, for their well doing in this their commendable and honourable attempt." Witness to this is a letter, he cites that Frobisher and Hall wrote him from the Bay of St. Tronians 26 June 1576, thanking him for his directions "which when we use we do remember you and hold ourselves bound to you are youre poore disciples, not able to be scholars bu tin good will, for want of learning." (Dee had given them intensive instruction in mathematics before their departure, though he writes that they

"greatly misliked their want of tyme sufficient for the Complemet and principall pointes of the Perfect Art of Navigation learning at his hands. Such pointes (I meane) as needed either great knowledge in the Sciences Mathematicall and Artes Mechanicall: or expert skill of many Causes and effects Naturall: Such points (I say) to their affaires and the Perfect Art of Navigation incident: he very aptly ould, & right willingly wold have dealt with them in: yf that pinch of tyme wold have so permitted," (107A) and they perhaps in return gave the name of Dee's Pinnacles to some crags off what they believed to be "Frizeland" (actually Greenland). Dee was similarly employed in 1580. Strype records (108): "that great and famous English Mathematician and Astronomer; noted throughout the world for his deep knowledge in those Sciences....in May anno 1580 wrote instructions for the North East passage to China, delivered to the two Masters Charles Jackman and Arthur Pett, at the Court Day, May 17, holden at the Muscovy House in London. With which instructions a new Chart made by his Hand, was given also to each of them, expressing their Cathay Voyage, more exactly than any yet published." William Borroughs presented advice to the two on currents, the use of the lode and on taking observations of coastlines. Mercator contributed commercial advice on trading with the natives of China, and on noting the natural commodities of places discovered, Dee presented them with Charts, calculations of the distances of various stages of their journey, advice about the best places to winter at, and some general information about Japan, "where you shall find Christenmen, Jesuits of many countries of Christendom" from whom he recommends them to seek further advice (109).

Dee seems to have been regarded as a specialist upon far eastern geography and affiars — a large part of Famous and Rich Discoveries is devoted to descriptions of them and in 1577 it appears from his diary that he was planning to find an overland route to N.E. Asia with Simon Alexander, and in 1581 he conferred with J.L. Haller about a proposed journey to China. A personal glimpse of him at work in this field is provided by a passage which concludes William Bourne's Hydrographicall Discourse, which discusses five possible passages to Cathay (110). He writes "And it is not unknowen but that the Great Cane of Cattay, is a Prince of great power as well by sea as by land; then judge you whether that such a Prince of such a force and wealth will not provide for all thinges meete for warres. Therefore as soone as they (explorers) come into those coasts they must orderly use the trade of Marchandize, and not use force etc. Moreover upon a time I being with Master Dee at his house at Murclacke, and falling in talke about the discoverie to Cattay and the shipping there abouts; thereupon he opened a booke and showed me a note what number of ships the great Cane had readie at one time to goe unto the sea about his affairs; you would thinke it incredible, for the number was 15000 which is a huge armie by Sea. I replied againe that it might be that they were but small things, and yet they might call them shippes; and then he turned unto another place where the great Cane did send one of his daughters by sea, and did appurt 14 of his ships, and the least of the 14 ships had 250 mariners, beside all the rest of his daughters train and such Nobles as did accompany hir, which would be no small number. Therefore it is most manifest that the great Cane is a great Prince of power as well by sea as by land."

Dee's last and most ambitious project in this field represents one of the offshoots of Humphrey Gilbert's final enterprise, which was already bruited in the spring of 1582 and which "branched into a great maze of individual and corporate enterprises for the conquest and settlement of North America, and although Gilbert lost his life in attempting to carry out his part of it, led to the first plantation of Virginia less than a year after his death."(111) Indeed Gilbert had been granted the First Royal letters Patent authorising the planting of an English Colony in 1578, and Hakluyt hails him as "the first to erect an habitation and government in those Northerly Countereys of America."(112) Dee, Adrian Gilbert and John Davies attempted the foundation of a company (113) for the colonisation, conversion and general exploitation of Atlantis (America) in 1583. They were to be known, according to the scheme they drew up when applying for a charter, as "the colleagues of the fellowship of the New Navigations Atlantical and Spetentrional," and they there suggest that they be granted a monopoly of all lands discovered, with full powers to make laws in those territories, and that the three originators be exempted from all customs duties for ever (114). A grant was made but perhaps never executed (115), for after Dee had left England similar application was still being made, Ralegh's name replacing that of Dee (116). One of Dee's works, which he dates 1581 (now lost) bears on one subject much emphasized in the original proposals, and which is generally recurrent in English colonising schemes of the day (117). (The dedications mentioned in the title are perhaps an indication of the broad "liberalism" of Dee's religious attitude; they might seem a little surprising for an English work of this date, and Dee politically seems to have been ardently antagonistic towards Spain; Wright discussing this last Grand Design of Gilberts of 1583 observes, however, that it "curiously had the support of violent Protestants and

patriotic Catholics, who both emphasized a religious motive in their endeavour."(118)) This is Dee's De Modo Evangelii Jesu Christi pulicandi, propagandi, stabiliendique, inter infideles Atlanticos; volumen magnum libris distinctum quatuor; quorum primus ad Serenissimam nostram Potentissimamque Reginam Elizabetham inscribitur; Secundus ad summos privati suae sacrae Majestatis consilii senatores: Tertius, ad Hispanarum Regem, Philippum: Quartus, ad Pontificem Romanum.

There is no record of Dee's obtaining any direct profit from any of the enterprises with which he was associated, though it is to be suspected that in a number of cases — as with Frobisher's "gold ore" — he emerged a financial loser. He did however receive various pledges of future benefits. Thus the "Diary" notes during July 1582 "a meridie hor. 3 1/2 cam Sir George Peckham to me to know the tytle for Norombegia in respect of Spayn and Portugall parting the whole worlds discoveries. He promysed me of his gift and of his patent 5000 akers of ye new conquest and thought to get so moch of Mr. Gerardes gift to be sent to me with seale within a few days." (Peckham was an anti-Spanish Catholic who had allied himself with the puritan Gilbert in his scheme of American Colonisation hoping it would result in the establishment of a Catholic refuge abroad (119).) Or again on the 10th Sept. 1580 Gilbert in the presence of witnesses made him a solemn promise of the rights of all future discoveries North of the fiftieth parallel of latitude. From the map presented by Dee to the Queen, 30th Oct. 1580, it is apparent, D.B. Quinn observes (120), that this promise gave Dee the greater part of Canada to exploit as he pleased, for he only includes on this map as already known, the straits of Belle Isle, an island representing northern New Foundland, a great part of the St. Lawrence Estuary and Labradoe up to 59 degrees 40' N. But before such benefits could mature, Dee had left for the continent, and seems never after his return some years later to have been able to re-establish fully his former contacts, or anything approaching the same position of respect and influence in public, commercial, and technical affairs as he had once enjoyed.