

G. W. Leibniz
ARS REPRESENTATORIA

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Ars Representatoria

Difficile est aliquid toto suo genere novum dare. Hanc tamen artem talem esse negari non potest. Ea tanto praestantior est Algebra, quanto majus est figuras et motus fideliter et nativa
5 facie menti referre quam solos numeros seu magnitudines.

Ductu igitur hujus artis et ope notarum simplicissimarum omnem figuram, motum, machinam, totam denique naturam quatenus mechanice explicata habetur, in mente possumus depingere, sine figuris et modulis, idque tam exacte quam fig-
10 uris et modulis fieri posset. Immo multo exactius et utilius. Nam possumus ita paucis et exiguis lineis repraesentare, quod alio-
qui repraesentandum esset multis et magnis figuris. Et cum figurae atque – cum ad solida veniendum est – moduli multo
15 tempore ne dicam expensis indigeant, et motus per solas fig-
uras sine modulis difficillime repraesententur, possumus hac arte intra horam plures figuras et earum transmutationes sive motus describere, quam figurae delineari possent intra
septimanam, et moduli fabricari intra annum. Praesertim cum ex multis figuris et modulis pleraeque initio inquirendi
20 descriptae aut fabricatae comperiantur inutiles, tempusque et sumtus perdantur; hac vero delineatione et fabricatione mentali sive repraesentatoria, facile multae figurae multique motus exhibentur brevi tempore et nullo sumtu.

Art of Representation

It is difficult to give something new completely of its own kind. However, it cannot be denied that this art is such a thing. It surpasses algebra by as much as it is greater to render figures and motions to the mind faithfully and in their native appearance than merely numbers or magnitudes.

By the leading of this art and the help of very simple symbols we can depict every figure, motion, machine, and in short all nature so far as it is regarded to be explained mechanically, in the mind without figures and measurements, and that just as exactly as could be done with figures and measurements. In fact, much more exactly and usefully, for we can thus with a few and small lines represent that which otherwise would need to be represented with many and large figures. And while figures and—when it comes to solids—models require a lot of time and needless to say expense, and motions are difficult to represent by only figures without models, we can with this art describe more figures and transformations or motions of them in an hour, than figures could be drawn in a week and models built in a year. Especially since most of the many figures and models drawn or built in the beginning of an investigation are found to be useless, and the time and cost are lost; but with this mental or representational depiction or construction, many figures and many motions are produced in a brief time and at no cost.

At inquires idem facere possum imaginatione, ita sane aliqua ex parte. Sed ad hoc ipsum inventa est haec ars ut sublevet et perficiat imaginationem; *sublevet* ne forti illa ad figuras attentione quae sane in figuris et motibus implicatis persequendis
 5 maxima esse debet, nimis fatigetur; *perficiat* vero, quoniam imaginatio nostra non simul multa considerare potest, praesertim cum ea quae non simul videri possunt, sunt simul cogitanda, ubi phantasmata mentem deserint; hinc fit, ut
 10 antequam ad postrema perveniat, prima effluxerint; certe distincte multa considerare; et per multas transmutationes ire, nihilque negligere aut transsilire, difficillimum, nec nisi a magnis artificibus in iis rebus in quibus jam multum habent usum fieri potest; quamquam et ipsi saepe peccent et haereant in difficilioribus.

15 Verum quod maximum est, praestat haec ars aliquid quod sit super omnem imaginationem, non tantum enim exhibet figuras sed et explicat atque exprimit, intimas earum naturas seu causas, adeoque rem reducit ad perfectam analysin et ex hac rursus resultantem synthesin.

20 Eaque ratione fit ut possimus omnes ordine modos enumerare efficiendi propositas figuras motusque; eligereque aptissima in rem praesentem, et determinare quod est impossibile, prorsus ut Algebra facit in numeris. Algebra hoc habet sane egregium, quod ejus ope etiam figurarum et motuum
 25 problemata possunt solvi, sed quia omnia a situ transferuntur ad magnitudines earumque habitudines seu ad calculum numerorum. Hinc ubi semel a figura rem transtulimus ad Algebram, jam imaginationem plane deserit mens, et quasi per metaphysica vagatur, dimensiones scilicet altiores quam
 30 ut in figuris dentur; unde ad exitum quidem pervenitur, sed miris ambagibus, a rei ipsius contemplatione remotis; omni cogitatione in symbola conversa.

And if you ask whether I can do the same with the imagination, yes of course in part. But this art was invented for this very reason, to support and perfect the imagination; *to support* lest perchance it becomes too fatigued in the attention which clearly must be very great
 5R to pursue complicated figures and motions; but *to perfect*, because our imagination cannot consider many things at the same time, especially since things that cannot be seen at the same time must be thought about at the same time, when images desert the mind; whence it happens that before it reaches the last things, the first have melted
 10R away; certainly it is very difficult to consider many things and go through many transformations and not neglect or jump over anything, and it cannot be done except by great artisans in those matters in which they already have a lot of experience, although even they often err and get stuck in the more difficult things.

15R But the greatest thing is that this art offers something that is above all imagination, since it not only exhibits figures but also explains and expresses their inner natures or causes, and so reduces the matter to a perfect analysis, and a synthesis resulting from it in turn.

For this reason it happens that we can enumerate in order all ways of making proposed figures and motions and choose the most suitable ones for the present matter and determine what is impossible, just as Algebra does in numbers. Algebra clearly has the outstanding feature that problems of figures and motions can be solved with its help, but because everything is transferred from situation to magnitudes and their relationships or to the calculation of numbers, the imagination
 20R has already deserted the mind, it wanders as it were through the metaphysical, namely higher dimensions than are given in figures, whence it arrives indeed at the exit, but by a strange detour removed from the contemplation of the thing itself, with all thought converted
 25R into symbols.
 30R

Sed in novo hoc genere calculi repraesentatoris perpetuo imaginatio mentem vel calamum comitatur, ut quicquid calamus designat, id continue phantasia possit imaginari. Et animus numquam ita symbolis adhaeret, ut rei ipsius considerationem deserere cogatur, ac proinde quaevis lineola est theorema aliquod vel proprietas ipsius figurae vel motus. (Ita tamen ut non sit necesse – nisi velimus – actu ipso calculum imaginatione sequi). Hinc etiam calculo ipso adhibito et constituto sequetur mirifica confirmatio atque confortatio imaginationis, ut possimus in postremum etiam difficillimas res et maxime compositas consequi, idque sine calamo et charta aut figuris, habito semel hoc filo Ariadnaeo mentis in imaginando quod iste calculus nobis ostendet.

Ac jam ostendi in tentamine quodam hujus artis, quomodo sphaerica et plana superficies, itemque circumferentia circuli et linea recta per notas repraesententur exactissime, ita ut eorum quasi imago cum notis menti subjiciatur (expressione tamen, non phantasiam tantum, juvante, sed et menti definitiones praebente). Hinc sequitur omnes alias lineas et superficies eodem modo posse exhiberi, quia per has possunt determinari.

Ultima analysis omnium erit in situs seu respectus punctorum. Videndum quomodo cognosci possit punctum quaesitum habere plures valores posibles. Non semper eundem ad ultimam analysin, sed quo licet manendum in mediis, seu in ipsis motuum genesium repraesentationibus; ut *in* calculis ita et [hic] semper determinanda puncta per locorum intersectiones. Cum magni sit usus calculus Trigonometricus res ita instituenda est ut quaelibet problemata ad ipsum commode referantur, est enim algebraico commodior in praxi.

But in this new kind of representational calculus the imagination perpetually accompanies the mind or pen, so that whatever the pen marks down can be imagined in continual apparition. And the attention never sticks to the symbols as it is forced to abandon consideration of the thing itself, and thus every little line is a theorem of sorts or a property of the figure or motion itself. (However, so that it is not necessary to follow the calculation with the imagination in the act itself, unless we want to.) Hence also from the application and constitution of the calculus itself there will follow a marvellous confirmation and invigoration of the imagination, so that we can in the end follow even very difficult and complicated things, and that without a pen or map or figures, once having this mental thread of Ariadne for imagining which this calculus shows us.

And in some attempt of this art, I already showed how a spherical and planar surface, as well as the circumference of a circle and a straight line, can be represented very exactly through symbols, so that an image of them as it were is subjected to the mind through symbols (however with the aid of an expression, not only visualization, but providing definitions to the mind as well). From this it follows that all curves and surfaces can be exhibited in the same way, because they can be determined by these.

The ultimate analysis of everything will be into situation or the regard of points. One must see how one can ascertain if the point one seeks has multiple possible values. One does not always have to go to the ultimate analysis, but stay in the intermediate when allowed, or in the representations themselves of the geneses of motions; as in calculus so also here points are always to be determined by the intersections of loci. Since the trigonometric calculus is of great use the matter should be established so that any problems can be conveniently referred to it, for it is much more convenient than algebraic calculus in practice.