
Who was Horatio Saltonstall Greenough?

Part 7 and The End

Berndt-Joachim Lau (Germany)

R. Jordan Kreindler † (USA)

37. His Attempts in Deserving Credit in Mathematics

We remember HSG's intention of 1901 Sept. 22 [Harvard, 13/30]:

"I am thinking very seriously of returning home for good this autumn, i.e. of coming home with a view to remaining if I find I can do so to advantage ..."

HSG postponed his sailing to 1902 April and his America stay took only two months.



This letter and the following one of 1901 Sept. 25 contain many thoughts on mathematics and geometry also and were sent to his only one life-long friend. The envelope is addressed to "A. Lawrence Lowell Esq^{re}, Counsellor at Law, 7 Exchange Building Boston, Massachusetts" and completed at rear side "If not found at given address try: 73 Marlborough Street, Somerset Club or 42 Beacon St. or Brookline, Mass."

It seems that HSG did not know that Lowell had become a professor of government at Harvard University in 1898.

Figure 123 Abbott Lawrence Lowell (1856-1943)
(https://upload.wikimedia.org/wikipedia/commons/6/66/Picture_of_Abbott_Lawrence_Lowell.jpg).

Lowell asked as far as he is concerned a natural scientist for comment on HSG's thoughts. On October 17 Prof. Gaetano Lanza (1848-1928), Head of the MIT Department of Mechanical Engineering and Applied Mechanics, wrote to Lowell: "I enclose Greenough's letters as you requested. Regretting that I cannot think of any more suggestions than those I made verbally yesterday" [Harvard, 13/30].

The authors will extract some passages to illustrate HSG's world of thoughts [Harvard, 13/30]:

"I find that I have made a complete mistake years back in beginning the work upon which I have been engaged through not taking account of the money aspect of the matter I had supposed that being in itself purely theoretical any expense incidental thereto would be trifling and also that if I obtained any theoretically correct result the support of a competent mathematical authority for the proper development of the same would follow as a matter of course – well I was totally mistaken in both respects. The brief hints that follow are given for the purpose of asking your opinion as to whether I could at home get the opinion of a first-class authority.

The Carl Zeiss house admit the correctness of the geometrical theory of my proposed Orthomorphic Microscope discovered by my own private method but will give me no assistance towards the development of my 'Kindergarten Method' of Higher mathematics other than attempting to construct the microscope itself and I have not very much confidence in their ability to this unless under my immediate direction & this owing to the radical & irriducible [sic] disagreement between us is not possible – Last autumn I sent them a brief statement of the nature of my method, which by the way is still in a rudimentary condition, having acquired the moral certainty (not absolute certainty) of its full mathematical validity, partly through spontaneous development of the same and partly through what I saw and heard at last year's exhibition. What clinched the matter was the 'Simple Harmonic Analyser' [sic] of the Professors Michelson (1852-1931, the authors) and Stratton (1861-1931, the authors) from University of Chicago, this instrument based on Fourier's Theorem (*Jean Baptiste Joseph Fourier, 1768–1830*, the authors) may also be considered, with the aid of certain theoretical considerations, as a demonstration of the Theorem & when so regarded is a typical example of the method by which I have worked ... Should you care to verify my statement you can easily get from them, the professors, their descriptive illustrated pamphlet *) of the Simple Harmonic analyser.

*) Michelson, Albert Abraham and Stratton, Samuel Wesley: A new Harmonic Analyzer. The American Journal of Science, Fourth Series, Vol. V, No. 25, Jan. 1898.

A replica of this mechanical computer is shown in operation by the video <https://www.youtube.com/watch?v=NAsM30MAHLg>

Before proceeding I had better say at once that I seek no financial aid from you personally, nor indeed would I accept any support whatever except from a recognised competent [sic] authority! But having great confidence in the soundness of your judgement I am writing at considerable length to ask for the favour [sic] of your opinion – Here I can only give a few hints; a full statement of the matter could only be made by word of mouth and with drawing & modelling materials at hand – In the first place the method by which I have worked is quite unprecedented and this must of necessity be a most serious hindrance to making it known; it offends prejudice, - See Riemann (*Bernhard Riemann, 1826-1866*, the authors) on the Hypotheses that lie at the basis of Geometry – The Dominant essential [sic] of the method consists in the statement that the axioms of pure mathematics are only working hypotheses based on sense perception concepts & derived therefrom by a process of abstraction. Next comes a multiple extension of the ordinary definition of mathematical Infinity, viz the indefinitely great; this extension is as follows ...

By doing as just stated we get in every case where the process is applicable results which are strictly exact relatively to visible concepts and consequently which are identical with those arrived at by the usual “analytical” methods & consequently also: - the “Limit method” the ordinary method of infinitesimals and infinities are merely different forms of the same process.”

A questionable calculation takes up the next page which shall “show that every finite part of a sphere of infinite radius is a plane.”

“I will next state the theory of a new, so far as I am aware of, non-Euclidian space discovered by my method; I have called it hyper-Euclidian, for when suitably operated upon it can be developed into Euclidian space.”

We skip the page showing the quantitative definition of his hyper-Euclidian space. HSG’s thoughts look like the non-Euclidian geometries discovered in beginning of 19th century. This term was coined by the German (Johann) Carl Friedrich Gauss (1777-1855). The following sequence of fictitious pictographs shall demonstrate “the use of a geometrical imaginary ... in an imaginary space, a space that has a transcendental curvature, that is infinite and unbounded, and incongrueable [sic] with the Euclidian space ...”

“I will next show that the abstract concept of infinity in the hyperquantitative sense is contained implicitly in the Limit method as an essential constituent thereof: it being of course understood that mathematical infinity is essentially relative. - For this purpose, I will consider the simplest case I can think of, it is typical of all others ...”

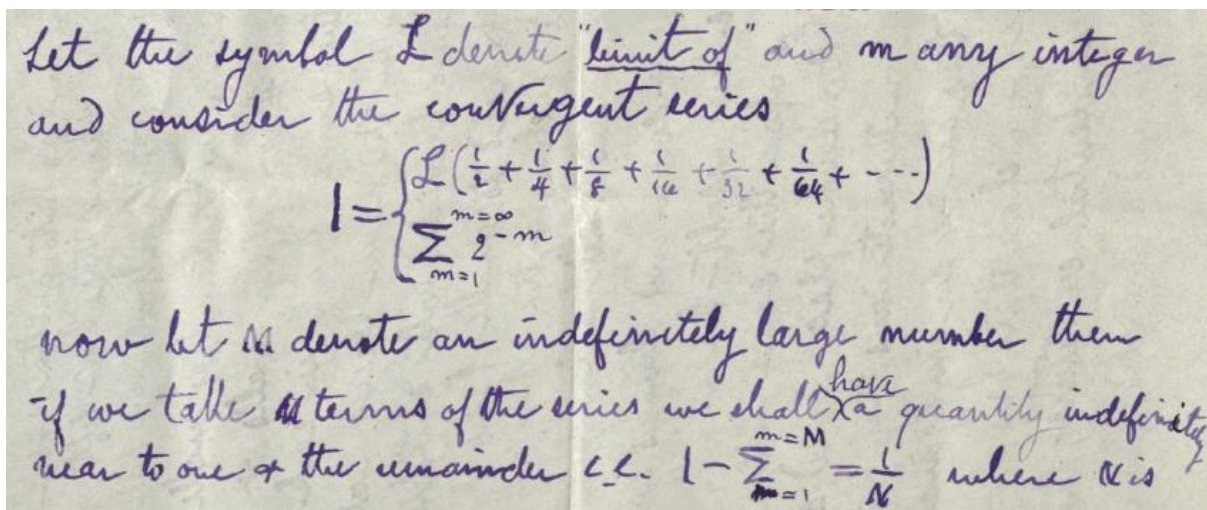


Figure 124 Geometric Series Mentioned by HSG as Simplest Case [Harvard, 13/30].

“... we must put $m=\infty$ this is of course entirely inconceivably but this simple case shows that the inconceivable is always present as an essential constituent in every concept of higher mathematics – it may be hidden or disguised but so far from considering such concealment advantageous I can only regard it as a disadvantage. This of course does not imply any objection on my part to the use of the limit method for this method is often very useful & convenient and perhaps even indispensable for some purposes.

“I fear I have already trespassed too much upon your time and attention so will not say anything about what has been to me the more interesting part of the work I have been engaged in, viz the geometrical theory of my proposed Orthomorphic Microscope and the application of the principle of least action to the study of Ontogony [sic, ontogenesis]; but will only add that by way of testing the validity of my method I have applied it to several well-known problems and in every case gotten identical results given in the text books, e.g. the Gauss’ measure of curvature, the area of the sphere, the projection of the sphere & the pseudo-spherical surface upon a plane so that geodesics shall be projected as straight lines, - the theory of the ellipsoid etc.

In conclusion I will say that my purpose in returning home is quite independent of any considerations of work upon scientific matters. I wish to see old friends again and to have plenty of opportunity for out of door recreation in a form that I really enjoy & these too I feel that I should like to be at home; life in a foreign country is for most people an exile & it is better to be at home if possible.”

The following letter of September 25 [Harvard, 13/30] corrects something of the foregoing letter and ends by: “Hoping soon to hear from you I remain ...”

An ample year later, in 1902 November 3 [BACZ 1576, 77-78] HSG wrote to the 1st Baron Avebury (1834-1913, Sir John Lubbock) and specified his method of mathematical analysis. The English polymath and also amateur biologist and Darwinian worked as President of the Royal Statistical Society in London at that time.

“Let me add, for your information, that the geometrical theory of this microscope is intimately connected with an unpublished method of mathematical analysis to which I have resorted for many years. This method was discovered by me in pursuing a line of action taken in accordance with the kind advice and assistance of my former teacher, the late Professor Benjamin M. Pierce of Harvard University. --- It is essentially a Kindergarten method, but it is capable of being converted into a special Algebra as yet only developed to a very slight extent and fully contained ‘in potentia’ (*potentially from Latin*, the authors) in six symbolic equations --- Here I will only quote equation (4), which may be translated correctly though somewhat inadequately in the following words viz.,

Every perfect Operation is one in which there is no waste of energy.

The equation itself is written:

(4) **Eff. $\odot \equiv I$**

where \odot denotes any ‘Perfect Operator’ or ‘Immutant’ and **Eff.** is the abbreviation for ‘Efficiency of’ so that the equation itself is merely reduced to shorthand, reading thus. The efficiency of any Perfect Operator or Immutant is unity, and inasmuch as the efficiency is the ratio of the useful action, for a given purpose, to the total action; equation 4 may also be translated by the verbal statement that any Perfect Operator or Immutant wastes no energy. Hence it follows that the action of any Immutant is wholly exterior to itself and not varying in direction, the word direction being understood both in a literal and extended sense. --- Further details are unnecessary. In this connection I need only add that among other application of equation (4) it becomes very easy indeed by means of this equation when retranslated into suitable Pictographic and Kindergarten forms to read off, ‘Currente calamo’ (*extempore in New Latin*, the authors), by more inspection of the Pictographs, certain maxima and minima of definite integrals with in our text books require several pages of intricate analysis for their determination ...”

Any reply of Baron Avebury is not known.

Some days later, on November 9, HSG wrote to Ernst Abbe as Professor of Mathematics at the University of Jena [BACZ 1576, 87-92]:

“My dear Sir

In as much as it now appears that the hitherto existing commercial contract between your house – The Carl Zeiss Optische Werkstätte – and myself is about to be closed altogether as it has already been in so far as payment of commission to myself is concerned; I feel free to write to you concerning my unpublished Kindergarten Method of Mathematical Analysis – I will not patent this method nor will I allow anyone else to patent it – I will give it freely for the benefit of society provided that I obtain the necessary support to enable me so to do; but in as much as this will involve a great amount of hard work on my part I will ask for an equitable payment in the form of wages for work actually done in the work shop & Laboratory – Fees for consultations I wave entirely wishing to give freely for the benefit of society what I have learned by some 30 odd years of study.

Since writing commercially I have had the opportunity of laying my Mathematical method before one of our prelates ¹⁾ who is a Dr. either of Theology or of Phylosophy [sic], I am not sure which and the method has his approval as to its Phylosophical [sic] basis: this basis may be stated thus

I An Infinite being Exists

II To every Finite Intelligence, Inadaquate [sic] Knowledge is an essential condition of Existance [sic]

III Every perfect Operation is one that wastes no energy

The Kindergarten Method itself is merely the translation into suitable Kindergarten-Pictographs of the above named propositions and would I think be very easily understood by anyone with a properly constructed Kindergarten Material for the purpose of Demonstration. - I fancy that the Special Algebra into which I have translated my Kindergarten Method would not be generally understood in Germany because this Algebra is an extension of that of Sir William Rowan Hamilton and the method of Quaternions must be thouroughly [sic] well graped [sic] in its essentials before my own Symbolic ‘Operators’ can be well understood. In spite of this fact I deem it prudent for reasons to be stated presently to give you some few indications concerning the essential character of my Symbolic Operators.

– Some years ago my friend Professor Wallerant, of the Ecole Normale Superiore, told me that my unpublished method of mathematical analysis would certainly be stolen from me if it proved to be valuable in practice: ...

¹⁾ The prelate was probably Father Osmund (Henry William) Cooke (1857-1901) who was Superior of the Passionists at St. Joseph’s Church, Paris and a former English architect (See Part 4/21).

Although I can not at present for reasons already stated (viz the lack of a large fortune) make known my Kindergarten Method in an adequate manner yet on the other hand I conceal nothing from those who do me the honour to consult me viz. Physicians, Officers, Man of Business, and students, - I have no distrust whatever of any single individual to whom I have imparted information concerning which I make no injunction of secrecy, but in view of what Professor Wallerant has told me I wish to keep some 'anchors to Windward'. – Hence my letter to Lord Avebury & hence too the following brief statement to yourself.

My Kindergarten-Method of Mathematical Analysis is wholly contained 'In Potentia' (*potentially*, the authors) in the size symbolic Equations herewith viz:

- (1) $I=I$ Red denoting finite magnification and green inverse finite diminution.
- (2) $I=I$ Blue denoting Infinite diminution and yellow inverse Infinite magnification.
- (3) $I=I$ Orange & violet denote inverse Imaginaries or Virtuals or both ¹⁾.
- (4) $Eff.\Theta=I$ Θ denotes any perfect Operator or Immutant ²⁾.
- (5) $T.\omega=2.\cap$ T denotes the Hamiltonian Operator 'Tensor' and ω the Isotome of Ω . and \cap is 3.14159... ³⁾
- (6) $T.\Omega=4.\cap$ Ω is a partially imaginable monocular conapt and can only be demonstrated properly in an experimental manner by means of my proposed Projectograph the nature of which Instrument has been explained to Dr. Culmann ...

All the foregoing will be quite incomprehensible to any one not thoroughly understanding the nature of the Hamiltonian Operator T .

From an Analytical point of view the Geometrical theory of my orthomorphic microscope depends upon the Immutant \square which is a projective dilator, depending itself both on the 4 dimensional potential function D and upon $\Delta_1\Omega$ and $\Delta_2\Omega$, both of which are themselves Immutants.

\square may also be defined quite rigorously [sic] but implicitly by the equation

$$\square\alpha = D_A\alpha$$

when α is a hamiltonian Vector and D_A an arbitrary parameter and a particular value of the four dimensional potential function D ⁴⁾.

¹⁾ The three "Kindergarten-Pictographs" mean that a magnification multiplied by a reduction of the same amount results in unity I .

²⁾ An explanation delivers the letter to Lord Avebury: The perfect operator Θ (or also called Immutant) works without loss and so its efficiency $Eff.$ is identical to unity I

³⁾ The equation $T\omega=2\pi$ is known from oscillations, T denotes the vibration period and ω the cyclic frequency. HSG's interpretation of T as a Hamiltonian operator seems strange.

⁴⁾ HSG used commonly D for magnification.

The nature of this function may perhaps be sufficiently suggested to one not familiar with Quaternions by considering the equation ..." (See following figure, the authors)

(a) $\frac{\partial^2 L}{\partial s \partial t} = \frac{\partial l}{\partial t}$ and consequently further
as in the case $l = \varphi t$

(b) $\frac{\partial L}{\partial s} = \int \frac{\partial l}{\partial t} dt = \varphi t + c.$

then if $c = 1$ $\frac{\partial L}{\partial s} = D$

in (a) L , l , and s all denote lengths
but in three different relations so that
the potential character of the function
 D is ~~expressed~~ expressed implicitly in
by the four variables L , l , s and t .

Figure 125 HSG's Equations of Motion [BACZ 1576, 91].

This example of differential equations of motion cannot understand completely and let miss the mathematical skill, e.g. the scale units differ from left to right equation side. It will keep HSG's secret how the indicated Hamiltonian analytics shall describe the principle of his orthomorphic microscope.

There is not any reply probably conditionally on sender's reputation and Hamilton's theory. Dr. (Louis Otto) Moritz von Rohr (1868-1940) remembered HSG's 1895 lecture at Jena and added:

"The impression of an unfortunate invalid was arisen for us indeed by his letters written only a few years after his visit."

HSG propagated Hamilton's ideas to the Zeiss scientists but the famous German mathematician Felix (Christian) Klein (1849- 1925) had tried the same before with little success. In 1900, Ernst Abbe was invited by Prof. Klein to visit his institutes of applied mathematics at Göttingen. Abbe reacted kindly to the acquainted colleague but recommended his collaborators for a visit. Dr. Czapski thanked Prof. Klein for both of his papers and wrote in 1901 September 20 [Tobies, 2020]:

"Your so simple reduction of Bruns' eikonal to Hamilton's characteristic function is astounding and - very pleasing for me. For my mathematical background is not up to Bruns' development ... I can't get around Hamilton, I can see that from everything, but I think that I will be able to get to grips with him".

Later Dr. Moritz von Rohr wrote on Hamilton's theory [Rohr, 1904]:

"The difficulties become insurmountable in the practical application of these teachings. So far, the characteristic function has only been successfully set up in the simplest of cases, which are either meaningless in practice or for which it has long since found the simplest solution in a more specific way."

Twenty months later, in 1904 July 6, HSG was beginning to have doubts although he repeated most of his already known thoughts. His letter [BACZ 1576, 119-123] shows a "Koch ad acta!" note expressing the lack of interest:

"Dear Dr. Czapski

My purpose in writing to request the destruction of my manuscripts was merely to avoid leaving behind me what I am now thoroughly dissatisfied with ...

Now I suspect false analogies & other undetected latent fallacies, as so often happens in anything quite unprecedented but on the other hand the result obtained are in every case identical with those given by ordinary methods where such methods are applicable, so that I find it difficult to believe this to be purely fortuitous; – The key note of all my work is the concept of a perfect Operation; worked out first in concrete form by analogy from observation of what happens when a man walks straight on level ground toward a given spotting then acts with an unchanging intention and in a manner practically continuous and uniform ..."

In 1904 November 13, HSG will report on a further mathematical demarche [Harvard, 13/30]:

“My dear Lawrence

On Thursday last I had some conversation with Monsieur H. Poincaré (*Jules Henri Poincaré, 1854-1912, French polymath, the authors*) Membre de l'Institut, to whom I had previously written. –

He tells me there is nothing contrary to what is admitted amongst modern Mathematicians in my idea of a perfect operation (one in which there is no waste) and in the application thereof to the study of Ontogony [sic, ontogenesis]. – But the whole subject is purely hypothetical and subjective and it is a question as to how far it would be of interest either to mathematicians or to Biologists. – The concept of immutabelety [sic] in every perfect Operator I have abandoned as untenable i.e. not always admissible were it so then there could never be more than one geodetic line between two points on a curved surface & this is not the case.”

HSG had found his master in Poincaré, who was Professor of mathematical astronomy with the Sorbonne and has been deemed "the philosopher par excellence of modern science" [Moulton, 1945]. HSG will forget soon his new realization that the perfect operator is not always immutable.



Figure 126 Jules Henri Poincaré, Photograph Published in 1913
(https://upload.wikimedia.org/wikipedia/commons/f/f4/PSM_V82_D416_Henri_Poincare.png).

38. His Final Fighting for Self-Centered Concept

HSG wanted to get Lord Avebury as witness of his interests and assistant for acquiring an alternative manufacturer. These were his main requests of the already mentioned letter of 1902 November 3 [BACZ 1576, 76-79]:

“Dear Lord Avebury,

I take the liberty of addressing you by the advice of my friend Mr. George M. Kelson (See *Part 6/32*, the authors). I have just taken the following line of action viz.,

(1st) I have withdrawn my former request made to the Carl Zeiss firm of Jena for their scientific co-operation.

(2nd) I have advised them that the business between us must be closed unless my order for an Orthomorphic Microscope is accepted by them at once.

The Carl Zeiss house people are aware that the microscope listed by them under my name meets with my sanction simply because I wish to act in fairness to them; but I have long since informed them that I consider the one they make to be an inefficient makeshift, and that the listing of the same under my name might injure my reputation as a man of science. ----

With the scientific staff of Carl Zeiss firm my relations are most cordial, and there is no difference of opinion between us as to the GEOMETRICAL THEORY of my proposed Orthomorphic Microscope. The theory itself has been reduced to practice in a manner that leaves nothing to be desired as far as all essential are concerned in the construction of a workshop model.

I have, however, offered a specimen of this microscope to my friend Dr. George J. Bull ¹⁾ ... should Messrs. Carl Zeiss execute the order. Still I doubt whether they would do so with such modifications in mounting as may suit Dr. Bull for his special purpose as an ophthalmologist [sic] ²⁾.

Should my agreement with the firm be cancelled I shall be pleased to offer a specimen of the instrument to The Royal Society, provided that I succeed in getting it made in a really practical and efficient manner.

¹⁾ HSG had written on October 24 [BACZ 1576, 74]:

“P.S. On second thought it occurs to me that it will be better for you to write to Dr. Geo. J. Bull ... asking his views on the medical aspect of the proposed new Orthomorphic Microscope & if you do this such letter from yourselves to him will I think meet the case.”

²⁾ Dr. Czapski had published already a paper on the Binocular Corneal Microscope in 1899 and the new 1902 catalogue of the Carl Zeiss Jena Company offered this first specific application of HSG's microscope (See *Part 5/30*).

It has occurred to me that Messrs. Powell & Lealand of London (*famous microscope manufacturer up to 1914*, the authors) are perfectly competent to make the instrument, and that, if properly approached, they might consent to my being present in order to supervise the work. If my opinion is correct I should be pleased to pay them a sum not exceeding £100 ...

In conclusion I would remark that I do not wish to do any serious scientific work for several months, desiring to pass as much of the time as possible in other fields of sport for the sake of thorough rest: in fact, I am looking forward to some two or three months salmon-fishing in company with Mr. George M. Kelson whom my landlord Monsieur C. Albert Petit has invited to fish with us on the river upon which I myself have just renewed my lease. My purpose in writing to you is to get in touch with the best scientific authority in England and I will be much obliged of your invaluable assistance whenever it may be quite convenient to yourself.

I beg you will excuse the length of this letter from the fact of my so rarely having the opportunity of addressing an English authority.”

The Zeiss Gentlemen were informed also on HSG’s new contact and aimed alternative manufacturer [BACZ 1576, 80]:

“I take it for granted, both because of the generous moral support you have hitherto given me and also because of the well-known high standard taken by your house in all that pertains to the advancement of science that, in case you prefer to decline my order for Orthomorphic Microscope, for commercial reasons, you will have no objection to authorize me to impart to other houses all the information I have received from yourselves. My object is to make known to these houses the dioptic [sic] apparatus which you have constructed. By means of this apparatus you have embodied in workshop model and in laboratory experiments (made by myself and Professor Wallerant) the Geometrical Theory of my Orthomorphic Microscope.

I enclose for your information typewritten copy of letter to Lord Avebury sent this day under registered cover.”

In 1901 spring, Prof. Abbe had postponed his retirement from the company board by two years due to a serious illness of Dr. Czapski – HSG’s main contact person. The reply [BACZ 1576, 83] came therefore from (Ernst Ludwig Victor) Hermann Ambronn (1856-1927), Professor of botany and Chair of Scientific Microscopy at Jena’s university. He was worried about the field glasses:

“We would, however, be very pleased to see your apparatus manufactured by the company you have in mind, provided that none of our patents relating to the use of Porro’s prism combinations in conjunction with a distance between the entrance pupils that is greater than the eye distance are infringed in the process.”

In 1902 Nov. 9, HSG made strong demands to Zeiss Gentleman [BACZ 1576, 86]:

"I write to say that having seen Dr. Geo. J. Bull ¹⁾ today. I find he is not prepared to give specifications concerning Orthomorphic Microscope offered to him. — My original [sic] order now holds good and wishing to have this matter settled in a business-like manner as soon as possible I enclose herewith full specifications for Orthomorphic Microscope not wishing to leave open for discussion any single item in the construction.

For execution of these specifications within 18 months from this date I am prepared to pay you not exceeding Pounds 100.

In case you prefer as I expect to decline my Integral order. I hereby make two partial orders lien thereof.

[1] for execution of order as per specifications except as to Electric light attachment to be omitted Pounds 50.

[2] for specimen identical in Construction with the work-shop-Model sent me last year but with the following modifications Pounds 20. — the modifications are 1st a larger "field" as large as possible consistently with the full Orthomorphic effect of the Microscope. 2nd 2 sets of stops or else a pair of iris diaphragms so that various degrees of stopping may be used and the smallest stops must be pin-hole ones.

[3] The Construction, if possible of a 2nd pair of object glasses giving as high a magnification as possible with this mode of construction, viz the use of Miniature photographic object glasses.

[4] the furnishing if practicable with this pattern of the instrument of Orthomorphic Eye-piece as per no. 4 of your this year's price list to be used with higher power object glasses than those possible of the minute photographic pattern.

Acceptance of conditions [1] and [2] are required for the order to hold good. [3] and [4] may be accepted or declined by yourselves at your own discretion — The price to be modified accordingly at your own judgement. In conclusion my order holds good at not exceeding Pounds 20 for Orthomorphic Microscope magnifying the same as last year's Work-shop model viz 5 or 6. But with larger field & means of stopping to a varying degree from full aperture to pin-hole stops.

P.S. If I do not get acceptance by Dec. 1st 1902 my offer no longer holds good & than business between us is closed."

¹⁾ HSG and Dr. Bull met surely in the Passionist parish. Dr. George (Joseph) Bull (1848-1911) was born at Hamilton, Southern Ontario, Canada as a son of Irish protestants and finally Catholic baptized by the Parisian Passionists in 1892 July — the authors remark that HSG's religious way was similar. Dr. Bull organized the St. Geneviève Society for the English-speaking Catholics of Paris [Ancestors, 2023]. His investigation of the claims of the different churches is explained by his 1906 book "Why I became a Catholic". He graduated in medicine from the Montreal University, went to Paris in 1886 and worked with the Ophthalmic Laboratory of the Sorbonne. His scientific work is reflected by the 1888 book "Spectacle lenses" and the 1889 one "Glasses And Nose Clips: A Medical And Practical Study" [bnf, 2023].

24 Avenue Carnot
 Paris, November 15th 1902

To the Editor of the Times

Sir

Referring
 to the Price list of the Carl Zeiss
 Firm, French edition 1902 page 72.
 I would point out that by the
 addition of a suitable electric-
 light-attachment together with the
 use of extra small stops on the
 Orthomorphic eye-piece no 4,
 the Orthomorphic Condition
 established by myself can be
 realized to much better
 advantage

Horatio S. Greenough

*The statement concerning Orthomorphic eye-piece no 4
 on Page 72 of 1902 Price list French Edition is
 incomplete & should be modified - How
 best to do this I leave to the judgement of the*

Figure 127 HSG on a Really Wrong Track [BACZ 1576, 93].

This copy to the Zeiss Gentleman is supplemented by his comment:

“The statement concerning Orthomorphic eye-piece no 4 on Page 72 of 1902 Price list French Edition is incomplete & should be modified – How best to do this I leave to the judgement of the Carl Zeiss Firm, in whose Moral Integrity I have full confidence. – In my opinion the present statement is both misleading to the scientific public & also is detrimental to the sale of the eye-piece no 4.”

On November 16, HSG climbed down and wrote to Jena [BACZ 1576, 85]:

“I hereby request that you will get from the Editor of the Times my letter of the 14th inst. sent under registered cover & countermanded by telegraphic dispatch because My friend Mr. Geo. M. Kelson (See *Part 6/32*, the authors) convinced me (the same evening) in brief conversation that the letter was in point of fact a libelous one – This was not my intention. On the contrary it is my wish to be of tewire [sic] to your firm in so far I am able - but I will go straight & wherever I may be in error I ask no better than to be corrected.

You may forward this letter to the Editor of the Times as your authority for asking that my letter to him – dated November 14th & sent under registered cover should be sent to yourselves. – I deem it important that the contents of this letter should be fully known to yourselves.“

We learn from Fig. 129 that the optical design of the orthomorphic eyepiece 4 was completed in 1897 end and handed over to the optics workshop. The later catalogue [Zeiss, 1902] states in contrast:

“... a RAMSDEN eye-piece, which is specially constructed for these instruments and is known under the name of **Orthomorphic eye-piece 4**, because of the original design of combining it with small diaphragms in the region of the upper microscopic nodal point in order to satisfy Mr. GREENOUGH’S orthomorphic requirements.”



The authors guess that HSG knew the original version with its top diaphragm for orthomorphic vision and demanded it passionately. But it is verified that its second version without diaphragm was shipped already from 1899 February and so HSG’s demand was no use.

First version: The top diaphragm should provide the orthomorphic condition together with the objective pair of the pre-series instrument.

Second version: The convenient distance of exit pupil resulting from lacking of diaphragm was welcome with the maximum magnification.

Figure 128 Second Version of Orthomorphic Eyepiece 4 (Courtesy N. Raue).

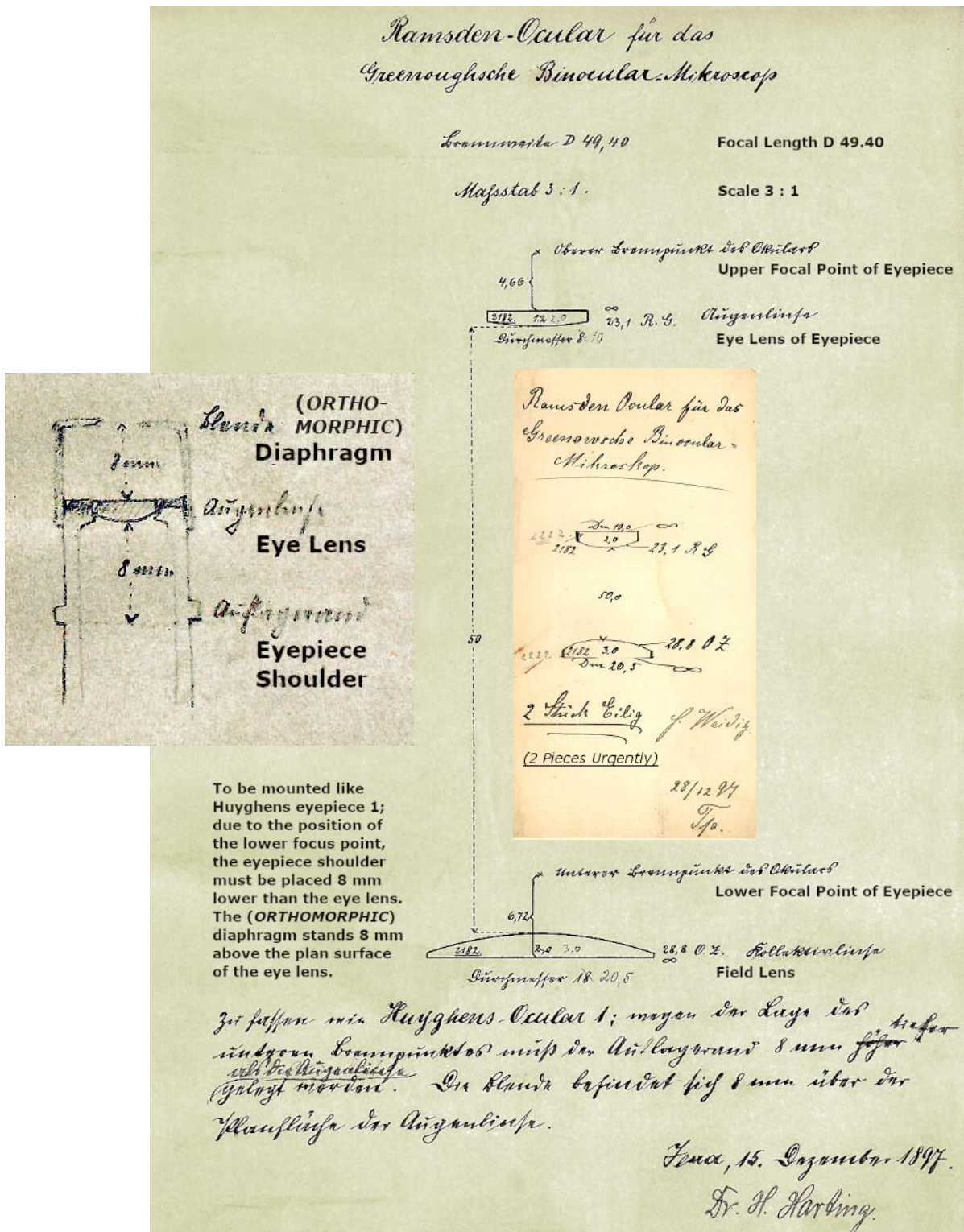


Figure 129 Data Sheet of Original Orthomorphic Eyepiece 4 [BACZ 19819, 39] and Work Order [BACZ 19819, no. No.], Translated and Commented by the Authors.

HSG repeated his criticism of the Zeiss instrument once more in 1902 November 16 [BACZ 1576, 94-95] sounding similarly to judge from 1901 October 29, see Part 6/36:

“Advice concerning Orthomorphic Microscope I

I deem it my duty to inform you that in my opinion the use of the Hartneck prisms (*Inverted Nicol prism is called Hartnack-Prażmowski one*, the authors) of the in Binocular Microscope is radically vicious because it cripples the practical utility & consequently the commercial value of the Orthomorphic Microscope. – People will pay a high price for a really first class article: they will not pay a medium price for an inefficient makeshift.

For the purpose for which I originally designed this instrument viz the study of Mathematical Ontogony. The most useful of all magnifications is one corresponding to $D=6$ or thereabout in my equation (1) $A/a=D$. Confirming myself for the present to this I would call your attention to the following statement viz. – In the workshop model sent me last year the miniature photographic objectives were comparatively long focused ones & this was necessitated [sic] by the use of the Hartneck Prisms. – By using a pair of sufficiently short-focused miniature photographic objectifs [sic, French] to give an unmagnified [sic] image of the object under the Microscope a wide field can be obtained the images satisfying my equation (1) ...

Advice concerning Orthomorphic Microscope II

... $A/a=D$ can then be thrown up & erected by a pair of wide angle objectives, these erecting objectives doing the whole magnification and then the 2nd pair of real images will be looked at through a pair of seeker eyepieces that do not magnify [sic] at all, but serve only to compel a correct direction of the visual axes of the observer.

In the construction above indicated the principle of the division of labour is carried out to the very best advantage. Ist by the use of short-focus but comparatively narrow angled front objectives a high degree of illumination can be obtained and also a linear field sufficiently extended I daresay up to 15 millimeters with $D=6$ and the unmagnified images of the object under observation will be as brilliant as possible. II In as much as the erection of the images is entirely independent of the accompanying magnification. both operations can be performed to the best advantage by the 2nd pair of objectives the acting Main Magnifiers. – III and last by the use of non magnifying [sic] seeker eyepieces a wide field can be maintained and at the same time the proper direction of the visual axes of the observer is secured.

The Front pair of objectives should be provided with either a set of stops to be inserted into slots or else with iris diaphragms as may be most suitable. – Aniline [sic] lightning would probably be sufficient for this magnification – but electric lighting would be very much better – and it would be needful to determine experimentally whether a sufficiently cold light (for use with organic bodies) could be obtained by suitable filtering through alum or other solutions. – This Construction would need a good link motion (*for adjusting the interpupil distance*, the authors) but I am told by a business man here that this last presents no serious technical difficulty.”

In the following November days, HSG wrote further letters of similar content and then he was quiet up to 1904 summer. The “Am” shorthand expressions show Professor Ambronn as reader of all these letters but any reply is missing. Dr. Moritz von Rohr explained in his memoirs [Rohr, 173]:

“... but here may be the remark that GREENOUGH, who was quite amiable as a partner, had practically drilled himself into creating a true-to-space image in a properly built double microscope. My friend KÖHLER, with whom I later worked on this matter, finally broke off the almost endless correspondence with GREENOUGH.”

In contrast to HSG’s opinion, we quote (Hermann) Friedrich Gmeiner (1870-1918), first Professor of internal veterinary medicine at Giessen’s university, Germany, for one of the praises of the Carl Zeiss instrument [Gmeiner, 1903]:

“The most suitable is the Greenough binocular microscope. This instrument is little known and yet I know of no better aid for the clinical examination of dermatoses than the one just mentioned ... It is thus made possible that during the inspection of a specimen, the same can be plucked up and in this way conveniently utilized; in the concrete case, living mites can be quickly isolated from scales and crusts with playful ease and brought to the demonstration. The surprisingly beautiful plasticity of the images, i.e. the possibility of physical vision, give this binocular microscope a high value.”

Here we pay attention to a zoological thought: HSG specified the principle named after Pierre Louis Maupertuis (1698-1759) to animal’s growth in 1904 July 6 [BACZ 176, 122-123]:

“Any kind of grow may be decomposed into two components one of which is isomorphic, and if this component be sufficiently preponderant then there will be a visible approximation to isomorphic growth, such approximation being greater or less according to circumstances. Conversely if there be a visible approximation to isomorphic growth then the isomorphic component is greatly preponderant more or less so as the case may be.

Now in Animals generally a visible approximation to Isomorphic growth is the rule and metamorphosis the exception and moreover when metamorphosis does occur it is generally preceded by a satten [sic] close approximation to Isomorphic growth. So that in the Growth of animals generally we have an example of a visible approximation to the symbolic minimum of a definite integral. – or again such symbolic minimum is a preponderant component of the observed mode of growth. So that the growth of animals conforms to the principle of least action.”

He claims that the animals grow mostly without changing shape which is not true for e.g. insects. HSG had investigated sea urchins (See Part 2/10) and also knew their metamorphosis, the bilateral symmetry of their larva’s is replaced by the adult’s fivefold one.

39. His Bereavement of Confidants

HSG lost two advisers: At first Father Osmund Cooke (1857-1901, see Part 5/28.) as his probable confessor and at second his Brother-in-Law Alphonse Hervoches du Quillion (1829-1903) experienced in public administration. His Sister Charlotte will leave France and move to Vevey, Swiss.

HSG kept a member of the Passionist's parish. The "Congregation of the Discalced Clerks of the Most Holy Cross and Passion of our Lord Jesus Christ" founded by the Italian Saint Paul of the Cross (1694-1775) in 1720 and engaged chiefly in missionary work.

HSG was mentioned as the 40th of 43 named persons in the large audience when in 1904 May the Le Figaro newspaper wrote on a "concert given in aid of the works of the Catholic chapel at Avenue Hoche" [Le Figaro, 1904].

The death of HSG's Uncle Richard Saltonstall Greenough (1819-1904) is reflected by the adapted "David Greenough Trusts" indenture executed at Boston in 1904 May 18. Richard's Father David Greenough (1774-1836, see also Part 1/5) worked as a builder and real estate dealer in downtown Boston [Greenough, 1969]:

Sculptor Rich. Greenough Dead.

Rome, April 23.—Richard Saltonstall Greenough, the American sculptor, died here today from grippe, in his 85th year. Mr. Greenough arrived in Rome last week. His remains will be interred in the Protestant cemetery in Rome. Mr. Greenough was born in Roxbury, Mass. He was a brother of Horatio G. Greenough, sculptor of the statue of Washington in front of the national capitol at Washington.

Figure 130 News Item from Detroit Free Press (Detroit, Michigan), Sun, April 24, 1904, Page 6.

"... [David Greenough] directed that upon the decease of his last surviving child the said trustees should hold all and singular the estates therein devised to them in trust to use of all his grandchildren then living who should take per capita share and share alike and in like manner should distribute all personal property so held by them.

And Whereas Richard Saltonstall Greenough, being the last surviving child of the said David Greenough died on the 23th of April 1904 and the thirteen Beneficiaries above named are all the grandchildren of the said David Greenough that were then living the said Horatio Saltonstall Greenough and Charlotte Gore Hervoches du Quillion being children of his son Horatio Greenough ..." [McClung, 1912].

In 1903 April 1, Ernst Abbe retired legally and Dr. Czapski became the CEO of the Carl Zeiss Company. Prof. Abbe had ruined unfortunately his health from paraldehyde narcotic and deceased in 1905 January 14 shortly before his sixty-fifth birthday. Siegfried Czapski was promoted to a professor in October 26 but will succeed his esteemed mentor only for a short period. In 1907 he was surged successfully on the appendix at Weimar and eight days later he died unexpected by a lung embolic on June 29 in his forty-sixth year [Knopf, 1907].

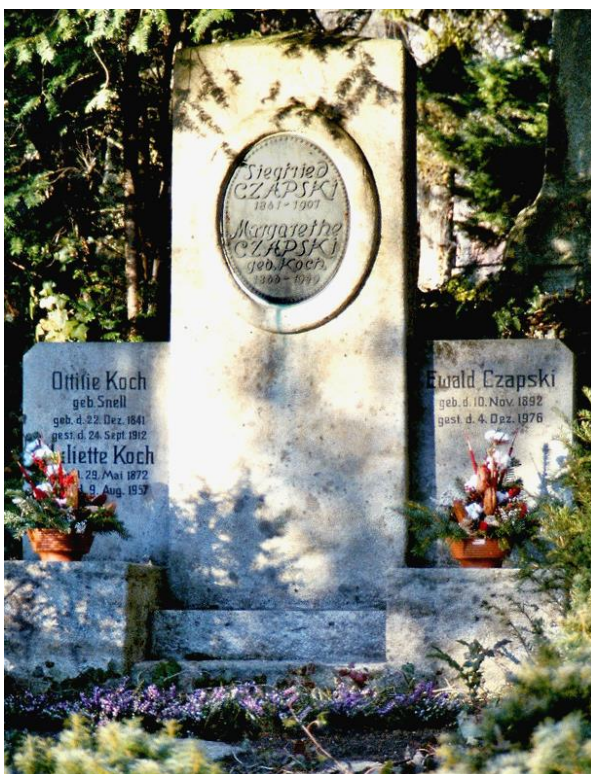


Figure 131 Czapski's and Abbe's Gravestones Side by Side at Jena's Northern Cemetery.

As result HSG's partner of the Carl Zeiss Jena Company had also to be changed. Dr. Moritz von Rohr (1868-1940) will continue the correspondence and he was very well qualified from his paper on human viewing [Rohr, 1904] and his historical studies on binocular instruments [Rohr, 1907].



Figure 132 Drawing from Trademark Registration in 1904 [BACZ W 15].

In 1895 Dr. Moritz von Rohr had joined the company as Abbe's assistant and optics designer. In his first weeks, he heard HSG's lecture at Jena (See Part 4/24) and he remembered later [Rohr, 173+194]:

"In our workshop, GREENOUGH's suggestion led to the widespread double microscope that bears his name, but which, to his sorrow, did not depict true to space ... To his liking, we had built a device for low magnifications that was true to the space in the strict sense of the word, but he still found things that we couldn't possibly deal with anymore ...

It was around autumn of 1897 that CZAPSKI, together with GEBHARDT, published a paper on GREENOUGH's double microscope, with CZAPSKI, as of course, had worked on the theoretical, GEBHARDT on the practical part. Understandably, I was particularly concerned with the somewhat cumbersome derivation of CZAPSKI, which, according to his expression, would have to coincide with the pupil of the entire single microscope with the main point, and I had a good opportunity to test the usability of my general presentation just published by SCHWIER in this particular case. The fact that I kept silent about it will be understandable to the reader, and I certainly couldn't have done anything wiser. At that time, like GEBHARDT itself, I lacked a knowledge of history to make a judgment about the GEBHARDT part: some of the aids and tools recommended there were already published in the 18th century."

We learn from [Harvard, 13/30] that HSG spent "for the greater part of the time ever since December 1904" at "16 Avenue de Madrid, Neuilly sur Seine, FRANCE, care Dr. Rene Semelaigne. It's a Sanatorium." The Parisian Police Prefect stated that HSG left 24 Avenue Carnot in 1905 April without an address hint [Archives, 1905].

In that time, HSG offered a second lot of his instruments at a price of 1,700 Franc to the École Normale Supérieure (ENS). A French handwritten letter from the Université de Paris of 1905 March 14 asks how to deal with it: "Is an authorization of Prof. Houssay needed for accepting this supply?" A second writer answers: "This generous donation might and shall be seen as a gift ... I support most the solution of proposing M. Greenough for the Order of Academic Palms" [Pierrefitte, 1905]. The authors assume that this unpleasant proceeding putted an end to HSG's contact to the scientists of ENS. The decoration proposal is reflected in official letters, so the Police Prefect wrote to the Minister of Interior, Security and Foreigner Department in 1905 May 20:

"In response to the desire expressed in your letter of May 10th, I have the honor of forwarding to you the information I have gathered on Mr. Greenough's account, concerning which you were consulted by the Minister of Public Instruction and Worship, in the matter of the award of the title of Officier d'Académie (*or of Silver Palms Order*, the authors). Mr. Greenough, Horatio, ... is an American citizen ... and his attitude on the national stage has never given rise to any particular remarks. Mr. Greenough has not submitted his declaration of residence to my Prefecture" [Archives, 1905].

40. His Correspondence with Jena Comes to Final Dissent

We do not know any HSG letter to the Carl Zeiss Company between 1904 July and 1906 November - surely a recreation span of 28 months. Dr. Moritz von Rohr and Dr. August Köhler (1866-1948) intended to reply finally to HSG in 1906 November 23 [BACZ 1064, 14590]:

“Your letter of Nov. 17th came duly to hand, was presented to our different colleagues, and we are now going to communicate you our conclusion.

We have read with interest the description of the way by which you received as early as July '92 at the idea of your orthomorphic microscope; we cannot but repeat our congratulation to you and we assure you of our sincere approval of this idea. We have not the slightest doubt that you have the merit of independently and successfully applying the theory of orthomorphic stereoscopy to the microscope. We shall in future, as we have done before, attribute this to you in public, and if any honour [sic] be attributed to you for it, we shall note it with our heartiest congratulations. We do so now, as we see from your letter, that the title of “Officier d’Académie” has been conferred upon you.

But as to your suggestion of our bringing out a new, really orthomorphic, binocular microscope somewhat on the lines of that workshop model *) sent to you some years ago through Dr. Culmann, we are sorry to say that we must decline to do so. We perfectly agree with you, that the image in our ordinary model is not orthomorphic, whereas that in the workshop model just mentioned is. But we must insist upon the impossibility of successfully solving this problem by means of the ordinary compound microscope for anything like a medium field of view even. Your suggestion of applying v. Rohr’s Verant-lenses in order to improve the general quality and especially the field of the eye-pieces cannot be successfully carried into effect.

*) Moritz von Rohr and August Köhler coin the ‘workshop model’ term for the modified instrument which was announced by Dr. Culmann in 1901 October 12:

“We have based our experiments on the explanations you gave last winter and this spring about the orthom. M., which we fully agree with in principle, as the basis for our experiments. We have only deviated from your suggestions in one, in our opinion insignificant, point, in that we have replaced the fine pinhole serving as a lens with a real lens, which must of course be stopped down in order to achieve the necessary depth ...” [BACZ 1576, 55].

You find HSG’s former judge of October 29 [BACZ 1576, 58] completely in Part 6/36: “I have this morning carefully examined the new Orthomorphic Microscope at Dr. Culmann’s and have much pleasure in advising you that the Orthomorphic effect is quite satisfactory. Indeed in this respect there is between the new Orthomorphic-Microscope and any hitherto constructed all the difference between success and failure; and this is the more satisfactory [sic] to me in that it strongly confirms my confidence in the validity of the geometrical theory of the Orthomorphic-Microscope ...”

The Verant lens will not do unless we have a large Exit-pupil, and in the ordinary compound microscope this pupil is necessarily contracted. Years ago we made experiments in this direction and met with complete failure. The real reason for it is to be found in the construction of the human Eye, as in this optical instrument the pupil is not at rest but is turned about the centre [sic] of rotation when in use. We do not see a possibility of getting orthomorphic images of a finite angle in direct vision by means of a compound microscope of uninterrupted action, but we must replace the aerial images furnished by the objectives by means of microphotographs. This we have done in the instrument sent on your ordre [sic] to the Paris institute.

We are truly sorry not to be able to satisfy a dear wish of a highly valued friend, but we are perfectly convinced that we cannot successfully carry your idea into execution.

Believe us, dear Sir,

Yours very truly"

M. von Rohr. *Dr. A. Michelson.*

Figure 133 Signatures at Letter of 1906 November 23 [BACZ 1064, 14590].

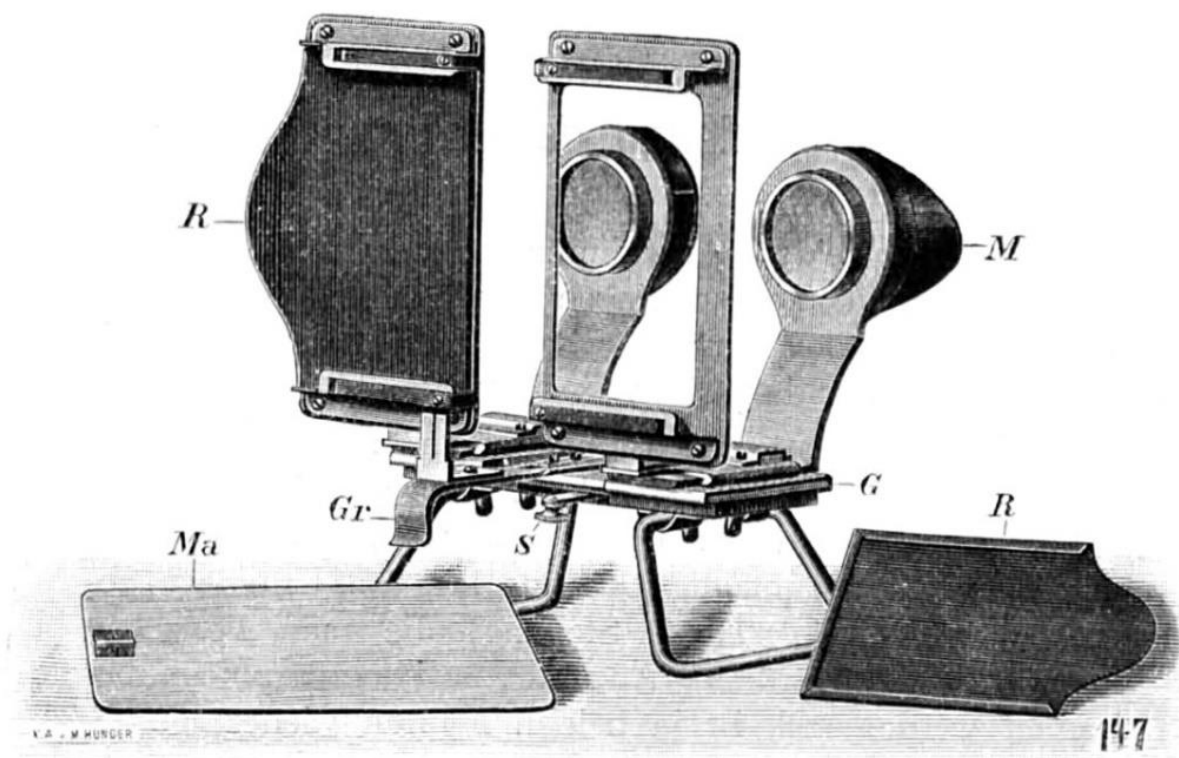


Figure 134 Rear Side of the Bi-Verant [Zeiss, 1904].

In 1901 the Swedish ophthalmologist Professor Allvar Gullstrand (1862-1932) suggested a magnifier device adjusted to the eye's center of rotation agreeing to the principle discovered by him. Corresponding this Dr. Moritz von Rohr designed the Bi-Verant for large distortion-free fields and it was described by the Carl Zeiss Company [Zeiss, 1904]:

“The Bi-Verant is an instrument for giving a *natural impression* when viewing two images, each intended for one eye. In the vast majority of cases, these are two *stereoscopic* half-images, but there can also be an advantage associated with viewing *identical* images. For this purpose, however, the representations of the objects in each frame must present themselves to the corresponding eye under the same viewing angles under which the objects themselves appeared at the location of the corresponding recording lens.”

For the present, HSG wished “a merry Xmas” to Dr. von Rohr, Prof. Czapski and Mr. Fisher [BACZ 1576, 130]. On the 1906 New Year's Eve, HSG sent six documents in separated covers [BACZ 1576, 135] to the “Doctors Siegfried Czapski and Von Rohr” with the hint inside the accompanying letter [BACZ 1576,131-134] “... before reading what follows I invite your careful attention to Document no. 1 and no. 2 under separate Covers herewith ...”.

The authors have added details in *Italic* to HSG's headlines:

- | | |
|------------------------|---|
| Document no. 1. | (1) <i>A/a = D, D</i> essentially a potential function. |
| Document no. 2. | Orthomorphic Stereoscopic Microscopy is possible – but not by any Compound with <u>Dioptric</u> Apparatus of good working Aperture. |
| Document no. 3. | On the Obtention (<i>obtainment</i>) of Orthomorphic Stereoscopic Microscopy by Micro-photography and by other Compound Optical but non-Dioptric Apparatus (<i>two well-stopped photo lenses at a 15mm stereo basis provide photos with good resolution and depth, they will look 20X magnified by stereoscope equivalent to orthomorphic microscope</i>) |
| Memorandum | Concerning non-Compound Orthomorphic Microscope (<i>useful for Ophthalmological Surgery</i>). |
| Memorandum | Concerning the Obtention of Orthomorphic Stereoscopic Microscopy by <u>Micro-photography</u> (<i>with D=6 and D=12</i>). |
| Memorandum | concerning asked-for <u>Experiments</u> (<i>on sales bundles of intensive light source, orthomorphic eyepiece no. 4 and capillary or prism rotator for examination of eggs, larvae and embryos</i>) |

In 1907 January 9, Dr. Moritz von Rohr will reply to HSG on the naming issue [BACZ 1064, no No.]:

“... with regard to your complaint about “Greenough’s Binocular Stand” cited from the last French edition of our Catalogue of Microscopes. Years ago we have had some correspondence with you on this topic and in compliance with your wishes we have in our description of Stand X^a left out – unwillingly enough – every reference to your name. This was done in our 33rd {German} edition of our Catalogue of Microscopes. We shall now await ourselves of your new demand will at most satisfaction. We shall state in our new list of binocular stands to be published in this spring that we are responsible for this particular form, as it is an alteration of your original design. In the hope that you will be satisfied with our answer as to stand X^a.”

Really the 31st (1898) and 32nd edition (1902) of the Carl Zeiss Catalogue mention HSG’s name but it will be erased beginning from the 33rd (1906) German, English but not French edition. In the twentieth years after HSG’s death, the Carl Zeiss Company will do HSG again the honor of the initiator of the first commercial stereomicroscope. In contrary HSG is not mentioned concerning his Capillary and Prism Rotator in the 1898 catalogue but in every catalogue starting from 1902.

Binocular Stands.

[Zeiss, 1902]

In the course of 1897 we introduced a new form of binocular microscope after designs by Mr. HORATIO S. GREENOUGH in which **stereoscopic vision** is obtained, not by division of a pencil of light passing through a **single object-glass**, but by a **combination of two microscopes, complete in themselves and combined with erecting prisms.**

Image-erecting Microscopes, provided with PORRO Prisms.

[Zeiss, 1906]

In the course of 1897 we introduced a new form of **binocular microscope** in which **stereoscopic vision** is obtained, not by division of a pencil of light passing through a **single objective** but by a **combination of two microscopes, complete in themselves and provided with erecting prisms.**

Figure 135 Comparison of Chapter’s Introductions of 1902 and 1906 Carl Zeiss Catalogues.

Some excitement and exaggerated opinion of himself seemed to coin HSG's reaction more than understanding of the rejection causes. Dr. Moritz von Rohr has to repeat the rejection in 1907 January 11 [BACZ 1064, no No.]:

"We had already written the enclosed letter of Jan 9th when we received your telegram which today was followed by your letter of Jan 9th. As you put the case in the following words: "A working agreement between us is possible in one of two ways, to wit: either by your convincing me of error or by your meriting my own design integrally" we come to the conclusion that we must decline the working agreement as we cannot but abide by our former decision.

1. We do not want to convince you of error, as we quite agree with you that the image of our ordinary model is not orthomorphic whereas that of a model made according to your idea is [see our letter of Nov. 23 '06].

2. In the same letter we gave you in some length the reason why we do not want to construct the ideal arrangement as a compound microscope {even furnished with short focus miniature photographic objectives}. You must add to the reason given there our conviction based on our experience with orthomorphic instruments like the Verant and the Bi-Verant that by far the greater part of our customers would not appreciate the advantage consisting in a correct rendering of form. We can only repeat that our experience has shown us – at our expense – that, although stereoscopy is growing more popular the question of orthomorphy and heteromorphy is not even considered by the greater part of the customers. You are far ahead in this respect to your contemporaries and it was your mission to point out the importance of orthomorphy in binocular microscopy. In this we have always given you credit and we are willing to mention at the sale of every stereoscope constructed on the lines of the specimen dedicated by you to the Paris Institute, that in this instrument your ideas of orthomorphy were fulfilled by means of photography.

We are, of course, aware that such a contrivance cannot be applied in certain cases like that of ophthalmic surgery, but even this insight cannot alter our conclusion.

Yours very truly
M. von Rohr"

This letter is supplemented by the last available Czapski's autograph to HSG, see Fig. 136 on the next page.

The last HSG letter of 1907 January 27 [BACZ 1576, 137] is also seen below and we learn that HSG's handwriting was strongly changed during the last ten years due to his nerve fatigue (Fig. 137).

Dear Mr Greenough,
 Your last letters having been partly addressed to me also
 I take the opportunity of confirming Dr von Sahr's responses
 of the 9th and 11th. I am heartily sorry that under the given
 circumstances outfit answer cannot be of a different tenor.
 I hope to be able within the next days to add a few lines
 respecting one certain passage in your letter of Jan. 9th.
 Meantime believe me, dear Mr Greenough
 yours affectionately
 H. Czapski

Figure 136 Prof. Czapski's Autograph of 1907 January 11, Copy of That Time [BACZ 1064, no No.].

16 Avenue de Baden
 Neuilly sur Seine
 January 27th 1907
 Dr. Von Sahr
 Optische Werkstatt
 Gena

Dear Sir

If the Bi-Vorant
 be sufficiently good - I have never seen
 one - to be capable of useful application
 for teaching Natural history and
Zoology (in ~~at~~ schools, it should
 be possible to ~~at~~ obtain a market
 for it.

With kind regards
 Very sincerely yours

Horatio S. Greenough
 P.S. It would not be necessary to have
 one for every pupil, but only for a
 certain percentage of the pupils - to be

indicated by the teachers. I have formerly
 taken stereoscopic views, with ordinary
 stereoscope, for the purpose of demonstra-
tive illustration in Natural History,
 and I think well of the method.

The use of the electric
 light combined with the
 smallest available stops at
 the centres of projection of the
 object glasses is an essential
 & integral part of the Ortho-
 morphic microscope as
 designed by myself
 H. S. Greenough
 May 11th 1897

(4) and also certain branches of geography

Figure 137 Last HSG Letter [BACZ 1576, 137] and Handwriting Comparison [BACZ 1579, 17].

41. His Orthomorphic Principle Assessed Multiply

Dr. Moritz von Rohr repeated HSG's favorite dwarf parable [Rohr, 1904]:

“HORATIO S. GREENOUGH first drew attention to the following consideration: If we assume an observer who looks at an object at a certain distance with both eyes, the angles at which he perceives the objects do not change if the observer, the distance and the object are magnified equally in each direction. Thus, obviously, the Lilliputian*) looking at a pea at a distance of 25 mm has the same impression of its size, shape and distance as a normal person looking at an orange from a distance of 30 cm.

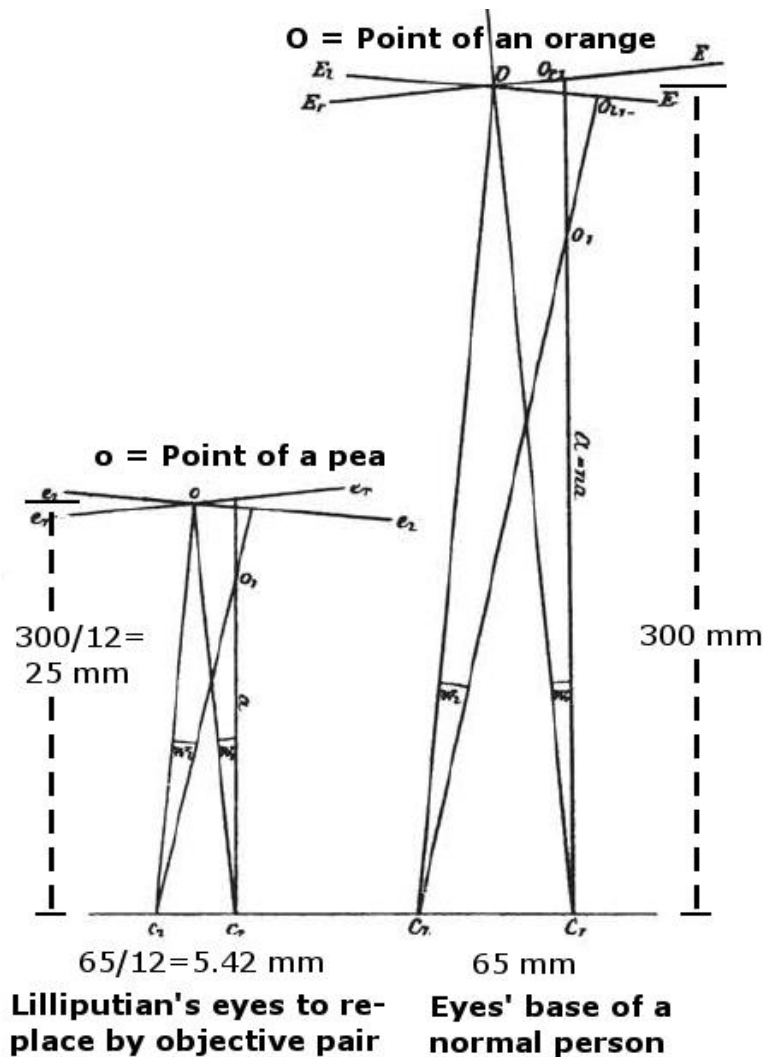


Figure 138 Unscaled Sketch of HSG's Consideration [Rohr, 1904] Commented by the Authors.

*) According to SWIFT's satire "GULLIVER's Travels" the inhabitant of Lilliputa is a human being reduced to 1:12 after each dimension ...

H. S. GREENOUGH uses this consideration for the construction of a low-magnification microscope with correct plastic ... This spatial image is strictly similar to the spatial object after its creation and shows all lengths in twelvefold magnification.

We obtain a three-dimensional image uniformly magnified in all dimensions if the linear magnification of the orthomorphic microscope is equal to the quotient of the distance of the eye rotation points divided by the distance of the entrance pupils of the objectives, and if both the convergence of the axes and the principal ray inclination angles have the same values for each individual system before and after passing through the instrument.”

HSG's intension and formula no. 1 were repeated and completed by the additional condition of generally equal principal ray inclination. Dr. Czapski's description using nodal points and diaphragms was been formally correct but with such a beam path and the usual types of lenses, the sharpness of the images would suffer.

What was the mentioned device for low magnifications that “was true to the space in the strict sense of the word” (See 39)? Dr. von Rohr explained this in the first edition of his book “The Binocular Instruments” [Rohr, 1907]:

“The lenses of GREENOUGH's device were completely adopted for DRÜNER's camera, in which for the first time in a long time the convergence images with two cameras were realized. Since the stereograms obtained in this way must give a heteromorphic impression in the ordinary stereoscopes constructed for parallel cameras, A. KÖHLER and M. VON ROHR constructed for H. S. GREENOUGH an orthomorphic stereoscope which still provides a subsequent magnification and which may be described below for the first time.”

HSG's formula no. 1 was used here also as the condition for orthomorphic imaging by Wheatstone's stereoscope.

“An unfavorable circumstance lies in the mirroring of the half-images (*by the mirror stereoscope*, the authors) ... and it is therefore advisable to choose (*diapositive plates upside down or*, the authors) a transfer process for paper images, so that the half-images themselves are copied mirror-inverted.

This is where the improvement suggested by A. KÖHLER came into play. If the negatives from the DRÜNER camera cannot simply be copied, then the reversal necessary here can also be combined with a subsequent enlargement (*of 2X*, the authors), for which the sharpness of the image was still quite sufficient ... The mirror-inverted copies are easily obtained in an ordinary enlarger by inserting the negatives upside down as usual and taking the picture through the glass.

The experimental versions produced in the ZEISS workshop satisfied even the most demanding requirements ...”

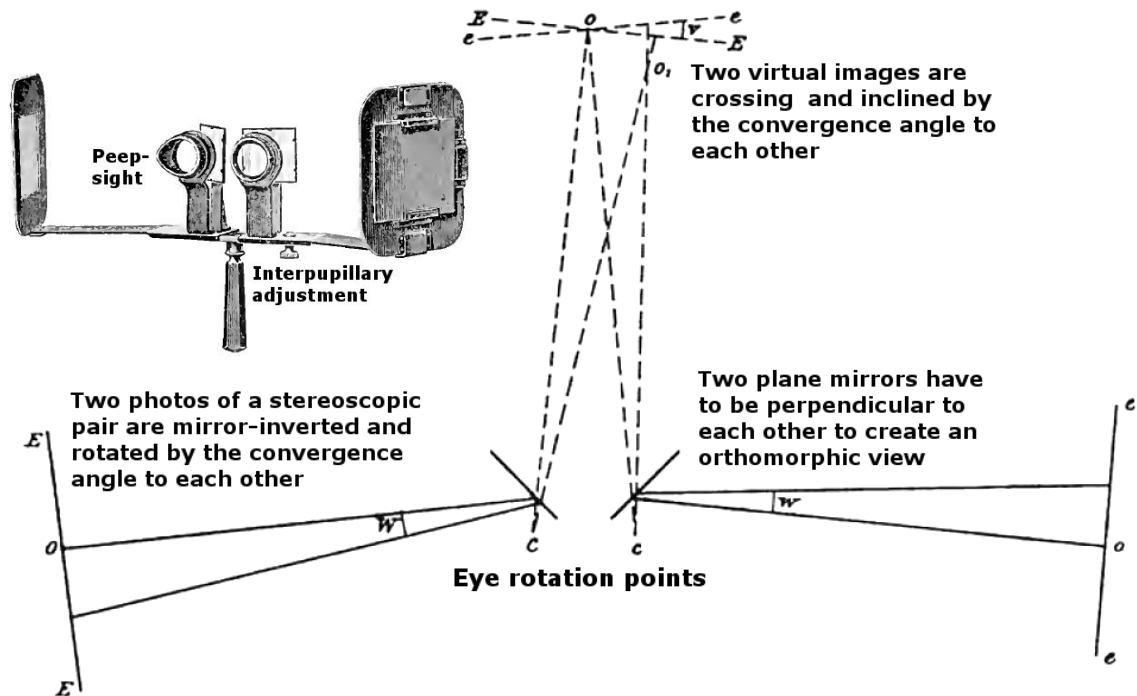


Figure 139 Orthomorphic Mirror Stereoscope [Braus, 1908] and Its Wheatstone's Principle [Rohr, 1904]
Commented by the Authors.

The German anatomist Prof. Hermann Braus (1868-1924) summarized [Braus, 1908]: “Orthomorphism can only be preserved for our eye if the stereoscope is constructed in such a way that the images appear to our image perception at the same angle at which the objective axes converge with each other in the recording apparatus, and that at the same time the images are within normal visual range.”

Dr. Moritz von Rohr compared the known orthomorphic instruments [Rohr, 1907]: “It may still be pointed out that such a device (*mirror stereoscope*, the authors) for homeomorphic representations, realized with the help of photography, even in front of an ideal orthomorphic microscope according to H. S. GREENOUGH, has the advantage that here free seeing can be taken into account in contrast to the keyhole perspective only possible there ...

However, a regularly reduced or enlarged spatial image can also be achieved by a device which is much older than GREENOUGH's ideas; it is HELMHOLTZ's telescopic mirror stereoscope ...”

He judged furthermore on the Zeiss double microscope [Rohr, 1907]:

“However, the equality of the angles of view, which H. S. GREENOUGH demanded on the basis of his correct theory, was not always achieved ... It would be well within the means of microscope optics to comply with this optical path without disturbing the conditions of good imaging, but the interest of the users of even this instrument in homeomorphism is too small to justify the introduction of a much more cumbersome construction for the sake of this requirement.”

The todays stereomicroscopes are optimized for different tasks but the authors know not a single orthomorphic one.

He added later [Rohr, 1920]: “Another innovation attracted a great deal of attention, at least among experts, and that was the GREENOUGH's double microscope ...”



Figure 140 Stereo Bodies for Different Applications, Details from [BACZ 7712+7716+7742] (Courtesy N. Raue).

42. His Review of Life

The review of HSG's life is indebted for a letter [Harvard 13/30] to his live long friend written from his last domicile at 16 Avenue de Madrid, Neuilly-sur-Seine in 1906 November 21. The authors will let HSG to speak self-explanatory and to allocate the assessment to our readers:

"My dear Lawrence

I have been taking a rest-cure, here, for the greater part of the time ever since December 1904. and am now feeling less ill than when I came here – My physicians tell me that my illness consists essentially in condition of nerve fatigue and of psychological irritation, and the Senior Physician Dr. René Semelaigne, *Medecine Alieniste (1855-1934, French psychiatrist, the authors)*, and himself a Catholic has told me again and again that I have the full use of my reason, and that I am fully responsible of my thoughts, words, and deeds.



Figure 141 Tram Connected Dexter Avenue de Madrid and Parisian City Since 1900 (No. 23 L.E.D. Postcard).

I now write with the intention of eliminating [sic], as but I can and as far as may be, any still outstanding equivocal or ill defined moral responsibility [sic] inherent in past transactions between us. and before proceeding further deem it best to state as my own personal conviction, that in as far as own individual respective properties are concerned I think it necessary that neither of us assume any financial responsibility [sic] whatsoever in the premises.

Because of the nature of the communication about to be made I am constrained to depart, upon this particular occasion, from my established custom, in my intercourse with non Catholics, to confine myself, in a Spirit of Kindliness, to such temporal matters as are common to them and to me, – but wish to do so only to such degree as is really indispensable.

You are, I think, quite aware that the dominant essential condition preceding [sic] my reception into the Church Militant, was the destruction in my mind of previous belief that “Space is a Self Existent [sic] Being conforming absolutely to the abstract Axioms of Euclid including the postulate on parallel lines,” and also that this belief was destroyed by the Secular Teaching of the late Professor William Kingdon Clifford (1845-1879, *English mathematician and monistic philosopher*, the authors). – Now concerning this matter and all that is proximate thereto I am convinced that I attached greatly or perhaps second alone exaggerated [sic] importance to subjective manifestations and not nearly enough to the certain objective tradition of the Church although I have always given precedence to the objective Tradition of the Church over subjective manifestations.

We both took part in the founding of the M.P. Club (1883, *Mathematical and Physical Club*, see also *Part 1/6*, the authors), concerning which it was my intention to promote in a Catholic Spirit the Study of Mathematical Philosophy [sic].

The foundation of the M.P. Club, led up to an unpublished method of mathematical analysis, and to the discovery thereby of the complete geometrical theory of the Orthomorphic Microscope, on July 4th 1902 (1892 *correctly*, the authors) and communicated by me to the late Professor Dr. Abbé on the same day by post in the form of equation (1) of my letter to him

$$(1) \quad \mathbf{A/a=D}$$

in which equation **A** denotes the distance between the geometrical centres of projection of the eyes of an observer, looking into the Microscope, **a** the homologous distance between the geometrical centres of projection of a pair of objectives and **D** an arbitrary parameter equal to the ratio of any dimension of the virtual object seen by the observer to the homologous dimension of the & similar real object under the Microscope.

- An incomplete geometrical theory of this same instrument, had, unknown to me, been published by a capucine [sic] some two hundred years ago (*See Part 2/9*, the authors).

When the Complete geometrical theory of the Orthomorphic Microscope came to me, I had been working upon it at least since 1888 by means of my private method of analysis, still in a far more rudimentary condition than later on, and equation (1) was read off *extempore in New Latin*, the authors) by inspection of an interior Pictograph completely defined as to its geometrical aspect incompletely defined as to its dioptrical aspect and discussed as self-demonstrative and moreover except that it was interior as though projected upon a Screen by some other person.

In what follows I shall use the word Mathematics in the wider sense defined by our teacher the late Professor Benjamin M. Pierce of Harvard University.

Piecemeal but not integrally I have submitted my private method of Mathematical Analysis to two of competent [sic] authorities, including most Eminent [sic] Professors of Mathematical Science on this Side of the Atlantic. – By no one has it been condemned and by the greater part it has been approved as mathematically valid.

For your information I now add such least account of my unpublished method of mathematical analysis, as may I hope, be sufficient for the purpose of this present communication.

Essential accessories of my “Operative calculus” are:

1st The use of colours as mathematical Symbols.

2^d Suitable Kindergarten Appliances. Some of the appliances have already been made, roughly, but sufficiently well for my own work.

An Essential of my Operative calculus, but not a Principal Essential consists in the employment of Non-Euclidian Geometry.

The Dominant Essential of my Operative Calculus was submitted by me in 1897 to several Doctors of Theology at the Congress of Catholic Scientists at Fribourg in the form of a proposition, and they were unanimous in declaring this proposition to be, in their opinion, fully admissible. –

I now proceed to give this Dominant Essential in another form and with fuller Development: - Preliminary Fundamental Postulate.

To every finite intelligence inadequate knowledge is an essential condition of its own existence...”

The authors leave the definition of infinite mathematical concepts, the dominant essential proper and the postulates for his Operative Calculus as a perfect operator.

“As you are familiar with mathematical technique I purposely omit Kindergarten Illustration in literary form and pass at once to a very simple example: Required to go from any one given point in space to any other given point. Using Clifford-Hamilton notation (*infinitesimal calculus*, the authors) we have immediately agreeably [sic] to Postulate no1.

(1) $\dot{\rho} = \beta = \text{constant Vector}$

Integrating we get immediately

(2) $\rho = \alpha + \beta t$

α denoting an arbitrary vector to the origin, or from the origin – and t time, and equation (2) is the equation of uniform motion in the straight line passing through the two given points. – A posterior discussion of (2) shows that no waste has occurred, as you can easily determine for yourself.

In my opinion the combined use of Colour [sic] Symbols and of Symbolical Perfect Operators admits of a briefness, terseness and clearness, in certain cases, not hitherto attained in mathematical written language.

For briefness I purposely refrain from any other example of a Symbolic Perfect Operator.

It is my deliberate conviction, based upon personal experience [sic] combined with memory of what I underwent at school [sic] and in college, that my Kindergarten Operative Calculus, properly developed and prudently taught would spare both to children of from twelve to fifteen years of age and also to young men much of the excessive mental fatigue and psychological irritation now endured by students in mathematics, and also that by my method Children of from twelve to fifteen years of age could easily learn in attractive and interesting manner the more elementary portions of Modern Higher Mathematics including some well known maxima and Minima of definite [sic] Integrals.

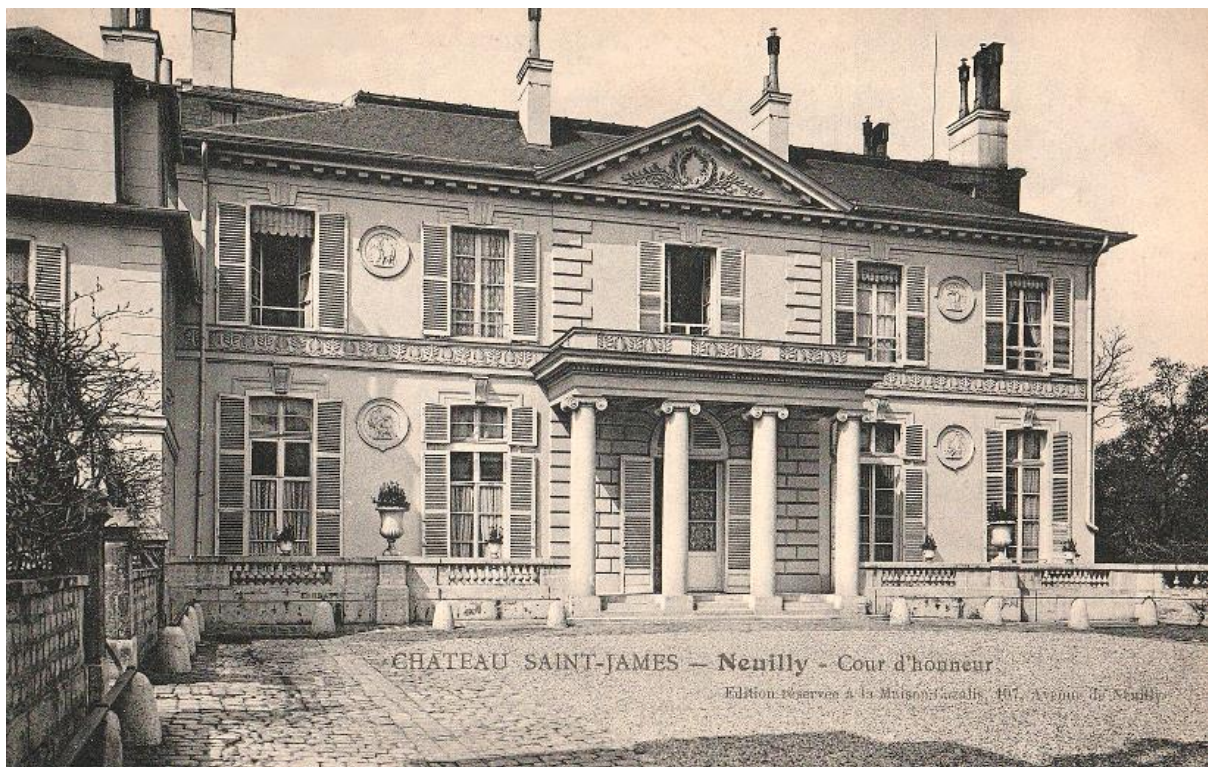


Figure 142 Dr. Semelaigne's Sanatorium In 1910 (Postcard Edition Réservée à la Maison Cuzalis, Neuilly).

Concerning my Kindergarten Operative Calculus, it was the advice of my late brother in law, Monsieur Alphonse Hervoche du Quillion (1829-1903, the authors), that I either obtain for it adequate support, both Moral and Financial, or else that I drop it together, and I have acted on this advice from the time it was given up to the present hour.

Should the development and teaching of my Kindergarten Operative Calculus, - which by the way can be used either in Pictographical form -, three dimensional and two dimensional, or in abstract symbolical form – be undertaken by any Authority Competant in the premises, I would be willing, under suitable conditions and if with the advice my Superior, to accept a stilly subordinate position upon the executive staff in payment of such equitable salary as might be deemed advisable. – but I would very much prefer to confine myself to giving counsel in answer to demands for the same and also whenever I might deem my own personal expedient on initiative.

Now as to needed support: - An Orthograp [sic] letter from Pius X, or from his successor would be necessary and sufficient.

Concerning all of the above I make no request.

My individual personal preference [sic] is for an obscure and retired life.

I request that you will show this present communication to Dr. Thomas Dwight Parkman Professor of Anatomy at Harvard University either at his house 235, Beacon Street, Boston, or at his room at the Harvard Medical School as you may deem most expedient issue.

I last wrote to you, the title Officier d'Academy [sic] has been conferred upon me presumably because of what I have published indirectly through the Carl Zeiss firm of Jena – See paragraph concerning Orthomorphic eye-pieces no 4 on page 72 of 1902 Edition of Carl Zeiss Catalogue of Microscopes and Microscopical Appliances. – The above title was confirmed upon me at request of friends without any soliation [sic] on my part.

With kind regards to Mrs. Lowell I remain always

very sincerely yours

Horatio S. Greenough

+ Passionist Tutiary [sic]

Officier d'Academie”

We know from the end of 39th paragraph that HSG's academic graduation was induced by the ENS scientists and prepared in 1905 May. The Passionist Archive in Ireland might keep a record titled “1901/06/26 Mr. Greenough named Officier d'Académie” [Rozières, 2017]. This could be a hint on an earlier attempt to HSG's graduation by his friends from parish, the ophthalmologist George J. Bull (See 38) was surely one of them.

43. His Old Age

In 1911 the Clerk of the MIT Alumni Association asked the President A. Lawrence Lowell, Harvard University for HSG's address:

"We are preparing a Register of Former Students ... Horatio S. Greenough, who was in the Massachusetts Institute of Technology during 1867-68."

Augustus P. Loring with Loring, Coolidge and Noble, Counsellors-At-Law, Boston replied to Lowell:

"Horatio S. Greenough's address is 16 Avenue de Madrid, Neuilly sur Seine, FRANCE, care Dr. Rene Semelaigne. It's a Sanatorium" [Harvard 13/30].

HSG spent his last years at a neo-classicistic Chateau built in 1777 for Claude Baudard de Saint-James (1738-1787), the treasurer of the French Navy under Louis XV of France (1710-1774). The anglophile baron should have instructed his landscape architect "make what you want as long as it's expensive." The "Folie Saint-James" was created as an extravagance French landscape garden of 12 ha which was partially destroyed up to 1895. Nevertheless HSG might take some pleasure in this garden corresponding to: "I wish ... to have plenty of opportunity for out of door recreation in a form that I really enjoy" [Harvard, 13/30].



Figure 143 Folie Saint-James, Oil on Canvas by Claude-Louis Châtelet, 18th Century (<https://picryl.com/media/la-folie-saint-james-a-neuilly-sur-seine-claude-louis-chatelet-8e0d87>).

Dr. (Louis) René Semelaigne (1855-1934) looked after HSG's health. He served as the director of the Health Center "Maison de santé de la Folie Saint-James à Neuilly". He was a French psychiatrist and Secretary of the Société Médico-Psychologique de Paris and also Honorary Member of the Medico-Psychological Association of Great Britain and Ireland. In 1919 he will be promoted to a doctor of law by the paper "Divorce et Aliénation Mentale" (Divorce and Mental Decease). HSG could had seen a second medical option in the 24-bed American Hospital of Neuilly-sur-Seine which was inaugurated in 1909 October.



Figure 144 Salon of the Saint-James Chateau, E. Gossin Art Photo, 1913 (<https://picryl.com/media/vue-du-salon-du-chateau-de-saint-james-a-neuilly-sur-seine-bafaf7>).

Dr. Moritz von Rohr remarked on HSG's decease by his memoirs [Rohr, 173]:
"As far as I know, he died mentally deranged."

HSG died on Sunday, 1916 April 2, 1.30 p.m. but any genealogist sites and even Hamilton Perkins Greenough [Greenough, 1969] state April 3 because the official registration was done only on Monday. The certified copy of the registry office document verifies that Dr. Semelaigne's wife, Thérèse de Joly (1869-1933) and a nurse testified on Monday HSG's yesterday death to the proxy mayor of Neuilly-sur-Seine [Etat-Civil, 2016].

NOMS ET PRÉNOMS DES DÉCÉDÉS		DATE DES ACTES	
Green	John S.	22 Août	1918
Greenough	Horatio Saltonstall	2 Avril	1915
Green	Bridgett	11 Juillet	1920

Figure 145 HSG Mentioned by the Alphabetical Death Register 1913-1922 of Neuilly-sur-Seine [Neuilly, 1923].

SPENT MOST OF HIS LIFE ABROAD

Horatio Saltonstall Greenough, Originally of Boston, Was the Son of a Famous Sculptor

Horatio Saltonstall Greenough, most of whose life had been spent abroad, died on Sunday, at Neuilly, France. He was in his seventy-first year and was a native of Boston. His father was Horatio Greenough, a prominent painter and sculptor, one of whose chief works is an heroic statue of Washington, which is located at the nation's capital. Mr. Greenough's mother was Louisa Gore Greenough. The son was educated principally in France. His pursuits then and later in life were along scientific lines. Mr. Greenough never married. His immediate survivor is a sister, Mrs. Herboches du Quillion, whose home is at Vevey, Switzerland. Louis Curtis and Laurence Curtis of Boston are cousins of Mr. Greenough.

Figure 146 News Item by Boston Evening Transcript of April 3, 1916, Part 2, Page 15.



Figure 147 HSG's Gravestone Monument at New Cemetery of Hauts-de-Seine (Courtesy Charles Sale, www.gravestonephotos.com).

Who made the choice of Matthew 5:4 Jesus' phrase?

37. Conclusion

A Far-East introduction to stereomicroscopy states on HSG [Nikon, 2021]:

“In the early 1890's, Horatio S. Greenough, an American instrument designer, introduced a novel design that was to become the forefather of modern stereomicroscopes. Greenough convinced the Carl Zeiss Company of Jena to produce the microscope, but instead of incorporating Greenough's lens erecting system, Zeiss engineers designed inverting prisms to produce an erect image. This design has withstood the test of time (and a large number of microscopists), and was a workhorse in medical and biological dissection throughout the twentieth century. The microscope is still a favorite for many specific applications.”

This is a correct summary excepting HSG's characterization as instrument designer. He was a self-made zoologist and engaged in improving his tools. The applicative demands - sometimes optically impracticable - were always his priority and we owe the handy optical instrument to the engineering knowledge and advanced workmanship by the staff of the Carl Zeiss Company. It is the concern of this paper to describe and differ both contributions which were verified by the extensive correspondence between partners. HSG did not hesitate to contact famous scientists used to be among the Harvard professors in his youth. We see that HSG profited from the leading scientists of the New and Old World and also that they were well connected. The idea of a double microscope was only new for HSG but he placed it to the right persons in the right time in getting an important innovation.

Today his name is known only from the Greenough design of the stereomicroscope nevertheless his demand to suppress his name which was fulfilled half-heartedly and temporary by the Zeiss Catalogues.

The former papers on HSG were written from the viewpoint of the live sciences [Sander, 1994]. Anna Simon-Stickley assesses his meaning [Simon-Stickley, 2019]: “The historiographical tendency of focusing on the progression of science, on scientists who produce new knowledge instead of new practices has, it seems, obscured Greenough from historical recognition. The topos of the forgotten scientist, brilliant but ahead of his time and hence unappreciated by the scientific community is, thus, not accurate ... So, despite his claims of being a “man of science” ..., Greenough's lasting contribution to science was not new knowledge but rather new practices. In this respect the few publications he published do, however, contain valuable information about the process that sparked his idea for a microscope with three-dimensional projection.”

Acknowledgement:

I acknowledge at first the staff of the Archive of Carl Zeiss AG, especially Mrs. Marte Schwabe and Dr. Wolfgang Wimmer, Archive's Head, complying with my wishes over so many years. The Harvard University Archives, Cambridge/USA supplies the second important material source, the HSG letters to A. Lawrence Lowell. I may acknowledge kindly Dr. Monika Marx editing Wallerant's letter as well Dr. Bernhard Gröbler the Pierrefitte's handwritten record and recurrent Dr. M. B. for his intensive literature researches.

References:

This list gives a not-English reference originally, but its content in this paper was translated to English by the authors.

[Ancestors, 2023] Dr. George J. Bull's Obituary on
<https://ancestors.familysearch.org/en/L41T-28M/dr.-george-joseph-bull-1848-1911>

[Archives, 1905] Archives-nationales Pierrefitte. Dossier de Monsieur Horatio GREENOUGH, cote: 19940448/388, dossier n° 32826

[BACZ 1064, No.] Archiv der Carl Zeiss AG, BACZ 1064, Schriftwechsel zwischen Prof. Dr. Moritz von Rohr und Horatio S. Greenough, Neuilly (Frankreich) über Mikroskope. November 1906 – Januar 1907. Sheet No. like quoted

[BACZ 1576, No.] Archiv der Carl Zeiss AG, BACZ 1576, Briefwechsel mit Horatio S. Greenough, Paris, betrifft Mikroskopverbesserungen, 1900 – 1906. Sheet No. like quoted

[BACZ 1579, No.] Archiv der Carl Zeiss AG, BACZ 1579, Mikroskop-Korrespondenz 1897-1898. Sheet No. like quoted

[BACZ 7712] Archiv der Carl Zeiss AG, BACZ 7712, Fabrikationsliste 3: Präpariermikroskope (1886-1910). Online https://dana.thulb.uni-jena.de/rsc/viewer/dana_derivate_00000437/BACZ%20%207712_001.tiff?logicalDiv=log_dana_derivate_00000437

[BACZ 7716] Archiv der Carl Zeiss AG, BACZ 7716, Fabrikationsliste Mikro 7 (1912-1919). Online https://dana.thulb.uni-jena.de/rsc/viewer/dana_derivate_00000506/BACZ%207716_000_1.tif?logicalDiv=log_dana_derivate_00000506

[BACZ 7742] Archiv der Carl Zeiss AG, BACZ 7742, Fabrikationsliste Meß 2 (1904-1920). Online https://dana.thulb.uni-jena.de/rsc/viewer/dana_derivate_00000499/BACZ%207742_000_1.tiff?logicalDiv=log_dana_derivate_00000499

[BACZ 19819, No.] Archiv der Carl Zeiss AG, BACZ 19819, Optiktechnologie Mikroskopokular–Berechnungen mit Skizzen von H. Harting, H. Boegehold und S. Czapski 1894-1919. Sheet No. like quoted

[BACZ W 15] Archiv der Carl Zeiss AG, BACZ W 15 (Warenzeichen Nr. 15)

[bnf, 2023] Textual Works of Dr. George J. Bull's on https://data.bnf.fr/14540811/george_joseph_bull

[Braus, 1908] Braus, Hermann: Das neue orthomorphe Stereoskop von v. Rohr-Köhler und seine Anwendung in der Rekonstruktionstechnik. In: Zeitschrift für wissenschaftliche Mikroskopie und für mikroskopische Technik, Band XXV, 1908, S. 282-287

[Etat-Civil, 2016] Ville de Neuilly-sur-Seine, Etat-Civil: Acte de décès 290 Greenough, Horatio Saltonstall. Copie le 29 août 2016

[Gmeiner, 1903] Gmeiner, Friedrich: Die Ohrträde des Kaninchens. In: Deutsche Tierärztliche Wochenschrift. Hannover, 11. Jahrgang, 1903, S.83

[Greenough, 1969] Greenough, Hamilton Perkins: Some Descendants of Captain William Greenough of Boston, Massachusetts... Privately printed, Santa Barbara, California 1969, pp. 37-40

[Harting, 1898] Harting, Hans: Ueber einige optische Vervollkommnungen an dem Zeiss-Greenough'schen stereoskopischen Mikroskop. Zeitschrift für Wissenschaftliche Mikroskopie Band XV, 1898, Heft 3, S. 299-303

[Harvard 13/30] Harvard University Archives, Cambridge/USA, UAI 15.896 Box 13 Folder 30 Greenough, Horatio S.

[Knopf, 1907] Knopf, Otto: Todes-Anzeige. In: Astronomische Nachrichten, Vol.175, Heft 14, Juli1907, S. 238

[Le Figaro, 1904] Le Figaro, Journal quotidien français. Lundi 30 Mai 1904, Paris, p. 2. <https://gallica.bnf.fr/ark:/12148/bpt6k286628j/f2.item.r=greenough>

[McClung, 1912] McClung, Robert Gardner: Representative Massachusetts Trusts. Volume III Gre-Lom. Boston, 1912, pp. 12-34

[Moulton, 1945] Moulton, Forest Ray; Jeffries, Justus J.: The Autobiography of Science, 1945, p. 509

[Neuilly, 1923] Département de la Seine, Commune de Neuilly Seine: Table de l'État Civil des Actes de Décès de 1 Janvier 1913 au 31 Décembre 1922. 1923

[Nikon, 2021] Nikon Instruments Inc.: Introduction to Stereomicroscopy. Online Tutorial, 2021 (www.microscopyu.com/techniques/stereomicroscopy/introduction-to-stereomicroscopy)

[Pierrefitte, 1905] Archives-nationales Pierrefitte. "Don Greenough" Box AJ/16/2893

- [Rohr, 1904]** Rohr, Moritz von: Das Sehen. In: Czapski, Siegfried: Grundzüge der Theorie der optischen Instrumente nach Abbe. 2. Auflage, Leipzig 1904, S. 284-287
- [Rohr et. al., 1904]** Rohr, M.; Culmann, P.; Czapski, S.: Die Theorie der optischen Instrumente. I. Band, Berlin 1904, S. 124-207
- [Rohr, 1907]** Rohr, Moritz von: Die binokularen Instrumente. Berlin, 1907, S. 185-188
- [Rohr, 1920]** Rohr, Moritz von: Die binokularen Instrumente. 2. Auflage, Berlin, 1920, S. 57, 140, 196, 219
- [Rohr, Page No.]** Rohr, Moritz von: Lebenserinnerungen. Deutsches Optisches Museum, Jena. Signatur NL5 Nr. 2, S. 172-173, 194
- [Rozières, 2017]** Rozières, Roselyne de, Parish Office of Saint Joseph's Church; 50, avenue Hoche, 75008 Paris France: Mail communication of 2017 February 14
- [Sander, 1994]** Sander, Klaus: An American in Paris and the origins of the stereomicroscope. In Journal: Roux's Archives of Developmental Biology, 203, 5: pp. 235-242 (March 1994). Or also in: Landmarks in Developmental Biology 1883–1924, 10.1007/978-3-642-60492-8, pp.76-83 (1997)
- [Simon-Stickley, 2019]** Simon-Stickley, Anna: Image and Imagination of the Life Sciences. The Stereomicroscope on the Cusp of Modern Biology. NTM Zeitschrift für Geschichte der Wissenschaften, Technik und Medizin 27 (2019), S. 109–144 (<https://doi.org/10.1007/s00048-019-00211-0>)
- [Tobies, 2017]** Tobies, Renate: Moritz von Rohr: Optik – Mathematik – Medizintechnik. In: Jenaer Jahrbuch zur Technik- und Industriegeschichte. Band.20. Jena, 2017, S. 117
- [Tobies, 2020]** Tobies, Renate: Symbiose von Wissenschaft & Industrie. Jenaer Jahrbuch 23 (2020) S. 11-67
- [Zeiss, 1902]** Carl Zeiss, Optische Werkstaette: Microscopes and Microscopic Accessories. 32nd Edition, Jena, 1902 (BACZ 98294)
- [Zeiss, 1904]** Carl Zeiss Jena: Der Doppelverant. Druckschrift M 173, Jena, 1904 (BACZ 30558/52)
- [Zeiss, 1906]** Carl Zeiss Jena: Microscopes and Microscopic Accessories. 33rd Edition, Jena, 1906
- [Zeiss, 1939]** Carl Zeiss Jena: Zeiss Mikroskope und Nebenapparate. Ausgabe 1939, Leipzig

©2025 Text and photographs (except as noted) by the authors.

Parts 1-6 are located in the [Micscape Library](#).

The author welcomes any suggestions for corrections or improvement.

Berndt-Joachim Lau can be reached at:

stereomicro@gmx.de

Published in the February 2025 edition of *Micscape*.

Please report any Web problems or offer general comments
to the *Micscape* Editor.

Micscape is the on-line monthly magazine of the Microscopy UK web site
at Microscopy-UK.