

Quantitative Photography: The Fragmentation of a Science*

JEAN ST. THOMAS, *Photogrammetry, Inc.*
Silver Spring, Md.

ABSTRACT: *In the face of the assertion that photogrammetry is quantitative photography in all its phases, the latter is widely used as a scientific tool by practitioners who are oblivious of photogrammetry, or who reject identification with photogrammetry, or who, from necessity, have by-passed and are found beyond the limited disciplines which constitute classical photogrammetric practice.*

Despite the all-encompassing meaning attributed to the term "photogrammetry," a growing number of designers, experimenters and routine users of photographic instruments forge ahead in science and industry, using new methods of data derivation which go unreported in the photogrammetric literature. The vital function which quantitative photography plays everywhere is of a magnitude such that the question poses itself as to which is really a "special application" of the other.

No data are available that would serve to express the relative number of the users of photographic instrumentation in science generally, versus that used in photo-surveying. However, with the aid of a series of clues, an attempt is made to show that current definitions are false, and that major contradictions exist which hamper the dissemination of knowledge relative to metrical photography as a whole. Thus, methods used in one field are denied to workers in other fields for lack of communication.

Recognition of the photo-instrument as the common denominator of all practitioners of metrical photography, and adoption of a standardized terminology based on instrumentation types, are advocated to achieve a break-through across the walls of knowledge compartmentation and to strengthen the field through a unifying codification.

PERSPECTIVE

THE field of quantitative photography is vast. No scientific research or industrial endeavor can do without it. Although its function is the determination of the values under study, there is irony in that its own magnitude should not be accurately measurable. But its relative magnitude can be simply conveyed: photogrammetry, itself the source of a considerable literature, represents a comparatively small and highly specialized area in this great domain. The first inkling that photogrammetry might not be quantitative photography in all its phases is found in the following two definitions:

Definition 1. Photogrammetry is "the science or art of obtaining reliable measurements by means of photography." (Definition by the founders of the ASP.)

Definition 2. Photogrammetry is the art and science of deriving surveys

from aerial photographs. (Webster's Unabridged.)

Each of these definitions is given by a source authoritative enough to challenge any questioning, were it not for the obvious contradiction. One such authority therefore must lack infallibility; and since quantitative photography is under discussion, it is pertinent that the record be examined for clues that would cancel one of the definitions.

CIRCUMSTANTIAL EVIDENCE

In the following, a number of clues is presented, each clue pertaining to some phase having direct or indirect bearing on the question of the synonymy of the terms "quantitative (or metrical) photography" and "photogrammetry." With this in view, the sanctification given to meaning by common usage and by sustained omission cannot be ignored, and *de facto* acceptance seems indicated in

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such cases where typical irreversibility of trend of meaning is involved.

1. The term photogrammetry as an encompassing concept is nullified by the use by respected authorities of one of the qualifying "non-topographic" (photogrammetry) whenever topography is not involved.
2. Major works, as well as most any textbook or journal on photogrammetry, are engrossed with surveying and cartographic problems to an extent so nearly exclusive that other applications are treated by implication as (a) curios, or (b) as "special applications." Finsterwalder¹ devotes four lines to special applications and nine and one half lines to scientific applications. Even if both are lumped, this represents at best a mention "en passant." Zeller's authoritative text² acknowledges a somewhat greater recognition of "special applications" 10 pages out of 304, or three per cent.
3. Lacmann³ found that support could not be had (even from photogrammetric institutions) for the compilation of knowledge pertaining to "non-topographic" instrumentation and procedures. He publishes this knowledge himself for fear that the information it represents would otherwise be lost.
4. Fink⁴ publishes a well-regarded book on methods of quantitative photography bearing a title which avoids the use of "photogrammetry," "non-topo" or "special." Calling a spade a spade, he uses "Photographische Messtechnik."* Although he touches on the art of deriving maps from aerial photography, he realistically treats it as a special application of quantitative photography.
5. Vast research projects in this country (and perhaps also abroad) many of them security classified, rely, to an extent that cannot be overestimated, on the data produced by photographic instrumentation. If quantitative photography were removed, some of these projects would lose meaning. Yet, photogrammetrists are conspicuous by their absence in many of such research

* "Technik" is to be translated as "technology" rather than "technique," hence *Photographic Mensuration Technology*.

centers. The photo-instrumentation used is conceived, designed, and built under the direction of photographic engineers and scientists who evolve data compilation and reduction methods that may completely by-pass the field of classical photogrammetry.

6. Beyond the purely mechanical advances, electronification of photographic instrumentation and data reduction has greatly advanced of late. While such instrumentation may or may not be airborne, most of it is not, it represents tremendous technical advances, as do the systems of data reduction that go hand in hand with such instrumentation. These advances steadfastly remain unreported by Commission V, of the International Society, that specializes in reports on "special applications."
7. There appears to be a considerable amount of confusion among photogrammetrists as to what should be viewed as a "non-topographic" application. For example, work involving studies of tooth decay has been termed non-topographic.⁵ Yet, what is involved is the determination of enamel erosion, in other words, *surface analysis*. But topography *is* the study of surfaces, irrespective of their location, on a tooth or on a mountain. Here then is the multiple contradiction caused by garbled terminology:

Premise (a): photogrammetry is the science of (all) photographic mensuration;

Premise (b): it is not so, and "non-topo" must be singled out;

Premise (c): topography is the analysis of surface;

Premise (d): the study of a (tooth) surface is non-topographic.

8. Significant achievements in the design and applications of photo-instruments for the location of events in time and of objects propelled in space, and the determination of quantitative values regarding both, are the subject of total and consistent silence in the photogrammetric literature. Quantitative chronophotography rests more squarely on instrumentation developed for the purpose—often of superbly ingenious concept—rather than on "souped up" motion picture cameras,

as the few classical texts in existence or those instances which the reports of Commission V of the International Society of Photogrammetry would indicate.

9. Phototopography—the term given as a synonym of photogrammetry by Webster's dictionary—is by etymological definition and practice a two-dimensional pursuit. The addition of a single direction of application not related to mapping, perhaps in the form of the photographic determination of volume, has seen the relegation of problems devolving therefrom as a "special application." When it becomes necessary to locate events in time, the four-dimensional curtain thus caused drops like a pall—barring knowledge of metrical chronophotography from dissemination.
10. The above effect can be reasoned thus: As a two-, or at best, three-dimensional creature, the phototopographer is tied to trigonometry. His geometry is cartesian. His mathematical discipline suffices for the static problems of locating points on a surface, to rectify perspective distortion due to instrument tilt, and—in the pinch of a "special application"—to calculate the volume of a coal pile, or the configuration of a sculptured bust from the photograph of a man. The elements of time and velocity, however, require the analysis of a complex interaction of factors of differential nature. Trigonometry, the classical backbone of static photogrammetry, is impotent in the face of non-uniformly distributed constants, which demand a higher order of differential equations. Trigonometry thus falls short of the requirement of seeking parameters in a four-dimensional space-time continuum. It is therefore only too natural that the evolution of metrical chronophotography should have been in the hands of ballistics, dynamics and kinetics engineers whose geometry is relativistic. They do not view themselves as photogrammetrists. Nor do they need to make special studies to manipulate such triangulation problems as they may face.
11. Failure to report the far-flung achievements and the data relating to metrical chronophotography (except for lone

instances) now places photogrammetry in the following position:

- (a) photogrammetry is (all) photographic measurement;
 - (b) it is not so because "non-topo" is "special";
 - (c) even though photogrammetry is (all) photo-measurement, the injection of an added dimension renders it impotent, since "trig" cannot cope with non-cartesian problems;
 - (d) or, "high speed photography" is really "movie" work, removed from Hollywood only by camera rpm, and therefore irrelevant to the field.
12. Elsewhere, it appears that the question can be raised as to whether photogrammetry is exclusively concerned with objective quantitative ends, or whether it should be understood also to encompass photo-interpretation, a highly subjective hunting ground. This instance is one that will readily be recognized by photogrammetrists whilst perusing the late literature, laden out of all proportion with papers on photo-interpretation, a trend which is on the increase. We are now placed in a position to learn and to deduce that:
 - (a) photogrammetry is all of photographic mensuration;
 - (b) it is not so, because there are, in addition to mapping, the non-topographic activities;
 - (c) by editorial implication photogrammetry is not concerned with measurement only, but with subjective interpretation and the thereby engendered differences of emotional approach.
 13. Engineers active in the photo-instrumentation field as designers or experimenters, and with some of them in charge of vast operations, and who are educated as to the practical meaning, to them, of photogrammetry and its literature, shun affiliation with photogrammetric groups, because of the latters' hypnotic engrossment with a phototopographic navel, to the almost nearly total neglect of the remainder of the anatomy of quantitative photography.
 14. From the literature treating with

- photographic instrumentation and over a period of time, it can be gathered that not only is there a wealth of knowledge that never shows up in photogrammetric journals, but that metrical photographic practice has pushed ahead and has by-passed classical topo-photogrammetric procedures. Photographic data production and data reduction systems (some highly mechanized) are being evolved in a steady stream by professionals who may never have seen a photogrammetric journal, or have as yet to attend a meeting of photogrammetric groups. That this is so, can usually only be stumbled upon by personal experience, in the absence of a Gallup poll or of writings on the subject.
15. A large number of specialists, active in quantitative photography on a professional level, are members of groups, which in varying extent disseminate knowledge relative to the field, although dedication to the field as such may, or may not be expressed: The High Speed Photography Committee of the Society of Motion Picture and Television Engineers; the Biological Photographers Association; the Instrument Society of America; the Technical Division of the Photographic Society of America; the Society of Non-destructive Testing; the Society of Photographic Engineers, and of late, the Society of Photographic Instrumentation Engineers, which it was deemed necessary to create.
 16. Elsewhere, the field of metrical chronophotography is subject to the same non-crystallization of purpose which afflicts the users of euclidean photoinstruments: No delineation is made between quantitative and qualitative, between the objective and the subjective approach, between the instrument and the camera, between the event-mensurator and the event-beholder, in short between the chronogrammetrist and the chrono-photo-interpretor. It is the lack of this simple but vital distinction that is responsible for the submersion of quantitative photography into general photography, for the impotence of effective systematic search, for the organized dissemination of relevant information.
 17. Activities in the fields of non-chronophoto-instrumentation, and of metrical chronophotography appear to be sufficiently far-flung to warrant the assumption that phototopographers are rather outnumbered. This likelihood is enhanced by the circumstance of the prevailing non-organization in terms of the *quantitative-photographic* interest, all while photogrammetry is known to be well organized. However, the purpose here is not to count noses, but rather to show that the fragmentation of quantitative photography could hardly be more complete.

Note: Since it appears from a good part of the foregoing that Webster's definition of "photogrammetry" is the more realistic, reference to the term under 17 above was made in the sense of that definition.

It should also be noted that the natural affinity of interest which exists between the (non-metrical) "high-speed photographer" and the photo-interpretor is not generally recognized, and that a much greater purpose could be served if society affiliation—and the literature—were divided along lines of interpretation vs. quantitative, rather than along the imaginary frontier created by the frame-rate of the instrumentation employed.

UNRECOGNIZED COMMUNITY OF PURPOSE

While it is natural that specialists in any field should gravitate towards such groups as avowedly represent their own chief interest, no useful purpose is served, if against all reason, such groupings attempt to function under hermetic seal from one another. The compartmentation that exists in quantitative photography today could not remotely be ascribed to wilful policy on the part of any group. It is the thesis of this paper to find the culprit in the form of (a) twisted and otherwise inexistent terminology, and (b) lack of intent of purpose. If it were not so, a small bridge, a thread however flimsy would have been spun to link all domains of quantitative photography. There is no such link even among such major areas known as "photographic instrumentation," "high speed" photography and "photogrammetry." Overtures for some sort of liaison, such as would be dictated by the

slightest recognition of affinity, have not been made.

Something is remiss in the house of quantitative photography. Above all, and since essentially mensuration is involved, there ought to be from the start a well defined modulus, a clear cut declaration of purpose, a concise, well-outlined structure. But the house of quantitative photography is no such organization. It is not even definable as a house, but just as a number of oddly assorted structures. Amongst these, a small, outwardly neat, but inwardly confused grouping stands out: topographic photogrammetry, relatively the best organized entity, although the population of the other odd structures far outnumber its own inhabitants.

It is the object of modern city planning that unintegrated and haphazard structures be replaced with harmoniously interdependent units, in systematic complementation for the benefit of all.

No planning, no integration of interest, no codification of the literature is possible without the aid of a basic modulus in the form of a systematic nomenclature. Elsewhere, and in fields totally unplagued by language defections, obstacles to the storage of knowledge are the most serious threat to scientific progress seen by our most eminent scientists. The problem becomes one of staggering despair, when those designations are in-existent to begin with, which should serve as the very foundation for such codification.

CONCLUSION

Before all else, a master key is needed, one that will proclaim and foster the recognition of the unity of quantitative photography, the common purpose. That purpose is to employ photography to obtain numerical data. No mensuration is possible in any field without the aid of calibrated devices, or instruments. The photo-instrument, then is the one denominator common to all who practice metrical photography. No codification pattern is thought possible which does not use as the point of departure this single, common tool, in forms as manifold as there are directions of development or forms of application.

Outlines for codification have been proposed elsewhere.^{6,7,8} It is not essential that the proposed patterns be accepted as such, just as long as a similar, or better,

convention is adopted and put to practice. The Photographic Instrumentation Committee of the Society of Photographic Engineers is working on the problem. Contact will be made in time with other groups interested in the furtherance of quantitative photography, for purposes of joint action on the ultimate convention.

If the concept of *metrical photography* as an entity apart from all phases of subjective photography can be conveyed as being desirable, the concept of *photographic instrumentation* as the common hardware, the concept of *photo-instrumentics* to denote the science, the concept of *photo-metrology* as the body of knowledge useful to the creation of data and to the reduction of data, the concept of the *photographic engineer* as the designer of instrumentation, the concept of the *photogrammetrist* as the user of the instrumentation in static geometric fields, the concept of the *chronogrammetrist* as the user seeking dynamic geometric parameters—if these concepts can be forged together to serve as the backbone of a harmonious nomenclature sanctionable by its very need, and acceptable for common usage, only then will there exist a sound basis for the orderly codification of quantitative photography.

Search, now a nightmare of tediousness, will be greatly facilitated. Papers relevant to metrical photography will be concentrated in a few journals devoted to the subject in its full and true meaning rather than to narrow applications. It is this hyper-specialization which has caused many a good manuscript to be channelled into the general photographic literature, or into journals devoted to sympathetic but hardly kindred interests. This specialization in one single aspect of metrical photography has also been responsible for blocking from dissemination valuable original work by serious authors who thus find themselves wanting of a logical vehicle for the dissemination of their findings.

Technical societies, now deep in subject matter other than quantitative photography (while professing allegiance to the latter) should establish a more realistic balance between the avowedly main purpose of their existence, and narrow specializations, and border interests of remote sort. If this is not done, then the surge for metrical photographic knowledge will create other foci of interest,

perhaps of better defined intent of purpose, but perhaps also agents for a still greater fragmentation of the field. The presence of a number of existing groups, which "dabble" in quantitative photography on the side, contributes little to consolidation.

If clarification is ever to come to this muddled situation, then photographic societies, their journals, as well as the individual member, should stand up and be counted: which do you serve? which are your chief reasons for being? Subjective ends: photography as a tool of opinion, of emotional pursuits, of individual and hence controversial interpretation? Or do you serve objective aims: photography as a precise yardstick for the appraisal of our surrounding world; as a means to measure, and hence to master, the transient event, the inexplicable phenomenon, the inaccessible point in space—or the unknown force which must be harnessed?

For such is the task of metrical photography. And however the belief may be nourished that its scope is one of narrow specialization, only its logical and thorough organization will reveal to us, in time, the full magnitude of the sustained impact that photographic instrumentation exer-

cises on the advancement of all human knowledge.

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