Esthetic Values in Computerized Photocomposition

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Can the computer achieve the same quality composition as a skilled typesetter? The author identifies some factors which contribute to successful esthetic solutions and discusses the compromises that must be considered; for example, in hyphenation and justification. "Feedback" of information and ideas from typographer to computer programmer is encouraged.

Can the computer ever achieve the same results, in terms of quality composition, as the skilled craftsman? If not, how good can such composition be? Will we have to sacrifice quality in the interest of speed and economy? These are the questions I shall attempt to consider in this article.

What the machine operator does

The linecasting machine operator—who can study the "fit" of his lines as he watches the matrices fall into the assembly elevator—if he is dedicated to the creation of high-quality composition, will keep a number of concerns in the back of his mind. It will not be sufficient for him to bring a group of words into the range of spaceband justification. He will seek to secure an even flow of composition, and he will not permit adjacent lines to vary in their interword spacing characteristics—if he can avoid it—by anything like the full range of spaceband expansion potential. He will not alternate tight and loose lines, and he will pay attention not only to the accuracy of his word division (hyphenation) but also to its frequency. He will avoid three hyphens in a row. He will try to divide words so that their meaning is not obscured and their root sense is not offended. Where paragraphs end, he will try to get around the awkwardness of the single word or portion thereof sitting on a line by itself. If the final sentence in the paragraph approaches the end of the line, he will try to fill out the remaining space lest it detract from the even march of words down the right-hand margin.

Such an operator, even if he keeps one eye out for what lies ahead and checks constantly on what he has already cast, will frequently find it necessary to discard lines and go back to try another solution, starting over with a different set of assumptions, perhaps at the beginning of a paragraph or at least several lines back, in order to get a running start and work his way out of the condition he has created. And when he has done his best, his product will be scrutinized by the critical proofreader and the more critical customer, so that the final result will be as pleasing as possible. Often the customer will contribute editorial change —adding or taking away—to assure an even more delectable typographic result.

General principles applied

Our linecasting operator thus applies a set of *general principles,* some of which he may never have heard enunciated but which he feels intuitively to be "right." But he deals with recalcitrant elements—words and pieces of words that do not lend themselves to any tidy system of apportionment into lines, paragraphs, and pages. One line will have a lot of little words and all kinds of space to *spread* a tiny bit. The succeeding assembly of syllables plagues diligent operators, causing anguished consternation, especially when confronting intransigeant elements like "through," "stretched," "strained," "thought," "sloughed," or "straight." Rule out letterspacing, call for a narrow measure in a large point size, and you set a task for which there may never be a good solution—only one that is least bad.

Computer optimizes choices

But whatever that solution is, it is theoretically possible for a computer program to arrive at that disposition which is optimal. In fact, it may be stated that a good *program* should be able to produce more consistent results, and more consistently *good* results, than even the best manual operator.

Such programs do not yet exist, although in many or perhaps most situations their weaknesses will not be exposed. They do not exist because those who have created them have lacked the insight adequate to define the task; and perhaps, too, because a satisfactory solution might require a "bigger" program and a larger computer system than might seem justifiable under existing economic constraints.

Conceptual limitations

We suspect, however, that conceptual limitations have been the major obstacle. In the case of our own company we are now engaged in our fifth major system redesign in five years, each being predicated upon broader and more ambitious objectives. We are now overcoming problems of whose existence we were not even cognizant several years ago.

It is the purpose of this paper to identify some of the factors which will contribute to successful esthetic solutions, and to indicate some of the trade-offs which will have to be considered. For every gain there is a cost, not only in economic terms but perhaps in esthetic ones as well. The good systems designer is one who can foresee the largest number of consequences which will flow from the introduction of any given variable and who can predict the incidence of occurrence so that he will get the best trade-off in the light of his particular universe of (partially unknown) data.

To make this point more cogent, consider a small concrete example. One of the "design specifications" for our "hyphenation and justification" program was that the last word in a paragraph could not be split. We wanted to avoid the situation in which an "ing." stood on a line by itself. This meant that if the program encountered the condition in which only one word remained in the paragraph, and the whole word would not fit on the preceding line, that word was not submitted to the hyphenation routine. The word was carried over in its entirety, and the preceding line was justified at whatever cost.

As a consequence, in narrow measure material we often encountered excessive interword spacing in the last full line of the paragraph. It appeared that this condition occurred quite frequently, especially in short paragraphs of lists and definitions. We therefore created an option. We could specify for the individual job, depending upon the measure (line length), whether to permit the last word to be divided or not. In those cases in which we elect to split the last word in a paragraph, we have concluded that a syllabic "widow" is a lesser evil than excessive interword spacing.

It might be noted that other solutions would have been possible. One would have been to "set a switch" in the program so that, automatically, when narrow measure material is encountered, the word-splitting feature comes into play. A second would have been to provide that the

last word in the paragraph would be split only when the resulting interword spacing in the preceding line (whatever its measure) exceeded certain (broader) tolerances. (But bear in mind that a fractional word widow on a narrow measure is much more acceptable than it would be on a very wide one!) But the best solution of all would be to instruct the program to back up, throw away the lines it had just "set" (computed) and try again—or again and again—until it worked its way out of that condition entirely. Such a solution would be slower, more costly in terms of computer time, and would represent a larger set of computer instructions and perhaps a larger "core" in which to retain these instructions, with the consequent increase in overhead costs.

Only one example

If the condition we have just described were our only problem, there could be no doubt about our solution. But it is illustrative of many hundreds of tough choices the systems designer makes—or ignores if he does not realize the implications of his systems design. Each such alternative must be recognized. Tentative solutions must be explored. The cost of these solutions in *throughput speed* and *core* must be assessed. The ultimate decision will take into account the extent to which a failure to meet the specific problem will impair the marketability of the product. If the market is known and its customers' predilections are predictable, then the easiest solution would be to design the program especially for that market. The poor esthetic product is a consequence of using a program for a market for which it was not intended. It happens today that most of the so-called "book composition" programs are nothing more than adaptations (if indeed any adaptation has been made at all) of newspaper composition programs. It should be readily apparent that the demands of newspapers (fast throughput, narrow measure, permissible *intra*-word spacing [letterspacing] and the like) are of a different order than for the fine book market. While adaptations may be more or less successful, the product will not begin to compare with that which could be produced from a *general purpose* systems design which takes into account every conceivable refinement of the typesetting art, but which allows for the optional exercise of certain of these features, depending upon the constraints for the task in question.

The relationship between hyphenation and justification

"Justification" is performed by the computer program by a process of addition. A line width is determined of, say, 500 units. Each character that is accepted into the line has a width value. Perhaps an upper-case S has a value of 15 units in a particular typeface. This sum is added to the total of accumulated values within the line, or, conversely and more probably, subtracted from the unit value width of the line. When a word is completed and a word space is reached, a minimum value, perhaps five units, will be deducted, but a separate tally will be kept of the number of spaces in a line.

Let us suppose that the last word processed brings the counter to 480 units—that is, leaves a remainder of 20 units—and the next complete word in the text stream would increase the count to more than 500, reducing the surplus to a minus quantity. If there are five interword spaces in that line, it is evident that if each space is allowed to assume the value of nine units rather than five, the necessary precise total of 500 will be successfully achieved. Since the problems of good justification are greater for narrow measures than for wide, and since the design of some typefaces is more conducive to loose setting than others, the first option in the construction of a justification program is to allow for the input, *uniquely for each job and perhaps for each typeface,* of special parameters or instructions which define the minimum and maximum values of an interword space. If the expansion of these spaces will fill up the line there will be no attempt to hyphenate. But if the expansion potential is not sufficient then an effort will be made to fit a portion of the next word into the line, if that word is found to be capable of being divided. At this point a subroutine is invoked to test the word to ascertain whether it should be submitted to the hyphenation "logic."

Esthetic judgment in hyphenation [1]

What is the smallest word that should be divided? *Suggested assumption:* only those words consisting of five or more letters. Hence an inflexible

1. We shall not discuss the problems of hyphenation itself. When words are tested by the hyphenation routine, satisfactory answers—including not only acceptable but even preferred points of hyphenation—can be secured. The usual constraints have to do with the size and speed of good programs, and their consequent costs in production.

rule might be adopted which would preclude the splitting of "a-way" or "Ma-ry."

Implication: if this is an invariable rule, there will nevertheless be circumstances in which the division of a hyphenable four-letter word could be preferred to an excess of interword space. A manual operator would use his judgment. The normal computer program could not. However, in a more elaborate program another "check" might be included to provide that if the computed interword space exceeded a defined tolerance, *then* four-letter words, *or certain four-letter words only,* should be scrutinized and divided. *Query:* would this feature be truly helpful? Our systems designer might conclude that only once in six million lines (or some such wild guess) would the hyphenation of certain four-letter words be essential to the sort of solution the customer would require. And he might determine that, given those odds, manual resetting of those lines, and hand stripping, would be the easiest, cheapest, and best way out.

Esthetic judgment: how many letters of a word should be "left behind," and how many carried over? *Suggested solution:* leave not less than two; carry not less than three. *Implication:* five-letter (or more) words that break after the first letter ("a-head," "a-breast") or after, say, the third letter ("hap-py") are discarded. Justification (and excessive interword spacing) occurs at the expense of hyphenation.

Esthetic judgment: how frequently should hyphenation occur? Bear in mind that the more frequently (successful) hyphenation takes place, the better and more even the interword spacing. But is it harder to read lines with excessive interword spacing or lines with too frequent hyphenation? *Suggested solution:* a tally on the frequency of hyphenation. If the two preceding lines end with hyphens do not submit the next line to the hyphenation routine.

Query: But suppose the third line, if hyphenated, produces a better result, in terms of interword spacing, than the second line, which has already been hyphenated and accepted? *Solution:* a program which does not approach the problem on a line-for-line basis, but reaches tentative solutions only, scans the entire "area of consideration," juggles the results to optimize them, and then "releases" the lines in question.

At the present time, so far as we know, no one has written a computer program which checks for successive hyphenations. Existing programs solve their problems on a line-to-line basis. Usually, then, poorly justified

lines and too-frequently hyphenated lines (as well as bad hyphenation) are corrected by manual keyboarding and stripping.

Manual intervention typical

In point of fact, most existing computer typesetting programs do not present the facility for making corrections (to eliminate keyboard or input errors) prior to typesetting, and thus manual intervention is a most common occurrence. In this respect, "computer-aided typesetting" is a more meaningful term than "computer typesetting." But when keyboard errors have to be corrected subsequent to typesetting, most of the advantages of the computer are sacrificed. We must take it for granted, therefore, that the entire process is not meaningful unless error-free copy goes through the hyphenation and justification program, for otherwise the "h and j" solutions would, in many cases, have to be discarded.

"Clean" input is now possible in a variety of ways, but such input is created without advance knowledge of how lines will break. If manual intervention is limited to the correction either of computer-generated errors or of solutions which are less than perfect, a substantial forward step has been made, but the process cannot be considered an acceptable and economical alternative to conventional typesetting until the program can achieve optimal (or virtually optimal) solutions in more than, perhaps, 95% of the cases, and achieve them in such a way that to correct the other 5% does not require a manual reset of much of the job.

Film versus metal composition

Perhaps we should have pointed out earlier that our entire discussion presupposes film composition, as opposed to hot metal.[2] What computers can do for linecasting on hot metal composition devices is only a small portion of what they can contribute in the film composition arena. Film devices are faster, more flexible in terms of the mixing of fonts and sizes, and superb in their ability to adapt to different measures, formats, and white space allocations. Most of the restrictions enforced by

2. We should like to consider the pros and cons of film composition from the standpoint of type design and character fit, and especially the quality of the image generated by CRT (cathode ray tube) devices, but that is the subject of another article.

economy during the reign of hot metal may now be thrown out the window. But film composition devices do these new things poorly when they are responding directly to human instructions. Film composition comes into its own only when it is computer-created. This means that it proffers an efficient product only when the material being composed is not only error-free, and properly justified and hyphenated, but is processed to conform to the proper format. A computer approach cannot be successfully applied merely to the creation of *galleys* of type composition in those situations in which page makeup in film is more cumbersome than in hot metal. Hence in all current discussions of the possibilities and limitations of computerized composition, attention focuses directly and explicitly upon the possibility of devising pagination solutions.

Problems of pagination

If justification and hyphenation seem complex, the making up of a book into pages is many times more so. The rules, for example, are even less clearly defined. The solutions are infinitely more varied. There is wider scope for esthetic judgment. There are more recalcitrant elements for the programs to cope with.

Chapter openings vary: right-hand pages only, right or left pages; a new chapter begins on the same page under certain circumstances. Chapter "sinkage," the treatment of running heads and folios, the manipulation of footnotes, the positioning of illustrations and tables, the requirements for "balance" between columns and facing pages, the extent to which succeeding pairs of pages may depart from standard —all of these and many more diverse elements must be identified, and general rules, with all of the foreseeable exceptions, must be formulated and programmed.

But even though the variables are much greater, the rules and standards are such that optimal solutions can be devised. These solutions are not difficult to realize for a limited class of work, because the variables can be foreseen and the tolerances can be specified. But the more "general purpose" the systems conception, the more intricate the options, the more varied the parameters to which the program must accommodate.

Here the demands upon the computer configuration are at their

Figure 1. Facing pages, balanced by computer program, avoiding widows, avoiding a new paragraph at the bottom of a page, with footnotes moved to correct position and running heads and folios allocated by program.

> Speak the language of the parents and forget the pedagogy. Be honest but kind. Some words create emotional reactions that can severely impair communication. For example, Johnny is stubborn, insolent, sloppy, and a liar. It is better to say that Johnny insists on having his own way, is sometimes outspoken, has a tendency to stretch the truth, and could do neater work.
> 2. Kinds of information to give and not to give. What is or is not to be communicated through the oral conference varies from school system to school system; therefore, the principal and classroom teacher will need to know what things are appropriate in their system.
> 3. Adherence to the professional code of ethics. Some parents will take *shots* at Johnny's last year teacher. Don't buy it! You will want to be sure your attitude reflects positive support of that teacher and of other teachers and other schools. Remember, Johnny will have another teacher next year, and it may be your turn.

In conclusion, the individual oral conference, if it is to be effective, requires considerable planning and effort on the part of the principal and teacher. The effort is justified when we see that elementary school children are benefited. Successful parent-teacher conferences are a means to the realization of this end."[4]

Question 22: Is the process of grading generally regarded as a punitive process by students and faculty?

Yes. While the reasons given in defense of the typical grading system are of the highest, the facts are usually quite different. When they are asked about the purposes of grading, teachers often respond as did Eugene L. Gaier:

> . . . to challenge and motivate the student; to inform the student and his parents of the quality of his work and his progress; to provide information for classification—to group, promote, retain, or certify completion of a given work program—hoping thereby to protect society from incompetency; to provide information for assessing the school, the curriculum, and the teacher's competencies; plus a host of others—all stated with academic solemnity.[5]

But further on in the article, the point is made that the process of grading is still generally viewed by both students and faculty essentially as a punitive process rather than as a learning guide. If the conclusions are correct, and I am inclined to think that they are, the implications are disturbing. These conclusions clearly reveal why students tend to shift their emphasis away from learning toward the earning of grades; they also reveal the limited value of grades as a guide for the student of how to effect improvement.

[4] Johnson, *op. cit.*, pp. 48-50.
[5] Eugene L. Gaier, "The Grade Society," *The National Elementary Principal*, Vol. XLV, No. 6 (May, 1966), pp. 42-47.

Question 23: Are there moral considerations to the grading system?

Yes. Any system of evaluation and grading that precludes the possibility of success for some children is immoral. Notice that I said, "precludes the possibility of success for some children." Of the 124 separate abilities identified by Guilford, only about eight are consistently prized by teachers; these have to do with factors such as memory, verbal intelligence, and the like. Thus, even one important factor of creativity, i.e., of divergent rather than convergent thinking, has been widely overlooked until recent years. The spectrum of opportunities for success must be widened if morality is to have any bearing on the evaluation system.

Question 24: What is meant by the phrase "Evaluation as Feedback and Guide"?

The title of the 1967 Yearbook of the Association for Supervision and Curriculum Development is *Evaluation as Feedback and Guide*. The entire book deals with the vital concept, borrowed from industry, that evaluation should provide information to the pupil and his parents that will help to control the pupil's future behavior in ways beneficial to him. The authors rather severely indict the traditional grading system as follows:

> . . . it is equally to be condemned for the narrowness of its focus, because in its gross exaggeration of the more mechanical, easier-to-measure features of education, it virtually blots the broader, more fundamental objectives out of sight. The end result is not simply bad evaluation; it is distorted teaching and learning.
> We believe that much of the trouble goes back to the marking-grading system and the kinds of records which it produces.[6]

I recommend this book to teachers and parents who are seriously concerned with improving the evaluation program of their schools and who, in the process, want to improve the nature of communication between faculty and parents.

Question 25: If the teacher should avoid using words such as "lazy," "bad," "careless," "sloppy," "irresponsible," and the like in talking with parents about children, what should she do?

Name-calling that reflects a judgmental attitude usually results in defensiveness in parents and reduced communication. Usually, a teacher who uses "loaded" words with a parent is unaware that she is doing so; she really wants to communicate but may not know how. One of the best examples of a contrast between "what was" and "what might have been" has been described by Rothney as follows:

> A few years ago, when the writer's children were in elementary school, he usually sent his wife alone (as was the custom) to represent the family at the

[6] Fred T. Wilhelms, Editor, *Evaluation as Feedback and Guide*, Yearbook of the Association for Supervision and Curriculum Development, Washington, D.C., 1967, p. 15.

greatest. If facing pages of text are to be balanced, and incomplete lines at the tops of pages or columns ("widows") are to be avoided, then the computer must have sufficient capacity to include within its "area of consideration" all of the relevant material. If sufficient text information must reside in "core" to permit a meaningful and useful analysis, "core" must be large and the required computer configuration expensive, unless alternative ingenious approaches to the balancing of pages can be devised.

Yet of all of the factors which may yet stand in the way of the achievement of the assignment, the major ones (in our judgment) do not relate to economics or to computer size, but to the lack of problem definition and lack of human ingenuity. For our part, at Rocappi, we feel that we have come a long way because we have been able to identify many of these problems, to categorize them, and to assess the "trade-offs" that are implied. We have devised answers, including pagination, which are capable of reaching a 95% result, on a wide variety of text problems, without manual intervention.

We may, therefore, state categorically that given unlimited resources in terms of programming talent and computer configurations, a product can be achieved which meets the most critical esthetic standards and which, in all probability, will be more consistently satisfactory than that which will be produced by craftsmen working within the limitations of the job assignment's time frame.

We are not there yet, but we are getting there. And what we most require is the sympathetic and imaginative interest of those whose calling it is to establish the yardsticks which measure the product and help to distinguish good from bad. They must learn, as we have had to learn, to move from the particular to the general. Instead of saying that "in this case I don't like this solution because . . . ," they must be able to re-phrase their criticism so that we can draw from it the following: "when these conditions occur, and these alternatives exist, this is the path you should follow." Given this degree of assistance the ultimate result will be not a deterioration of quality, in a mass production era, but greater style, vivacity, variety, and beauty than we have achieved in the practical world of book composition by the application of conventional methods.