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ACTIVITY ANALYSIS[1/]: AN AGRICULTURAL MARKETING TOOL[1a/]

by

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Treatment of the algebraic mechanics of activity analysis are now available.[3/] Fortunately, too, these treatments are comprehensible by the mathematically unwashed. Thus, this paper will not discuss mechanics. It will attempt to show for agricultural marketing the import of the assumptions of activity analysis and the orientation dictated for this tool by its own assumptions.

A Word About The Technique Itself

The basic economic problem of allocating scarce resources so as to maximize the ends embodied in some predetermined objective has not been changed by activity analysis. Thus, the usual assumption of measurable means of maximization must still vex the economist in light of the growing

1/ The author refuses to engage in prolonged semantic discussions about the title of this paper. However, the term, "activity analysis", is used purposely to eliminate the restricted inference of other terms such as "linear programming". The reasoning for this is much the same as that stated in Activity Analysis of Production and Allocation, Editor, T. C. Koopmans, New York (1951), pp. 5-7.

1a/ Purdue University Journal Paper No. 894. Published in Journal of Farm Economics, December 1955, pp. 1236-1248.

2/ The author expresses appreciation to his colleagues, especially Earl Kehrberg and James Snyder from Purdue, for suggestions on this paper.

3/ See for example, Dorfman, Robert, "Mathematical, or 'Linear' Programming: A Non-mathematical Exposition", The American Economic Review, Volume XLIII, December, 1953, pp. 797-825.
Henderson, Alexander, and Robert Schlaifer, "Mathematical Programming: Better Information for Better Decision Making", Harvard Business Review, May-June, 1954, pp. 73-100.
T. C. Koopmans, Editor, Activity Analysis of Production and Allocation, New York (1951), especially Chapter XXI.
Charnes, A., W. W. Cooper, and A. Henderson, An Introduction to Linear Programming, New York (1953).
Dorfman, Robert, Application of Linear Programming to the Theory of the Firm, Berkeley (1951).
Heady, E. O., "Simplified Presentation and Logical Aspects of Linear Programming Technique", Journal of Farm Economics, Dec. 1954, pp. 1035-1048.
Boles, J. N., "Linear Programming and Farm Management Analysis", Journal of Farm Economics, February 1955, pp. 1-24.

shroud of doubt generated by psychic considerations. Neither has activity analysis supplanted marginal analysis as the standard formulation of this type of problem. Rather, activity analysis is a refinement of, or at least a supplement to, marginal analysis which seems to have advantages for many of the practical problems of today.

Such an approach was bound to merit serious consideration. Economists have long been somewhat chagrined that their marginal mode of attack has so often failed to impress men of affairs on practical problems.4/ Such has probably been the case even more with marketing problems than with farm management problems.5/ Also, this criticism is levelled more in the field of short-run entrepreneurial decisions than in that of long-run ones. Thus, the imposing number of short-run marketing problems lends credulity to the ear being given activity analysis.

The mathematical form of activity analysis is the maximizing of a linear function subject to linear inequalities. The economic substance of most of these problems is the fact that a group of limited resources must be shared among a number of competing demands, and all decisions are "interlocking" because they all have to be made under a common set of fixed limits.6/

Activity analysis cannot answer all things. At last year's meeting some cautioned that the method might be getting too much acclaim. Query of some of these revealed that their cry was not to discredit the technique but merely to put it in proper prospective. This seems prudent. Dorfman7/

4/ See Dorfman, Robert, Application of Linear Programming to the Theory of the Firm, Berkeley (1951), pp. 1-22, and Wiley, J. W., "The Contrast Between Break Even Point and Marginal Cost-Marginal Revenue Analysis", Paper given before the Indiana Academy of Social Sciences, October 3, 1953.

5/ Clawson, Joseph, "Is Marginal Utility Measurement the Key To A Comprehensive Theory in Marketing", Harvard University Studies in Marketing Farm Products Number 9-H, June 1954.

6/ Henderson and Schlaifer, op.cit., pp. 74.

7/ Dorfman, Robert, Application of Linear Programming to the Theory of the Firm, Berkeley (1951), p. 80.

has said, "No mathematical model simple enough to be manageable can reflect adequately the intricate blundering decision-making process of the real economic world". Thus, we will probably need be satisfied with the conclusion of Henderson and Schlaifer[8/] that, "Mathematical programming cannot replace judgment, but it can supply some of the factual information which management needs in order to make judgment".[9/]

Generally, the technique must select optimum alternatives for a manager who must operate with an inherited bundle of production resources left by tardy adjustment to rapidly changing technology. I strongly suspect that this is the most pressing problem of farm and business manager alike. The technique may be used on some planning problems where all resource choices are open, but these problems are probably the exceptions.

Specific guidance suggests use of the tool for problems of selecting among a finite number of qualitatively different alternative enterprises or processes when the problem is "large sclae". Heady[10/] has probably rightly suggested that the budget is best for this type of problem when it is "small scale". Marginal analysis is probably still the most fruitful problem formulation for many of the infinitesimal and quantitative questions dealing with minor production practices. Either activity analysis or marginal analysis can solve either of these problems. Thus, we should consider these recommended applications as points of departure only.[11/] Also, to some degree marginal analysis emphasizes long-run static conditions, and activity

8/ Henderson and Schlaifer, op.cit., p. 82.

9/ For two interesting articles on the broad aspects of this problem, see MacKay, D. M., "Comparing the Brain with Machines", American Scientist, April 1954, pp. 261-268; and Ingle, D. J., "Psychological Barriers in Research", American Scientist, April 1954, pp. 283-293.

10/ Heady, E. O., "Simplified Presentation and Logical Aspects of Linear Programming Technique", Journal of Farm Economics, Dec. 1954, p. 1035.

11/ For an excellent development of this point, see Dorfman, Robert, Application of Linear Programming to the Theory of the Firm, Berkeley (1951), pp. 84-85.

analysis emphasizes short-run, dynamic conditions. Activity analysis can nearly be likened to a salvage operation, useful to managers keeping up with today's technological treadmill.

Assumptions Necessary

Most assumptions of activity analysis at the present stage of development fit comfortably in the following classifications:

"a. Linearity. By definition, in linear programming, each process is characterized by certain ratios of the quantities of the inputs to each other and to the quantities of each of the outputs. These ratios are defined to be constant and independent of the extent to which the process is used.

b. Divisibility. It is assumed that any process can be used to any positive extent as long as sufficient resources are available; indivisibilities and 'lumpiness' in production are ignored.

c. Additivity. It is assumed that two or more processes can be used simultaneously, within the limitations of available resources, and that if this is done the quantities of the outputs and inputs will be the sums of the quantities which would result if the several processes were used individually.

d. Finiteness. It is assumed that the number of processes suitable is finite."12/

Permeating all of these assumptions is the idea of a process. Actually, the raison d'etre of activity analysis is the process. The above assumptions apply to the process. The problem itself may have curvilinear or indivisible aspects. By formulation into alternative processes, the problem is solved, despite its over-all characteristics. Understanding this is fundamental to understanding activity analysis.

Technically, the process involves "one, or more functional relationships in which all the inputs and outputs enter as dependent variables and there is only one independent variable, the 'level' of the process".13/ Practically, process merely means a particular way of getting an economic

12/ Ibid., p. 81.

13/ Ibid., p. 93.

job done. For example, in cottonseed oil mills, processes have been defined as: hydraulic, screw press, direct-solvent, and prepress-solvent.[14] Each of these processes requires a different bundle of production factors. Variations in each of these processes, if occurring, could be treated as additional processes. In work now being conducted by J. C. Snyder and the author, it was feasible to select for a fluid milk plant a group of processes each of which resulted in a different product, such as wholesale distribution of milk in paper, one-half gallon containers; wholesale distribution in glass, gallon jugs; retail distribution in glass, quart containers; etc. We selected only one prevailing process for producing each product. However, further study anticipates adding alternative processes for each product. For example, a different type of gallon bottling machine might be introduced.

The idea of the process or activity involves a particular, complete way of getting the job done. It is a departure from our common way of thinking of absolute divisibility and substitution of individual factors of production one for the other. The smooth production opportunity curve or transformation curve has now become a broken line with special significance to the angles involved.

Activity analysis exploration is seemingly timely for marketing studies. Food industries have traditionally lagged in industrialization. Only in relatively recent times have marketing innovations necessitated large scale substitution of complete new processes. For example, practical commercial freezing methods were of little use until a new process of transportation, storage, distribution, and consumer handling evolved. Bulk handling, so dynamic in changing heavy industry, is being retarded in agricultural marketing until process adjustments come in farm organization; transportation equipment design; work methods of warehouses, elevators, feed mills, and

14/ Brewster, J. M., "More Economical Cottonseed Oil Mills and Returns to Growers", Journal of Farm Economics, August 1954, p. 423.

fertilizer plants; receiving point unloading facilities; consumer buying practices; and organizational policies. Continuous food manufacturing processes, self-service distribution, quality control, waste disposal, and numerous other marketing changes are making for extensive process substitutions. Automation will call for even more.

Linearity Assumed. This means that input factors combine in fixed proportions at all levels of output. Also, output will vary in fixed proportions with any given input, and thus, we have neither economies nor diseconomies of scale in the use of a given process. Traditional economic eyebrows rise at these assumptions. Actually, these assumptions need not delimit the activity analysis researcher below a normal work week.

My initial exposure to the first assumption was in the "law of definite proportions" in chemistry. This meant simply that two atoms of oxygen would combine with only one of hydrogen regardless of the number of hydrogen atoms available. Such assumption finds a friendly atmosphere in marketing. Many marketing processes are based directly upon chemical, mechanical, or physical relations of just this type.15/ Automation suggests a myriad of examples.

The environmental control in marketing should yield us greater accuracy in attaining this assumption than will ever be possible in farm management — even with air-conditioned animal structures! In addition to controlled plant processes, transportation rates tend to conform closely to this assumption. Rising cost of space suggests a group of problems here that will

15/ Marketing workers might take heed of farm management workers' caution to strive for "practical" coefficients rather than to assume for example, that chemical relationships are the same as, for example, nutrition values. (See Fisher, W. D. and L. L. Schruben, "Linear Programming Applied to Feed-Mixing Under Different Price Conditions", Journal of Farm Economics, November 1953, p. 478.) J. C. Snyder and the author concluded that a gross type of storage space coefficient meant more than one based only on size of storage case in dairy plant studies much as Warren's example that what went into the manger was more important to the farmer than what went into the cow (see S. W. Warren, Discussion of John C. Redman's paper, Journal of Farm Economics, December 1954, p. 1033).

conform naturally. Plant location problems arising out of distribution and transportation innovations should fit rather well here where costs of utilities, transportation, space, etc., are involved. Current trends toward stabilized wage rates, job rating and evaluation systems will tend to make labor problems conform more and more to this assumption.

The second assumption of linearity, that the ratio of output to a given input will remain constant regardless of process scale, is slightly more troublesome, but not prohibitive. Changes in scale themselves do not cause curvilinear production functions. Curvilinearity generated by changes between input factors can be consistent with constant returns to scale assumed in activity analysis. In activity analysis, process substitution directly accounts for the traditional curvature of the production surface. Substitution of input for input is accounted for indirectly.16/

Inclusion of fixed costs, too often arbitrarily allocated, cause many problems in curvilinearity. Activity analysis will show maximum return possible to a set of fixed factors, both restrictive and non-restrictive. Often this seems to shun a large part of the management problem. Yet, it seems more useful to give the correct answer for this part of the problem than to clutter the whole thing with arbitrariness. The effectiveness of the tool here seems promising, indeed.

Businessmen have illustrated repeatedly that they do not worry much about curvilinearity in short-run decisions. Witness the common usage of the so-called payback concept for capital expenditure. Farm and business managers have traditionally argued over methods of depreciating, for example, labor saving equipment. Businessmen will almost invariably insist that it be paid for out of operating capital. Farm manager and agricultural econ-

16/ Dorfman developes this point well, substantiating it with work of Knight, Koopmans, and Samuelson. Dorfman, Robert, Application of Linear Programming to the Theory of the Firm, Berkeley (1951), pp. 81-82 and "Mathematical, or 'Linear', Programming: A Non-mathematical Exposition", American Economic Review, December 1953, pp. 808-810.

omist will depreciate it over long periods. Witness, also, common usage of the break-even analysis concept in industry. The essence of break-even charts is linearity. Their popularity continues to increase, however.[17] Business accounting manuals seldom dwell on curvilinearity.

Activity analysis is based upon the fundamental idea that factor ratios represent the amount of a factor which is <u>used</u> not the amount <u>owned</u>. Economies of scale analyses have often considered the amount of goods owned not the amount used. Again my chemistry taught me that best results often required that we have some elements left over. Tardy adjustments of production facilities to technology may suggest a sensible analogy in our economic problems. Traditionally we have thought of excess capacity **of an individual production factor** as a cardinal economic sin. Activity analysis may show that we were not as sinful as we thought.

Ordinarily linear approximations of appropriate sections of curvilinear production functions are adequate for most of the answers plausible from data available. Each applicable approximation is handled merely as a new process. The idea of using a separate process for overtime labor or supplemental storage space, for example, may let us expand such fields of analysis rather than force us to restrict them. This points up again the necessity of better defining the nature of production surfaces.

Any remaining circumscription of our analytical sphere attributable to these assumptions of linearity is temporary. The mechanics of handling curvilinear relationships directly are being refined and simplified rapidly. More work is needed here, but it will be forthcoming.

Many marketing problems such as those dealing with machine capacity, manpower requirements, full employment output, space, transportation, location, scheduling, seasonality, or inventory seem to present no special problems in regard to this assumption.

17/ See Wiley, <u>loc.cit.</u>

Divisibility Assumed. I can see no particular problem with this assumption in agricultural marketing problems. Process inputs are of three types: producers' non-durable goods entirely consumed in the process, services of individuals and outside firms, and services of capital equipment owned by the firm itself.[18] Few examples of gross indivisibility of these should be found in agricultural marketing. Some raw material contracts and possibly service payments such as for consulting might be problems. However, in most cases a new process ray will take care of the situation. Output of most marketing institutions is divisible. One-half case of milk or loaf of bread should create no special problem. Less than carload lots, for example, can be handled as a special process. Minimum market requirements can be specified and handled by the method if necessary. Remember also that we have not assumed away managements' use of judgment in such cases.

Additivity Assumed. This merely says that we can add two different processes just as we said we could duplicate the same process. Obviously, some processes as now conceived are not additive. For example, some food processes may need be integrated because quality will be damaged by successive replacement and removal from refrigerated storage. However, process integration of this type may be handled as one process rather than as a group of successive processes. Many traditional processes will not violate this assumption, however.

Excess capacity of marketing firms has been established in many cases. A good businessman will usually reply that his company obviously added a new product in order to spread sales overhead. However, my observations have been that the typical pattern results rather quickly in more sales overhead being added to the increased product line and before long we have merely duplicated the old process or have added a complete new one. Thus, the

18/ Dorfman, Robert, Application of Linear Programming to the Theory of the Firm, Berkeley (1951), p. 83.

assumption of additivity is not violated except in the very short-run. Complementarity of processes is merely reduced to process duplication. The general tendency to carry division of labor too far in many processing plants almost invariably gives this result. Tendency toward unionization and increased mechanization will probably reduce the restrictions of this assumption. Also, many of the factors in excess which could apparently result in non-additive processes in my opinion will never become limiting and these can be assumed out of many short-run problems.

In our studies of fluid milk plants, we found additivity often assumed in practical operating situations such as for paper or glass bottling processes. Witness, for example, systems of production factor modifiers such as the ones used by the Bureau of Markets in California. Also, actual plant surveys such as the one by Williams in Alabama[19/] showed paper and glass to be additive. However, the synthetic study of Conner, et.at.[20/] found paper and glass processes to be non-additive. Consumer satisfaction with a diversified product line is probably more important here than efficiency gained by non-additive processes. Activity analysis can even be effective on this type of problem by handling market situations as if they were production factor restrictions. The additivity assumption may be restricting on some marketing problems, but not on the majority.

Finiteness Assumed. Anyone who has done economic-engineering analysis has felt the apparent uniqueness of each work method or piece of equipment as he attempted classification. Yet our work has taught us that practical classification is possible and finiteness can be approached. As we gain input-output data, and sharpen our concept of the process, this assumption

19/ Williams, Sheldon W., "Costs and Returns to Alabama Milk Distributors", Alabama Polytechnic Institute Bul. 287, June 1953.

20/ Conner, M. C., et.al., "Specifications and Costs for A Milk Pastuerizing and Bottling Plant", Northeast Reg. Pub. No. 16, 1952.

will be less worrisome. However, at present we must grapple with it.

Selection of proper processes means that sampling will be a problem for activity analysis. This is not new for marketing research. I have been uncomfortable in defending judgment samples or case studies on other occassions, but I expect activity analysis will call for even more.[21] With activity analysis we admittedly get the "one best budget". Yet, I suspect that proper selection of processes may be more important in many cases than attainment of the "one best budget". Apparently, farm management researchers must fear the same thing.[22]

On the other hand, Ray Bressler feels that alternative marketing processes are often so few that in many situations sampling will be no problem. Neither will we need the sophistication of this approach to get at the answer.[23] I would tend to agree that this is true where complete process description and quantitative measurements are available. Yet, I am afraid that most of our research will need to continue on fairly small parts of the problem and there the variations can be numerous. I have never been able to reduce the number of feasible alternative processes to the obvious without some difficulty. As a matter of fact, I have always felt that just "discovering" the newer processes being used by our efficient managers and then telling our poorer managers about them was a service. After all, farm management researchers by this very technique built much of our early professional reputation. Ricardo would probably have found activity analysis little more effective than marginal analysis because his alternative processes in the early nineteenth century English wheat production were definitely

21/ French, C. E., "Sampling Dairy Plants to Study Efficiency of Receiving Room Operations", _Proceedings Marketing Research Workshop_, July 1950, pp. 81-90.

22/ Plaxico, J. S., Discussion of paper by Heady, E. O., "Simplified Presentation and Logical Aspects of Linear Programming Technique", _Journal of Farm Economics_, December 1954, p. 1049.

23/ Letter to author, June 16, 1955.

limited. Ours are too in some situations, but in many cases I fear they more nearly approximate the infinite than the finite.[24]

Assumed finiteness immediately prompts questions concerning time. This has been our most worrisome problem with activity analysis. Obviously, a finite number of processes today can become an infinite number over time. Yet, an alert researcher with an eye for the practical can guess along with the manager as to which inventions will become innovations. This is a continuing problem, but one for which activity analysis probably adds little or takes little away. Possibly, the efficiency of our computational machines will let us test more of these new "processes" sooner than has been possible in the past.

The more troublesome time question involves the nature of the supply curves in activity analysis. Typically, production factors are divided into two groups: unlimited factors available in any amount at a constant unit cost[25] and limited factors which are obtainable at a constant unit cost (usually zero) to a point and then unavailable at any cost. Hicks explains well the origin of these limited factors:

> "The entrepreneur already has under his control a complex of goods, the equipment of the firm. Equipment includes land, buildings, machinery, tools, raw materials, goods in process, goods technically finished but not yet sold. Now it does seem reasonable to assume that this equipment will have acquired some organic unity, so that it cannot be exactly reduplicated at a moment's notice. It is the firms legacy from the past, and, as such, does seem to constitute a block of 'fixed resources' in the relevant sense."[26]

24/ I grant that I may be defining process in too narrow a sense. Fully I realize that we have tried to answer some problems with a stopwatch when our time would have been better spent by appraisal of scale, machinery specifications, or building plans. However, I feel that activity analysis can handle many of these minor problems, and such problems must be answered before the total production scheme can be defined and quantified.

25/ Admittedly, cost may vary with quantity obtained; however, this again is handled by adding a new process for each cost bracket.

26/ Hicks, J. R., Value and Capital, Oxford (1941), pp. 199-200.

Dorfman[27/] suggests that the permanent and integrated staff of the establishment be added to Hicks' catalogue of fixed resources.

Thus, what is limited and what isn't, and over what time period? This will test the ingenuity of the marketing researcher. Using labor, for an example, you must determine degree of skill, normal training, contract restrictions, immobility due to building design, turnover, etc. Again the technique will give an answer in terms of return to a lump of fixed factors. Management can then make the decision within this group with better information than when an arbitrary allocation clouds the picture on the obviously limiting group, which can be properly allocated.[28/]

Activity analysis is probably best suited to short-run problems but it is not limited to them. Fortunately the dual solution necessary for activity analysis yields as a by-product marginal values of each of the factors in limited supply. Thus, a manager has these for his long-run plans. We should be cautious in the use of these, however. Our curves now are not smooth but rather broken lines. Sharp breaks or gaps in the marginal curves are the rule rather than the exception. It is possible to program a fore-casted process change which will give a good estimation of long range plans. J. C. Snyder and the author worked with an interesting problem of this type. Since fat and skim must be bought as joint products in milk for fluid plants, it was interesting to drop the butterfat content of the milk procured and determine variation in product mix. This might represent to a degree a situation that could develop if butterfat test continues to drop as a result of shifts in value of fat relative to skim.

Problems of using estimated prices and demand in budgets are not eliminated in activity analysis. Most agricultural applications of activity

27/ Dorfman, Robert, Application of Activity Analysis to the Theory of the Firm, Berkeley (1951), p. 26.

28/ See Henderson and Schlaifer, op.cit., pp. 79-82.

analysis to date are vulnerable to severe criticism because of prices and demands assumed. Price situations may be easier to predict in marketing problems than in farm problems, but demand situations will probably give greater concern. Yet, the flexibility of the approach will probably let us establish much better ranges on problems of this type than was possible with other techniques. Many demand studies suggest use of the approach. Possibilities here will grow as techniques are refined.

Obviously the approach takes a vast amount of detailed and accurate basic input-output data. Marketing data may better conform than farm management data. However, our experience in making use of secondary data in fluid milk analyses was not good. We were able to use some, but a disappointingly small amount. Possibly, access to consultant engineering data, such as available to the Northeast Regional Dairy Marketing group, would be more fruitful.[29] Yet, I am afraid that the input-output data already available in marketing are generally inadequate for this approach.

Both because of lag in collection of good input-output data and "intangibles" in entrepreneural decision making, a critical need exists for development of appropriate stochastic models. Babbar, Tintner, and Heady[30] have made a start in this direction.

Applications

Agricultural marketing applications of activity analysis are relatively few. Yet, a start has been made. Time will not let us look at all of these in detail, but I will enumerate some with which I am familiar.

At Purdue, we are completing a study of a fluid milk processing plant. We are interested in determining optimum product mix with a set of fixed

29/ Conner, et.al., loc.cit.

30/ Babbar, M. M., Gerhard Tintner, and E. O. Heady, "Programming With Consideration of Variations in Input Coefficients", Journal of Farm Economics, May 1955, pp. 333-341.

resources, some 25 of which we believe may be limiting under different conditions. We have 20 possible products or processes. We believe we have demonstrated the applicability of the approach, and hope that we can make some general plant recommendations. Some twenty-odd situations were examined. We plan to continue work in this area, expanding process variations, plant sizes, market situations, etc. Also, meat packing has been studied to select between alternatives of selling "green" or "cured" products.[31]

Fred Waugh[32] has solved an interesting problem in connection with awarding contracts for the school lunch program. This had the typical characteristics of the transportation type problem, except that the amount bought at each shipping point was unknown. This depended upon the relative bids. This suggests a whole array of variations in transportation problems vital to agricultural marketing.

George Judge has solved a useful transportation problem involving the optimum means of moving eggs from surplus to deficit areas.[33] Several variations of the model were investigated.

Also, Judge and Jim Plaxico are planning a study of optimum location and organization of individual livestock marketing firms.

Earl Swanson has illustrated how the technique can treat the problem of mixing fertilizers.[34] The work of Waugh[35] and particularly that of Walter

31/ Chatto, K. A., "An Application of Operations Research Methods to the Selection of a Processing Plan in a Meat Packing Plant", unpublished Master's thesis, Purdue University, June 1955.

32/ Reported to the author in letter of June 27, 1955.

33/ To be published soon as Connecticut Bulletin. Judge, G. G., "Competitive Position of the Connecticut Poultry Industry: 7. A Spatial Equilibrium Model for Eggs".

34/ Swanson, E. R., "Minimizing the Ingredient Cost of Fertilizer Mixes", Research Report AERR-8, University of Illinois, May 1955.

35/ Waugh, F. V., "The Minimum-Cost Dairy Feed", Journal of Farm Economics, August 1951, pp. 299-310.

Fisher and Leonard Schruben[36] has demonstrated usefulness of the approach in feed mix problems. More work is needed in these areas.

Paul Kelley and Henry Tucker plan to do work on optimum plant organization and product mix of dairy manufacturing plants. Here balancing price flexibility against processing efficiency should present an extremely challenging problem.

Industrial applications of activity analysis are now being reported regularly. Henderson and Schlaifer[37] have given an excellent illustrative survey of different problems being solved. Management consultants have been working on a range of problems. The Methods Engineering Council, for example, has worked on problems of product mix, where to buy and where to make parts, inventory, methods improvement, scheduling orders, location, seasonality of sales with fixed labor force, and where to produce.[38] These organizations are also adding simplicity and refinement to the method.[39]

Other applications suggest themselves. The whole area of procurement seems fertile. Bulk milk pickup, for instance, has an intriguing set of interlocking management decisions. Transportation differentials in marketing orders, price differentials between livestock markets, interregional competition, government program buying and storing, empty railroad car routing,[40] truck fleet scheduling, labor employment and placement (especially migrant), and many others are suggestive of appropriate problems.

36/ Fisher and Schruben, op.cit., pp. 471-483.

37/ Henderson and Schlaifer, op.cit., pp. 73-100.

38/ Ferguson, R. O., Address given at Industrial Engineering Conference, April 21, 1955, Purdue University.

39/ Ferguson, R. O., "Linear Programming", American Machinist, April 11, 1955, pp. 120-136.

40/ ______ "High-level Railroad Cooperation, Plus Operations Research Methods Equals More Efficient Railroading", Railway Age, April 20, 1953, pp. 71-76.

Manufacturing and processing suggest a wide range of problems. Space and labor method compromises could use the tool.[41/] War uses where minimizing time was of essence suggests a range of labor utilization problems. Clerical and administrative processes, long overdue for evaluation, suggest the method. Work on seasonality already done[42/] and promise of new tools for analyzing sequential events may give us a toehold in another neglected area.

Distribution studies will find some uses. Meat packer planning boards have worried with many typical problems of this type. The flexibility of the tool suggests it may have usefulness in studying impact of instutional marketing policies. If we can ever supplement it with practical application of the theory of games, we might invade this area of unknown. The whole area of demand shifts and elasticity studies will furnish suitable problems. Quality problems can also be handled.[43/]

Some classify the tool as a firm tool, or at best, a micro tool. Others are more enthusiastic that it is a macro tool. Such classification does not interest me much. Supply of problems far exceeds the resources available to answer them. However, as a suggestion of macro problems, possibly the production and marketing workers should in combination use the approach to answer the accusation that our marketing systems are failing to keep production and consumption in balance. Also, foreign trade problems, especially in their conflict with domestic price support programs, might find the tool effective. Work will continue on broad problems such as

41/ A problem such as the one reported by A. B. Lowsteter, et.al., "The Comparative Efficiency of Various Arrangements of Railroad Tracks at Stores in Wholesale Produce Markets", USDA, Agricultural Information Bulletin 55, June 1951, might well lend itself to this approach.

42/ Management Topics, March-April 1955, Published by Methods Engineering Council, Pittsburgh 21, Pennsylvania.

43/ Dorfman, Robert, "Mathematical, or 'Linear', Programming: A Non-mathematical Exposition", American Economic Review, December 1953, p. 821.

industry interdependence, business cycles, and government policy.

This paper has emphasized the use of activity analysis as a research tool. Activity analysis is demandingly practical. Answers should be of the type and in a form quite useful in extension teaching. Also, classroom students have repeatedly been critical of the abstract presentation of marginal analysis. Thus, this formulation may be more pleasing to their palates.

Conclusions

As for activity analysis as an agricultural marketing tool, we can conclude the following:

1) It is no panacea, but deserves more use than it has had.
2) It need not supplant marginal analysis, but will add to it.
3) It is inherently practical and flexible despite fixed assumptions.
4) It adds precision to our analyses by selecting the optimum budget.
5) It may well become more and more useful due to present technological trends.
6) It allows routines which will relegate to clerks some chores now using managerial and researcher time.
7) It may make for more precise problem formulation.
8) It may result in better data preparation -- a much needed improvement.
9) It will yield some marginal cost data for long-run planning.
10) It will increase sampling problems.
11) It will concentrate more marketing research on short-run problems.
12) It will cause re-examination of prevailing methods of problem formulation.
13) It will yield research results in form ready for extension teaching.
14) It will be easier to teach in the classroom than is marginal analysis.
15) It will live or die by its test on practical problems of importance.