THE CONSTRUCTIVE INTERESTS

OF

CHILDREN

BY
ERNEST BECKWITH KENT, A. M.

SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY
IN THE
FACULTY OF PHILOSOPHY
COLUMBIA UNIVERSITY

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PREFACE

The school's obligation is no doubt to society first, and only afterward to the child; so that the curriculum in its broader outlines must be determined with a view to what society will require rather than to what will please the child. But in developing the details, interests need to be carefully reckoned with. This is especially important with all of the more expressional subjects, whether manual training, design or English composition. Society is certainly demanding acquaintance with industrial life, and any mere tool practice, no matter how formal, which will give the pupil some notions about industrial life and his fitness for it, is probably worth having in the school. But practice in *inventing* is worth infinitely more—in inventing new uses for old tools and machines, new economics of material, new applications of old principles. A child's inventiveness is never either trained or tested except while he is deep in some absorbing problem. The following study was a quest for additional data upon the question of what problems are the most likely to prove absorbing to children in the latter half of the elementary school period. It is the writer's hope that some of the suggestions which it developed may be found applicable and helpful in practice.

THE CONSTRUCTIVE INTERESTS OF CHILDREN

I THE FREE CONSTRUCTIVE WORK OF 150 SCHOOL CHILDREN

Introduction

A large number of studies upon children have given data which bear upon the subject in hand. The instincts and reactions of infancy and early childhood have been studied intensely by Baldwin, Perez and many others. Studies by Bryan, Burk, and Hancock have traced the general course of motor development and have shown the degrees of motor control normal to the different stages of childhood. Children's plays and games, as their most spontaneous form of expression, make the best single index to the general trend of interests during any given period and extended reference to certain studies of these will be necessary as we proceed. Most directly valuable of all is Dewey's account of the constructive interests which grow out of three successive mental attitudes or modes of attention.[1]

James makes constructiveness a special instinct which he says is as genuine and irresistible in man as in bee or beaver.

"Whatever things are plastic to his hands, those things he must remodel into shapes of his own, and the result of the remodelling, however useless it may be, gives him more pleasure than the original thing. The mania of young children for breaking and pulling apart whatever is given them is more often the expression of a rudimentary constructive impulse than of a destructive one."[2]

However important this constructive instinct may be, it clearly does not in any sense explain or constitute the motive of the bulk of that construction which forms so large a part of the

[1] *Elementary School Record*, Vols. 1–9
Direct attention, focused wholly upon the outgoing activity itself;
Voluntary attention, directed to the accomplishment of certain practical ends;
Reflective attention, concerned with ends which persist in the form of intellectual problems.

[2] *Principles of Psychology*, Vol. 2, p. 426.

world's work. While constructive instincts may determine in a measure which men are to work in constructive lines, the actual motive for doing the work is an ulterior one; it is the utility of the things made and their power in satisfying human needs that causes their production. In other words, most construction is carried on as work and it is only within the limits of construction-play that we can class the constructive instinct as an important motive. But these instinctive activities to which James refers are constantly observed in small children and we need to trace through the years of childhood the general development of constructive motive from this instinctive one to a motive which, having little to do with processes and materials as such, rests in the distant purpose to be subserved by the product.

Between these two extremes we may distinguish two intermediate stages. Following the instinctive activities with materials comes a time when certain forms of construction are attempted by the child not—or at least not wholly—because of the "besoin de creer"[1] but from mere impulse to imitate the activities of adults. This results in his reproduction of constructive activities among others—possibly more of these than of most others, but if so not necessarily because of reinforcement by "constructive instinct." For while this may count somewhat, the presence of certain tangible and dramatic elements in the constructivities of his elders would sufficiently explain the partiality which he shows for them at certain times.

Gradually, however, this imitation construction ceases to satisfy and the construction comes to be carried on for definite ends, though not ordinarily of course for the utility ends of the adult, but the various play ends of childhood. The worker's point of view here is that of the adult so far as separation of means and end is concerned, for with both there is a definite need to be satisfied irrespective of any pleasure involved in the constructive process as such. On the other hand, it is generally very close to the earlier stages of imitation activity in that the ends themselves are often of an imitative sort. That is, while the construction is merely a means of obtaining play apparatus,

[1]Which Ribot says corresponds in the mental sphere to the "besoin de la generation" in the physiological. *Psychologie des sentiments*, p. 323.

the play itself gets its main meaning and interest from the fact that it in turn is an imitation of some phase of adult life, the imitation element being simply pushed a little further away. We have then these four stages in the development of constructive motive:

1. The instinctive.
2. The imitational.
3. The play-utility.
4. The adult-utility.

We may now study these more in detail to determine as clearly as possible (1) just what forms of activity belong to each stage, (2) how definitely and how exclusively different purposes and their forms of expression belong to children of a certain age, and (3) what materials are best adapted to the realization of these purposes, the abilities of the children being considered. Any data gained regarding these points will be of direct assistance in determining what lines of constructive work best fit the different stages of elementary education.

(1) It may be questioned whether the purely instinctive handling of materials should be called constructive in the ordinary sense of the word. James in the passage quoted suggests a fundamentally constructive motive for even the so-called destructive acts of early childhood. Groos takes exactly the opposite view, looking at these as responses to the fighting instinct.[1] Perhaps it would be safer to call most of these efforts mere random responses to the general impulse to activity reacting in the easiest way upon the most convenient material. This we may call the manipulative instinct as distinguished from either the constructive or destructive. In the following pages we shall use the word manipulation for activity of this sort, while the word construction will mean work (ordinarily synthetic in nature) carried on with reference to some end other and more remote than that of the mere sensations involved in the process itself. Along with this wholly sensational pleasure of pure manipulation there is probably the beginning of an intellectual pleasure, and from this side the activity might be called experimentation as well as manipulation—the child wants

[1] *Play of Man*, pp. 97–8.

to see what will happen. But this shows no such strength as the other. Groos mentions another element, "pleasure in being a cause," which he thinks appears very early and which is responsible for the way in which "moist sand is heaped up or dug away, snow tunnelled through or rolled into a great ball, sticks of wood piled, water collected in a pond, etc."[1]

As to the period of this manipulation interest: Groos suggests no dates whatever in connection with the list of activities just quoted. With Miss Shinn's niece the "era of handling things" began in the sixth month.[2] How "synthetic" or at least how "analytic" the acts of that period might be would probably depend a good deal on the materials at hand. Perez says that they appear in all children from the age of eight or ten months.[3] Probably only isolated cases will be found in which the activity is due wholly to this manipulation impulse, for the imitation factor begins to count very early. But the former persists for several years as an important factor in the child's relation to concrete materials and indeed many adults are affected by it in a degree, as is shown by their tendency to handle, modify aimlessly and play with any new material which may be presented to them. With the adult, however, this tendency is a mere survival and cannot be strong enough to influence perceptibly his work, though perhaps it does his recreation. At what age it loses its influence on a child's more serious voluntary activities it would be difficult to say.

(2) The "mud pie" is perhaps the most typical representative of the transition to the imitation stage, or rather of the infusion of the imitation motive into the one preceding. Here is clearly a double pleasure in manipulation and imitation. Heretofore he has been contented to "heap and dig away" his sand, but now

[1] *Play of Man*, p. 99.

[2] *Biography of a Baby*, pp. 141–161.

[3] A child of nine months, seated on the floor in the middle of a room, seemed like a creating and despotic deity in the midst of his playthings, and anything else that was given to him or that he could get hold of by crawling along,—trumpets, drums, balls, paper, books, cakes, fruit,—were piled up together, ranged side by side, separated, put back higglety-pigglety, pushed away, fetched back again, hugged, kissed, gnawed, etc., etc., and all with bursts of joy which showed his imperative need of exercising his physical powers, of satisfying an ever new curiosity and of imitating. *The First Three Years of Childhood*, pp. 276-7.

he adds to the pleasure of modifying a plastic material, that of reproducing a household occupation. The pie is clearly not an end in itself.[1] It is demolished as soon as completed or at least set aside to make room for another and another.[2] Building with blocks is perhaps the line of work that depends most exclusively upon the imitation motive—manipulation pleasure would seem small compared with that obtained from plastic materials, and the product is still nothing. This work retains the interest for a long period, probably because of its imitative adaptiveness—because of the variety of things and activities which may be reproduced by means of blocks.

Common observation and the general tendencies of kindergarten practice combine in pointing to the kindergarten period of childhood as the one in which this motive has the longest and most direct connection with handwork. No one seems to have ventured any sharper definition of this stage. The gifts and occupations, so large a part of the kindergarten program, seem to be motived almost entirely by the combination of this manipulation and imitation interest. With the gifts there is no permanent product, and while occupation work does issue in a permanent product, this does not seem to be a large center of interest —except perhaps near the end of the course, when their occasional utilization in play forms the connection with the next kind of activity.[3]

(3) The play-end stage comes when these very crude imitations of adult activities cease to satisfy the child. To be sure, many if not most of the plays of the whole preadolescent period are directly imitative in

[1]The object has no conscious existence at the time save in the activity. The ball to the child *is* his game, the game is his ball.
Dewey, *Interest in Relation to Will*, p. 16.

[2]See Dewey, *Elementary School Record*, p. 49. Also p. 50 for suggestion as to how the realization of ends should at first be developed.

[3]Compare Dewey: "The work of children of ages six and seven includes activities which combine an immediate appeal to the child as an outlet of his energy with leading up in an orderly way to a result ahead. It thus forms habits of working for ends and controlling present occupation so as, by a sequence of steps, to accomplish something beyond. These habits may be gradually transferred to ends more consciously conceived and more remote." *Elementary School Record.*

their method and motive.[1] But the imitation becomes more refined, detailed and accurate, and consequently requires more highly specialized apparatus than heretofore. So the child can hardly help giving more or less attention now to making what might be called the tools of play—the things necessary to the carrying on of this more definite imitation. Play houses, toy boats, furniture and weapons, dolls, dolls' clothing, etc., are made and used in this form of play. It seems accepted that this imitation type of play holds the interest until into the eleventh or twelfth year,[2] and that it must influence constructive preferences seems evident—though how much or in just what ways we have no means of telling. But it is clearly within this period and generally in connection with these forms of play that we must look for the first real appreciation of construction as means rather than end. It seems safe to say that during this period work is occasionally done with the adult-utility motive, and that the proportion of this work increases with age up to adolescence and beyond.

On the whole, it can hardly be denied that our knowledge regarding these factors of constructive interest is exceedingly vague. This becomes particularly apparent when one attempts to give it any influence upon school work. About all we can really hold to is the conviction that in the development of constructive motive the progress is through instinctive manipulation, imitative occupational work, and the making of play materials, to the making of things useful in the adult sense. We hardly know whether these attitudes are sufficiently differentiated to justify calling them stages, or, with any definiteness, at what age any one of them reaches its point of greatest influence, if indeed there is any such point clearly defined. We know little of how far sex affects motive in constructive work. We have no data by means of which we can compare these stages with the various physiological and psycho-

[1]Outside of school a large proportion of children's plays are simply more or less miniature and hap-hazard attempts at reproducing social occupations.
Dewey, ibid, p. 84.

[2]Johnson, *Pedagogical Seminary*, Vol. 6, p. 519.
Gulick, *Pedagogical Seminary*, Vol. 6, pp. 137-8.

logical stages of growth established from other points of view. The following material is offered as a preliminary contribution of data upon such points.

THE FREE CONSTRUCTIVE WORK OF CHILDREN IN TWO SCHOOLS

A natural material for such a study of construction motives and interests was thought to be detailed knowledge of the various lines of constructive work done spontaneously by children of both sexes and the different ages. As an attempt to obtain such knowledge, papers headed as follows were given to 200 children from eight to sixteen years of age in the Horace Mann and the Ethical Culture Schools, both in New York City:—

LIST OF THINGS MADE OUTSIDE OF SCHOOL DURING THE LAST TWELVE MONTHS

By_____ Age_____ yrs._____ mos.

Grade_____ Brothers' ages_____ Sisters' ages_____

DIRECTIONS: Put down everything you can think of, no matter how small or simple. Ask your parents if they will help you to make the list as complete as possible.

Name of Article	Made in what month	Of what materials?	How large?	What for?	Whom for?	Remarks

These questions, when all answered (as they were with 95 per cent of the articles listed), give what would seem to be a fairly clear idea of the main motives behind the making of an object, its purpose and its value to the child, and a considerable basis for judgment regarding the technical difficulties involved.

One hundred and seventy sheets were returned filled out. Of these twenty-two children mentioned less than three articles made and their records were not computed with those of the rest lest they should have undue influence upon the averages. There

remained one hundred and forty-eight sheets, sixty-three being from boys and eighty-five from girls.[1]

The number of articles reported seldom exceeded ten, the average number being seven for the boys, and eight for the girls. Considering the age of the children and the chance of accidents to papers, it is hardly fair to assume that the 13 per cent of unreported cases necessarily represent lack of work or different work by those children. And the 13 per cent of meagre reports omitted from the tabulation give no indication of being fundamentally different from those of the 74 per cent studied. Still, strictly speaking, the study related only to that 74 per cent of the whole group which pays the most attention to handwork, or rather, reports the largest number of articles. It should be noted also that most of the children in these two schools remain till graduation, and thus are more alike in general ability than could be claimed for children of the same ages in public schools where so many are withdrawn before reaching the age of 14 years.

CLASSIFICATION

Five independent classifications of this material were attempted, the child's age being made in each case the basis of the tabulation. Of these the two most important dealt with the motive behind the making of the article, and the material of which it was made. The third tabulation shows the number of times that such distinctively art work as drawing, painting, etc., were recorded, and the fourth shows the presence of an element which we will call "vitality"—the "go" which belongs to a toy water wheel or windmill, and is lacking in a tool chest or picture frame. Both of these really belong under the general

[1]While a larger quantity of them would have been exceedingly desirable and easily obtained, it seemed important that the tabulating should not be delegated and that it should have the uniformity of one person's view-point. It is believed that a somewhat careful and detailed treatment of the data presented has more value as a preliminary study than the kind of work which would have been necessary with a larger amount of material.

head of motive but are tabulated independently of what appears to be the ruling motive of a project. The fifth tabulation was an effort to determine the part played by the school in suggesting the handwork done outside, but the information here proved too meagre to be worth recording.

It was difficult to determine what classification of the motives for making these different articles would be the most inclusive and fruitful. The utility class and the play class are the two which we are perhaps most interested in comparing. But while these are very general they do not seem to cover the whole field. Things made as gifts are often useful and often play-things, but the utility or play motive here involved is quite a different thing from that entering in the making of things for the child's own use. So the most logical basal division would seem to be into the two classes, made-for-self and made-for-others, each of which may be subdivided into play and utility classes. This, however, is an incomplete analysis of the made-for-others section, for in addition to useful gifts and play gifts there are also those which are mere remembrances, and have no further purpose. However, our main purpose is a quantitative study of the various forms of the play and utility motives already mentioned and of their relative importance in the different years or periods of childhood. So the smaller made-for-others classes were kept separate, not so much for their own significance as in order not to prejudice results in these main groups. The most practical though not the most logical primary division is into classes representing the play, the utility and the gift motives.

The subdivisions of play motive are in general those already discussed, the two main ones being play-imitation in which the construction itself constitutes the game, and play-utility in which the purpose is to obtain tools of play. Several lines of work which were quite prominent and continuous were listed independently of these two classes. These were (1) the making of boats, (2) construction connected with animals (houses, traps, etc.), (3) the making and dressing of dolls, and (4) cookery. These are all particularly hard to separate into the two classes first mentioned. It seems to the writer, however, that in the making of boats, dolls and animal traps, the play-utility motive is the most general and prominent and that making animal

houses belongs here also, though less completely, as the simple utility motive seems to enter rather more. Cookery is hardest of all to classify. It probably depends more largely upon the instinctive manipulation pleasure than any other line of productive work included in this study. At least, it will seldom be practiced voluntarily except by the children who do gain some of this kind of pleasure from it. But this motive will be greatly reinforced by that of play imitation in the case of younger girls and doubtless by the utility—or gustatory—motive with the older ones. Things made with the adult-utility motive were placed in two classes: that of "utility," containing the things made for the worker's own use, while such things made for others fall into the useful-gift class. The gift class as a whole was divided into the three of useful gifts, play gifts and gifts, the last including such gifts as are mere remembrances and without other value. It is evident that these classes must shade into each other with great delicacy at times, and that the attempt to take things which must represent such an interplay of motive, and place them in classes so simple and sharply defined is bound to raise some question as to the real value of such a study. It must be admitted that it was sometimes difficult to select one of two or even three classes for a given article. This, however, was far more often due to the fact that the article clearly represented a transition stage than for mere lack of information about it. For example, does the building of a camp-hut to sleep in or the making of a real row-boat belong in the play-utility or in the adult-utility class? They were finally placed in the former, but so far as the separation of means and end is concerned the adult view-point seems fully reached, and the utility class would seem to have an almost equal claim upon them. Then there were sometimes difficulties in classifying certain things which proved to be made by children of all ages and would thus seem to have some place in all three of these classes. Thus the making of a dam might mean anything from the mere play with water to furnishing the power for a large factory. But if we have in addition the statement that the dam was made in order to sail toy boats, then this particular dam stands out plainly as a member of play-utility class. With these articles some such cue to the motive was generally at hand so

that they were a less serious problem than the first one mentioned, while the great majority of articles belonged quite clearly to one or another of the groups.

The method of tabulating was as follows: Each article in a child's list was scored in that motive column which seemed most appropriate, then the child's record as a whole was formed by reducing the number of articles recorded in any one column to its percentage of the total number of articles recorded by that child. Thus two useful gifts in a sheet mentioning eight articles, would give a weight of 25 per cent to that motive. The following is a sample record of a boy: No. 207. H. R. Grade V. Age, 10 yrs., 2 mo. No. of articles, 9.

For animals	2	articles	22	per cent
Play utility	3	"	33	"
Play imitation	1	"	11	"
Useful gifts	3	"	33	"
Vitality	4	"	44	"

As no sheet containing less than three articles was included in the final tabulation, no one article could make a showing higher than 33 per cent in the individual child's record, while its average weight there would be from 12 to 14 per cent. Then a variety of age groups were formed and the aggregate of percentages was divided by the number of children in the group, thus giving an average per cent indicative of the rank of that motive within the group concerned.

Partly as a check upon accidental results due to the small number of cases, six independent groupings were formed and averaged, three for each school. The first was into three groups, including ages 8-9 years, 10-11 years, 12-14 years respectively; the second grouping was by periods of one year; and the third by periods of six months. We may call these the groups by periods, the groups by years, and the groups by half-years. On the following page will be found the period averages of boys for each school and for the two schools combined; the year averages of both schools combined; then the total averages for each school and both schools. The half-year and year groupings of

the two schools separately contained too few cases to give any curves. The half-year groups of the schools combined developed a few points of interest which will be mentioned later.

The only material similar to this known to the writer is in Crosswell's study of games already referred to[1]. In a questionaire given to 10,000 Worcester school children he asks them to describe anything which they themselves have made. Wherever possible, I have tabulated his lists of articles according to the present plan. The results here, representing as they do a much larger number of children, furnish some interesting comparisons with our own general averages and with the relative frequency of the different projects shown in the article lists. These figures will be indicated as we proceed. The ages of his children not being stated, this material cannot, of course, help us on the genetic problems within this period.

[1] *Pedagogical Seminary*, Vol. 6, 315.

TABLE I. BOYS. Showing the relative importance of the different interests, by the per cents of the articles made which belong to them

	Both Schools			H. M. School			E. C. School			Both Schools						H.M	E.C.	Both
Age	8-9	10-11	12-14	8-9	10 11	12-14	8 9	10-11	12-1.	9	10	11	12	13	14	8-14	8-14	8-14
Average number of articles	8	7	6	7	7	6	14	7	5	6	7	7	6	6	7	7	7	7
Number of children	12	24	27	10	13	11	2	11	16	9	13	11	9	10	7	34	29	63
INTERESTS																		
Play-Imitation	27	20	5	26	23	8	30	14	3	29	19	20	10	4	3	20	9	15
Play-Utility																		
Boats	9	18	15	11	26	18		9	13	11	17	20	7	15	22	19	10	15
For animals	6	5	9	7	2	14		7	5	7	5	5	14	7	4	7	6	7
Dolls	1	1					5	2			1						1	
Other	13	24	27	14	21	24	5	27	30	13	24	25	24	17	43	18	26	22
Total	29	18	51	32	49	56	10	45	48	31	47	50	45	39	69	44	43	44
Total Play	56	68	56	58	72	64	40	59	51	60	66	70	55	43	72	64	52	59
Utility (self)	5	6	20	4	5	19	5	7	21	5	7	5	21	25	6	9	13	11
Useful gifts	34	20	14	31	19	9	51	21	17	32	26	14	11	15	15	19	21	20
Play gifts	2	2	6	1	1	3	5	1	8		1	3	4	10		2	5	3
Mere gifts	3	4	2	4	5	2		4	1	3	3	7		2	2	3	2	3
Total gifts	39	30	22	36	27	13	56	35	26	35	30	24	14	27	17	24	28	26
Art	3	4	4	3	3	4	2	5	4	3	4	2	3	4	5	3	4	4
Vitality	22	37	41	27	37	50	7	38	34	25	35	40	35	32	58	33	34	33

LIST OF THE ARTICLES MENTIONED BY BOYS. BOTH SCHOOLS

Play-imitation, 59 articles: Spears, swords, etc. 10, theatres 8, houses 5, docks 3, chairs 3, claywork 3, beds 2, cranes 2, windmills 2, elevators 2, derricks 2. Wild West show, cave, card-board monkey, acorn pipe, Indian head-dress, cannon, camera, spoon, railway track, Indian village, saw-mill, brush, mud-pie, paper pasting, telephone, mask, bridge, 1 each.

Play-utility, 188 articles: Boats 64, for animals 28 (13 traps and 15 houses), wagons 12, balls 11, bows and arrows 9, houses 9, kites 5, bean shooters 5, guns 3, tents 2, bean bags 2, whistles 2, stilts 2, sleds 2, water-wheels 2, derricks 2, elevators 2, dams 2, toboggans 2. Swing, bridge, show-house, ring-toss, tennis-poles, gunpowder, cave, bathing-chute, paddle, lead-cannon, high-jumping poles, basket-ball goal, torpedo, reins, whip, scrap-book, "wether vain," fishing tackle, fish-nets, mask, jumping-jack, camp-bed, 1 each.

Utility, 45 articles: Picture frames 6, boxes 3, tool chests 2, pen wipers 2, book covers 2. Hen-coop, basket, braid, shooting-blind, loom, clothes-rack, wand, flower-box, paper-cutter, candle-holder, easel, pen-holder, pen-rack, book-case, ruby lamp, sail-boom, tray, calendar, book, "sew clothes," caning chair, tooth-brush holder, stamp book, card printing, type making, camp sign, ladder, stone bridge, pin cushion, camp hut, 1 each.

Gift-utility, 72 articles: Baskets 14, boxes 5, picture frames 4, calendars 4, mats 4, match boxes 3, book covers 3, brackets 2, paper knives 2, pen wipers 2, pen holders 2. Scrap book, thermometer back, book, bib, lamp shade, book mark, match scratcher, table, sleeve board, letter rack, "monogram frames," blotter, breast pin, sponge bag, foot stool, soap box, "burnt work," "paper weight," hat, fernery, chicken nest, doiley, corn-popper stand, sofa pillow, hammock, Christmas tree stand, whist counter, 1 each.

Play-gifts, 14 articles: Doll's chairs 2, doll's hammocks 3, boats 2, Rolling pin, dart, doll's house, reins, knotted cord, doll's bedding, hunting knife, 1 each.

Mere gifts, 12 articles: Easter cards 5, valentines 4, paintings 3.

Painting and Drawing. Mentioned by 12 boys.

Looking first at the three columns of Table I which represent the total averages, it will be seen that with one or two exceptions the records of the two schools are very close together. With five of the fifteen motive elements recorded they are only 1 per cent apart, and with five others only 4 per cent apart. So the averages of the two schools seem to offer a fairly good basis for a quantitative ranking of these various interests during this

six or seven-year period of childhood taken as a whole. Assuming that we are justified in looking at this period as a unit, we may conclude that nearly half of a boy's voluntary construction projects will be things to be used in his play and that some three-tenths will be articles of real use (two-tenths for use by others against one-tenth for his own use). Of the work devoted to play it appears that one-fourth to one-third of the articles within this group will be boats, while a rather even one-tenth of them will relate to animal life. It is further shown that roughly a third of the whole, and a much larger part of the play division, have the element which we have named vitality.

Croswell's study[1] furnishes material for an interesting comparison at this point. It includes lists of 10,000 articles reported to be made within a group of 4000 boys. How many of them mentioned things made is not stated. These articles, classifiedin the rough way possible with no data except their names, give to—

Utility 1 per cent.
Dolls 1 per cent.
Play-imitation 2 per cent.
Play-utility 96 per cent.

and furnishes a rather startling evidence of the conservativeness of our own play record. The contrast is an indirect suggestion of the relative intensity of these different motives, for Crosswell's request to "describe anything you have made" was only one among a number relating to different subjects and would likely elicit only the most important and best remembered projects, while our own request to "mention everything you can recall no matter how small or simple," might better from this point of view have been omitted as it has doubtless resulted in the recording of more or less that has very little comparative interest. A comparison of the two tables suggests very strongly that if the relative intensity of these different construction motives were measurable the result would give a far larger place to the play-utility type of work than is indicated by consideration of the mere number (44 per cent) of articles. How far the 96 per cent of the Worcester boys might vary with age we have no means of knowing.

[1] *Pedagogical Seminary*, Vol. 6, p. 315

There remains, however, the question,—is there sufficient unity to these six years of boyhood to give value to such analysis of it as a single period, or are the interests of its different parts so diverse that this lump average of the whole has no meaning for any particular part and cannot in the least degree serve as a guide to school practice? This must be determined by comparison of the sub-groups formed on a basis of age. If diversity appears we shall need to subdivide the period into divisions containing the greatest possible degree of homogeneity, defining them and measuring their differences so far as possible. We shall quote from the figures for the combined schools, with which it will be seen that the separate records of the two schools largely agree, calling attention to the discrepancies as they occur. The division by years allows only ten cases to a group, so that perfectly smooth curves here could not be expected, but it is valuable in showing the limits of variability within the larger groups, where the results are much more uniform.

It will be seen that, while a number of interests remain at about the same level for the whole time covered and one or two fluctuate irregularly, the four in the following table show a distinct rise or decline:

Changing Interests

Age	8-9	10-11	12-14	9	10	11	12	13	14
Play imitation	27	20	5	29	19	20	10	4	3
Play utility	29	48	51	31	51	50	45	39	69
Utility	5	6	20	5	7	5	21	25	6
Useful gifts	34	20	14	21	26	14	11	15	15

While the directions of these changes are what one would expect, the figures give some measure of their extent. Play-imitation decreases quite evenly from year to year. If similar figures were available bearing upon this element in the sixth to eighth years, it would doubtless prove very strong there. That the reports of the eight-year-olds show an amount less than that at 9 years should not be thought to weaken the argument seri-

ously, both because there are only three of them and because being in advance of their age at school they would likely be precocious in respect to these interests also. Although a waning interest, it seems to be a not unimportant element in the work of the period from 9-12 years. The twelfth is evidently the transition year showing 10 per cent here between 20 per cent in the eleventh and 4 per cent in the thirteenth. There is an almost identical difference between the 10-11 year period and that of 12-14 years, one which is fully supported by the separate tabulations of the two schools.

The play-utility interest increases, though not with the regularity of the curve just noted, though it is doubtless mainly responsible for the decline of the play-imitation interest. Its maximum of 69 per cent at fourteen years should be qualified by the fact that there were only seven boys of that age. The general tendency, however, is evident and its decline, like its beginning, would seem to occur outside the age limits of this study.

The other two most changing interests are those of utility. That the utility (for self) class waxes, while that of the useful gifts wanes, would suggest a reaction between them. However, the figures in detail do not correspond closely enough to demand that position, and there is nothing in common experience to suggest that children in any direct way transfer their interests from making useful things for others to the making of useful things for themselves. The way in which the extreme figures of the play-imitation and utility columns counterbalance each other would give more reason for claiming a direct transfer of interests here, and this would support the idea of a sequence of development through play-imitation, play-utility and utility.

The reasons for the diminution in useful gifts are not so easily determined, coming in the twelfth to fourteenth years during which time the social instincts are thought to be coming to the fore. In fact the large percentage of these useful gifts during the earlier years is itself rather surprising. The results with the girls seem to throw a little light on this point. It will be seen later that their proportion of useful gifts is much higher throughout, with a general average of 40 per cent against that of 20 per cent for the boys. Girls seem in general to be more

amenable to suggestion than boys, and the boy's attitude seems much more like that of the girl before the age of eleven or twelve than it does afterwards. It will be seen by reference to the lists of articles that the useful gifts tend to be of a conventional sort—calendars, picture frames, match-boxes, and such things as a child would hardly think of making except through direct suggestion and imitation. These are the things most likely to be suggested by the elders to a child as a means of satisfying his craving for doing something he knows not what, or as a means of keeping him busy. So it might be held that the utility element as such is not a large one in the motive for the making of these more or less useful gifts during the ages 8-11, and that the motive is rather the general instinct toward constructiveness manifested along suggested lines. However, it is a matter of common observation that the desire to give presents reinforces this motive strongly in many cases, even with very small children. To the relative importance of these motives such figures furnish no clue.

The Vitality Classification

This is independent of the others and gives a fairly definite quantitative statement of a constructive tendency, the existence of which would be sufficiently attested by common observation—the tendency to make things that will "work," "go," "do something."

Ages	8-9	10-11	12-14	9	10	11	12	13	14	8-14
Vitality	22	37	41	25	35	40	35	32	58	33

It is thus seen to belong to from one-quarter to one-third of the articles made. It might be questioned whether the increase is due to development of the taste itself or merely to increase of power for satisfying it, but the latter seems to the writer the more probable explanation. Its distribution, too, is striking. Only eight boys, four in each school, fail to record at least one

article falling within this class, thus making it the most widely diffused element of motive—that of play in general excepted—which our analysis of these returns discovers; for to the useful-gift class, which stands next, there are twenty-five boys who contribute nothing, and thirty-seven record nothing in the utility column.

The Gift Motives

Ages	8-9	10-11	12-14	9	10	11	12	13	14	8-14
Useful gifts	34	20	14	21	26	14	11	15	15	20
Play gifts	2	2	6		1	3	4	10		3
Mere gifts	3	4	2	3	3	7		2	2	3
Total gifts	39	30	22	35	30	24	14	27	17	26

The sub-divisions here have only a negative value. The gift element in the motive is doubtless altogether dominant in all three, so that the question into which sub-group the article falls is a very incidental matter. The play gift may be looked upon as a useful gift in the fullest sense so far as the maker's motive is concerned. The doll's bed made for the small sister may in a much more real sense be called a useful gift than the match-scratcher made for an uncle. We may, however, give the name of "serviceableness" to the common element in these play and adult forms of utility, and this is almost invariably present in the children's gifts here recorded. The mere-remembrance gifts, consisting largely of drawings, Easter cards, etc., are seen to be generally less than one-tenth as numerous as those having more or less of this serviceableness, so it would seem that the child likes to do something definite for the person concerned as well as merely to give expression to the feeling of friendship.

The division into play and useful gifts may be made to serve another purpose. The so-classified "useful" gifts are almost invariably for adults while the play gifts of course go to children. However explained it is an interesting and rather surprising fact that even including the mere gift with those of

play, many of the former being also intended for children, they are seldom more than one-half as numerous as those made for adults, and sometimes one-eighth of the latter. The figures are as follows:

Ages	8-9	10-11	12-14	9	10	11	12	13	14	8-14
Gifts made for adults	39	20	14	21	26	14	11	15	15	20
Gift made for children	5	6	8	3	4	10	4	12	2	6

This very striking preponderance of making for adults may be looked at in various ways. It may be that the question has no relation at all to that of motive in construction, and that if all presents given by children were classified in this way they would show the same preference for adults. On the other hand, there are two influences which might bear on the handwork concerned. The child perhaps gains a feeling of dignity in making something which he imagines will be of actual use to a grown person, which might not accrue from the making of something for a playmate. Further the adult is likely to make much of the fact that the child made it himself—a fact which would mean much less to a playmate.

It is apparent that the excess of gifts to adults is in the years 8-10 and that it becomes much reduced later. This is due to decrease of gifts to adults much more than to increase of those for children, yet there is a clearly marked increase of the latter. The things which the older boys make for chlidren are apparently for children much younger than themselves.

Regarding gift construction as a whole, then, we seem to have first the very pronounced tendency of the small boy to make things for adults, and with the adolescent boy a smaller gift total, divided much more equally between adult and small children, but nowhere any marked tendency to make presents for his friends of his own age. How far this tendency deserves encouraging or discouraging on ethical grounds is a question which might be worthy of consideration, and it would be of interest to know whether this means a comparative non-exchange

of gifts between mates or simply that "store presents" are here substituted for the work of one's own hands.

The More Stable Interests

The following groups appear to be much more stable in their appeal, and while fluctuating somewhat betray no genetic reason for so doing.

Ages	89	10-11	12-14	9	10	11	12	13	14	8-14
Total Play	56	68	55	56	66	70	55	43	76	59
Total Utility	39	30	34	37	32	19	31	40	21	31

The total formed from the two utility classes is seen to keep fairly close to its general average of 31 per cent. This, however, does not seem to the writer to be significant of any special stability in the utility interest as such, for the reason already suggested that in the class named useful gifts the utility element in the motive is distinctly incidental to the gift motive. So this total utility class is in reality a combination of two very different interests which vary in opposite directions.

With regard to the play total, the same thing is true but in considerably less degree. In all of these the play element of motive is in one form or another the leading one, (play gifts are not here included) and the general average of 59 per cent seems a fair estimate of the influence of play upon construction between the ages of eight and fifteen. The fluctuation is considerable but too irregular to suggest any inferences, the minimum and maximum appearing in the thirteenth and fourteenth years respectively. It is to be said regarding the 76 per cent of the fourteenth year, that it includes various pieces of camp and athletic apparatus which might with almost equal propriety be placed in the utility column (which is proportionately weak at this point), thus giving a much smoother curve for both these interests.

The two special classes of boats and things-made-for-animals also make a comparatively even record throughout the six years.

Ages	8-9	10-11	12-14	9	10	11	12	13	14	8-14
For Animals	6	5	9	7	5	5	14	6	4	7
Boats	9	18	15	11	17	20	7	15	22	15

This, coupled with the evidently large amount of the imitation element in boat-play, suggests that boats might be given partially to the play-imitation motive. While a very few might fit better there, the great majority seemed to belong most naturally to the play-utility class, while the "for-animals" class seems to belong there unquestionably—though with a leaning occasionally towards that of utility in the case of a very few articles like chicken coops, etc. As the list of articles (p. 22) shows, these are clearly the two great constructional projects of boyhood. Twenty-eight pieces reported are for animals and sixty-four are boats, making them respectively twice and five times as numerous as the baskets, which rank third. Of the boats twelve were rafts built for use in paddling about, diving, etc. Of these twelve, ten were made by boys of the Horace Mann School. Probably a larger proportion of these boys spend their summers in the country. The boats appear quite evenly after the age of ten years, the numbers for each year beginning with the ninth being 1, 0, 3, 2, 2, 4. The toy boat holds its own in the later years as well as the earlier ones, and is here generally a model racing yacht or a rather elaborate model of a battle ship.

The fact that in each of these six years from ten to twenty per cent of the boys' free construction goes to boat-making seems a strong demand for much more attention to the boats as an object of school handwork. On the side of interest at least, its claim is seen to be sufficiently pre-eminent. And when we think of the possibilites either of simplicity or of complexity, the exceedingly varied constructional problems that boat-making

may develop, the variety of materials which it may require one to work in and the problems in physics which must be solved experimentally in order to insure success, it would seem very advantageous to have a rather definite series of boat-contructions in the handwork curriculum which would develop the problems in a progressive way, and one of which would appear in every year or second year of the elementary course.

Of the twenty-eight things relating to animal life, thirteen are some form of trap and fourteen are houses, cages, etc. However much or little these may be thought to differ in motive, they are just as nearly balanced for each year as they are in the total.

Ages	9	10	11	12	13	14	9
Animal-Houses	3	2	1	4	2	3	14
Animal-Traps	2	4	2	3	2		13

These are the work of sixteen boys, four having made traps alone, eight houses alone, and four both.

The percentages for art work as such are as follows:

Ages	8-9	10-11	12-14	9	10	11	12	13	14	8-14
Art Work	3	4	4	3	4	2	3	4	5	4
No. of children reporting				2	2	1	2	2	2	

These figures have not the same significance as those already discussed as they generally rest only upon some such statement as "some paintings," "several drawings," etc., and so give little idea of the comparative importance of this work in the child's mind. The fact that fourteen out of the sixty-three boys mentioned drawing or painting is more significant than the general average of 4 per cent which is an attempt at representing

the proportion of interest in this as compared with constructive work. But in every case the per cent is based on a single sheet and necessarily recorded as such. But the evenness of the per cents for the different years and periods is equaled by that of the number of children of such age reporting art work. It seems safe to say not only that an average of two children in ten do some such work of their own accord, but that two children out of every ten do so, and no more. The attention given to art work in the school room is too nearly the same in the two schools to allow of any judgment regarding its influence upon this form of home work. It is considerable in both of them.

The List of Articles by Classes

These lists which follow Table I on p. 22 present points of interest, some of which have been already touched upon. Some articles such as windmill, house, etc., appear in the list of more than one class, the detailed description seeming to require this.

The play-utility class is seen to have the least variety of articles, its size being considered, while the utility class is the most diffuse in this respect. Even omitting the 64 boats and the 28 animal contrivances which so far exceed everything else, there are still the 12 wagons, 11 balls, 9 bows and arrows, and 9 houses, while in the utility class there are only four articles mentioned more than once (6 picture frames, 3 boxes, 2 tool chests, 2 pen wipers,) with 33 things mentioned only once, as against 22 pieces mentioned once in the play-utility class, whose total is four times as large. A rather common argument for making only useful articles in the school room is based on the thought that it is only such work that can be expected to appeal to every child in a large class. If the play interests are as general and the utility interests as highly special and individual as these figures suggest; if the tendency among boys to *use* the same things is so much weaker than that to *play* the same things, an exactly contrary practice should prevail in so far as the current one is based on this idea.

It must be added at once that the useful-gift class is almost as diverse as that of utility. The variety here is somewhat against the suggestion already offered that the things made for this purpose are largely suggested by adults; still the list of articles does not read like one evolved wholly from a boy's inner consciousness. The number of baskets recorded (14) is more than twice that of any other article in the gift list. This is the only kind of home work recorded by boys which gives evidence of influence by the manual training work of the school, and it is doubtful whether any would be made by children who were not taught to do so at school. That so much of the work is done outside is a decided argument for basketry as a part of school handwork, and the fact of its almost exclusive connection with the gift motive would suggest attention to basketry as one of the most effective ways in which the school may encourage the gift habit.

Perhaps mention should be made of the articles mentioned about ten times each which may be looked at as forming a second class: They are: Houses, 14; baskets, 14; toy machines, 13; weapons, 10; picture frames, 10; bows and arrows, 9; other shooters, 8; theatres, 8.

The suggestion offered by the play-utility list regarding the relative popularity of the different projects is corroborated in a striking way by a similar arrangement of Crosswell's toy lists. The same 12 articles rank first in both, with considerable agreement respecting position within the group. Below are given these twelve in the order of their rank in our own list, the rank and the number of articles for each being expressed by open figures, while their ranks and numbers in Croswell's list are enclosed in parentheses.

1	(1) Boats 64	(205)	7	(6) Kites 5	(39)
2	(8) For animals 28	(27)	8	(11) Bean shooters 5	(16)
3	(3) Wagons 12	(138)	9	(7) Guns 3	(28)
4	(5) Balls 11	(42)	10	(2) Sleds 2	(151)
5	(4) Houses 9	(125)		(9) Whistles 2	(26)
6	(11) Bows and Arrows 9	(16)		(10) Stilts 2	(25)

The evidence from these two lists seems to the writer sufficient basis for an emphatic demand that the elementary school include each of these twelve projects at least once, perhaps oftener, as a part of its constructive work. His opinion is that there are very few programs of handwork that touch even half of them in any adequate fashion.

STATISTICS OF THE GIRLS' HANDWORK

The same scheme of classification is used as for the work of the boys except that a special place was made for the food-making activities to avoid the responsibility of placing them in any one of the other classes, for the source of interest here seems a peculiarly even combination of manipulation, imitation pleasure and utility pleasure. This need not, however, be called a departure from the first tabulation scheme, as not a single boy reported the making of food or candy.

The results looked at in a broad way, point to two main classes for girl's constructive work: (1) The making of things directly connected with doll play, (2) the making of (more or less) useful gifts; the one having a general average of 24 per cent, the other of 40 per cent. The only other class with any claim at all to a place beside these is that of utility with 14 per cent, nothing else rising above 6 per cent.

TABLE II. GIRLS. Showing the relative importance of the different interests, by the per cents of the articles made which belong to them

	Both Schools				H. M. School				E. C. School				Both Schools							H.M	E.C.	Both
Age	8-9	10-11	12-14	15	8-9	10-11	12-14	15	8-9	10-11	12-14	15	9	10	11	12	13	14	15	8-15	8-15	8-15
Average number of articles	5	8	8	5	6	6	7	5	11	9	9	5	8	8	7	8	8	6	5	6	9	8
Number of children	17	26	37	5	10	8	18	3	7	18	19	2	13	16	5	14	12	16	5	39	46	85
INTERESTS																						
Play-Imitation	3	4	2			3	1		5	2	4		5	7	2	4	1	1		1	5	2
Play-Utility																						
Dolls	34	32	17		18	23	8		56	36	26		35	32	26	13	21	17		13	35	24
Boats		3				4				2				3	7	1				1	1	1
For animals	1		1		2								2		1		3			1		1
Foods	1	2	7	10			13	13								5	5	4	10	7		4
Other	4	2	1		7	4				1	1		6	2	4	2				3	1	2
Total	40	39	26	10	27	31	21	13	56	39	27		43	37	38	21	29	21	10	25	37	30
Total Play	43	43	28	10		34	22	13	61	41	31		48	44	40	25	30	22	10	26	42	32
Utility	9	9	17	32	8	11	18	20	10	8	16	45	7	9	4	13	18	20	32	14	13	44
Useful gifts	32	36	45	58	47	36	48	67	10	37	43	48	33	32	39	59	36	44	58	47	35	40
Play gifts	3		1		4		2		1				2			1	1	2				
Mere gifts	9	8	4		9	13	2		8	8	6		7	5	12	46	6	2		6	6	6
Total gifts	44	44	50	58	60	49	52	67	19	45	49	48	42	37	51	64	43	47	58	53	41	46
Art	3	4	3		1	7			6	3	3		3	4	6	3	5	2		3	3	3
Vitality	1	3	1		2	7	1			2	1		2	2	11	3	1			4	1	2

LIST OF THE ARTICLES MENTIONED BY GIRLS. BOTH SCHOOLS

Utility, 75 articles: Baskets 7, collars 5, hats 5, pen-wipers 4, ties 5, boxes 3, shirt waists 3, skirts 3, aprons 3, trimming hats 3, mats 3, purses 2, pillows 2, pen cushions 2, picture frames 2, night gowns 2, dresses 2. Napkin ring, table cover, doily, pillow case, quilt, guimpe, glove case, "patches," darning, wash cloth, "made my bed during summer," address book, sachet bag, pencil slip, stockings, slippers, school bag.

Useful Gifts, 380 articles: Doilies 48, baskets 27, picture frames 13, pin cushions 13, sewing bags 10, "embroidery" 10, calendars 10, pillows 9, mats 6, needle cases 6, silk bags 6, pen wipers 5, tidies 5, handkerchiefs 7, collars 5, babies' garments 5, slippers 4, pillow cases 4, book-marks 4, dish towels 4, napkin rings 3, books 3, wash cloths 3, napkins 3, towels 3, dusters 3, capes (crocheted) 3, sachet bags 3, picture mounting 2, book covers 2, card cases 2, glove cases 2, match-scratchers 2, glove menders 2, napkins 2, Christmas tree decorations 2, stockings 2, towels 2, shaving-paper holders 2. Apron box, shawl, stamp case, picture easel, iron holder, copper bowl, curtains, toothbrush case, hair receiver, handkerchief case, hat, shirt waist, blotter, envelope, tapestry, portfolio, shaving case, neck tie, clipping holder, postal holder, jewel bag, bib.

Gifts, 34 articles: Valentines 21, Easter cards 6, Christmas cards 3, Easter eggs 3, gilded clam-shell 1.

Play-utility, 282 articles: Dolls and dolls' clothing 162, boats 6, animals 3, bean bags 3, balls 2, houses 2, whistles 2, bows and arrows 2, jump-rope handles, pop-guns.

Play-imitation, 10 articles: Making flowers 2. Tent, flag, dish, napkin rings (for nobody), chair, barn, hay wagon, doll's cap (What for? "to do something." Whom for? The ash barrel.")

The doll is evidently the center of practically all of a girl's play-construction. It is doubtless motived in the earlier years by what was called in the case of the boys the play-imitation interest, and later becomes the counterpart of the boys play-utility work. The lists of articles as well as the percentages show how very few toys, not directly connected with doll play, are made by girls of any age. The boat and animal classes, so prominent with the boys, are almost negligible with the girls.

The figures point to a definite decrease in this sort of construction and its disappearance at about fifteen years. But the two schools differ very widely in their doll records:

Ages	8-9	10-11	12-14	15	8-15
Horace Mann School	18	23	8	0	13
Ethical School	56	36	26	0	25
Both	34	32	17	0	24

The Ethical Culture School thus shows nearly three times as much doll-handwork throughout with the maximum of 54 per cent in the first period, while in the Horace Mann School it is only 23 per cent with the children of 10-11 years.[1]

The play totals of boys and girls show striking differences both in size and direction of change.

Age	8-9	10-11	12-14	15	:	9	10	11	12	13	14	15	:	Av.
Girls	43	43	26	10	:	48	44	40	25	30	22	10	:	34
Boys	56	68	55		:	56	66	70	55	43	76		:	59

The boys' play-construction, nearly always more than half of their work, reaches 3-4 in the fourteenth year, while that of the girls, always less than half, drops to 22 per cent and 10 per cent in the fourteenth and fifteenth years.

As the doll and play elements weaken, those of utility take their place and the making of useful gifts is seen to be the leading occupation of these girls, though here again there is a difference between the schools. This work increases with the age of the girls as clearly as it decreases with that of the boys.

Utility

Age	8-9	10-11	12-14	15	9	10	11	12	13	14	15
Girls	32	36	45	58	32	32	39	59	36	44	58
Boys	34	24	14	—	21	26	14	11	15	15	

[1]These curves agree in a general way with that of the period of general doll interest as given by Hall and Ellis: "The doll passion seems to be strongest between 7 and 10 and to reach its climax between 8 and 9. . . . Girls often play with dolls regularly till 13 or 14, when with the dawn of adolescence the doll passion generally abates." *Pedagogical Seminary*, Vol. 4, pp. 156-7.

The evidence for this increase with age is, however, somewhat weakened by the 59 per cent which appears in the twelfth year with its 14 girls, when that of the fifteenth year is only 58 per cent. This may be taken as showing a considerable degree of variability in individuals without wholly contradicting the direction and degree of development indicated by larger periods which contain 20 or 30 cases each.

It is in the useful things made for one's self, however, that we find the most noticeable increase with age and the one striking agreement between the records of boys and girls.

Age	8-9	10-11	12-14	15	9	10	11	12	13	14	15
Girls	9	9	17	32	7	9	4	13	18	20	32
Boys	5	6	10	—	5	7	5	21	25	6	

It would seem that there is a very marked turning to this kind of work at the twelfth year, and with both sexes. If the making of bread, cake, etc., were included here, as it probably should be, this increase with age would be for the girls still further accented. Reference to the class list will show that with the girls as with the boys it is here that the largest proportional variety of project occurs, and that about half of the things mentioned are articles of clothing, most of the others being also needle work of one form or another.

The drawing and painting recorded by girls is seen to be even less than that of the boys though very close to it.

Age	8-9	10-11	12-14	9	10	11	12	13	14	Gen. Av.
Girls	3	4	3	3	4	6	3	8	2	3
Boys	3	4	4	3	4	2	3	4	5	4

This sex similarity in pure art is very far from holding good in respect to applied art. For a very large part of the doilies, pillow covers, embroidery work, etc., which constitute so much of

the girls' work, evidently includes a considerable art element, while there is comparatively little of the boys' work which shows any special thought about or interest in the art side.

The sex differences here shown may be summed up as follows.

(1) The toy is the boy's leading product and the useful gift that of the girl.

(2) Doll play is the center of nearly all of the girl's play-construction, while with boys the doll hardly appears at all although there is in the earlier years some of the play-imitation construction which has a certain resemblance to doll play.

(3) The girl's play construction as a whole is always less than half of the total and decreases with age, the boy's is more than half and tends to increase somewhat up to the age of fourteen at least.

(4) The useful-gift class, while holding about a third of the articles with both sexes under ten years, decreases to one-sixth with the boys while increasing to nearly half with the girls. The element which we have called vitality appears in 33 per cent of the boys' projects and in only 2 per cent of the girls'.

In addition to these differences of underlying purpose in construction, it is further to be noted that where the motive is the same, the things made with the work and materials involved are radically different;—e. g., although boats seem to belong exclusively to boys and dolls to girls, both seem to be rooted in very much the same sort of play instinct. As will later be shown, the boy depends very largely upon wood as his material and the girls upon cloth. The only marked similarity in materials or projects appears in the class of useful gifts which with both sexes contains quite a number of calendars, picture frames, and, most notably, baskets.

These facts regarding sex differences would point toward an almost complete separation of boys' and girls' handwork from the ninth year up—so far as the question of interest is concerned, which of course is far from the only consideration in planning a course of study. However, such a conclusion is limited by the fact that we do not know how far external suggestion has given form to the work which we have studied. Of course an element of that must be present in every case. The

fact that this suggestion is accepted and built upon voluntarily by the child is evidence that it meets some innate need, but is no evidence whatever that any one of a hundred other lines of work if suggested would not meet the same need as well or even better. So while these records show the suitability of certain kinds of work, they do not prove any other work unsuitable except in so far as it may appear that the suggestions for the other work were actually received and refused. If then we can assume that boys and girls do build upon the same body of suggestion, the exclusion of articles not made by one or the other sex will be evidence against the naturalness of that type of work for that sex. If we take the view that they build upon radically different suggestion foundations, we can draw no conclusions about the unsuitability of a line of work from the mere fact of its omission.

Upon this question it is to be said on the one hand, that the environment of boys and girls of these ages is practically identical, that they see, hear, and read about the same things in home and school, in city and country, and that consequently the widely separate elements of that environment which boys and girls select for reconstruction in play must have a peculiar adaptation to innate needs which are fundamentally different in the sexes. From this point of view these records support a demand for decided sex differences in school handwork, *i. e.*, so far as the question of interest is concerned.

On the other hand, it may be said, and with considerable force, as it seems to the writer, that while both boys and girls have the same environment there is at present a pressure of suggestion from without that has almost the force of law, and that this, rather than instinctive tendencies, is the reason why a boy becomes so early ashamed to sew or to play with dolls, and a girl feels it unlady-like to saw a board or sail a boat. The children were asked to state the ages of brothers and sisters in the hope of obtaining light on this question, but in this we were disappointed. Common observation furnishes isolated cases in which girls once started do supposedly boys' work with much enthusiasm, groups of boys have been known to become deeply absorbed in acquiring a knowledge of "camp cooking," etc. But only experiment

in giving to each sex the other kind of work under conditions peculiarly favorable to it in respect to suggestion can determine the actual importance in education of the sex differences so clearly shown in the above records. For the present, these must be regarded as bearing only on the question of what kinds of work will appeal to either sex, not on that of what kinds of work will not.

The Materials Used

Table III shows the same articles grouped on a basis of material, within the same age groups. As in the motive classification, the unit is not the number of articles but the per cent of articles of a given material, on the total number of articles reported by that particular child.

It will be seen that the attempt has been made with the three most general materials, wood, cloth, and paper, to distinguish articles made by combination of different parts, from those which may be made out of a single piece of the material; *e. g.*, rabbit houses, sail boats, shirt waists, sewing bags, paper dolls' furniture, etc., are placed in the construction class (1), while a whittled out arrow or paper knife, a doily or a paper book mark, would be placed in the non-construction class (2). Paper used for mere drawing and painting was not recorded in the "paper" class. The class "metals" includes, in addition to the few which were wholly of metal, those in which metal other than nails and screws was used as an important material.

These tables have little significance on the genetic side, the only regular variations with age being those which might have been pretty safely prophesied in advance,—*e. g.*, for the boys: (1) Increase in constructive wood work coupled with a decrease of the non-constructive; (2) Marked decrease in use of paper—19 per cent, 13 per cent and 10 per cent for the age-periods—most of the decline being in the non-construction class; (3) Decrease in the use of cloth—10, 6, 4 per cent by periods; (4) An increase from 1 to 11 per cent in the use of metals, though the two schools vary widely here. With the girls we find (1) much the same decrease in the use of paper as

STATISTICS OF THE BOYS' HAND-WORK

TABLE III A. BOYS. Showing the relative importance of the different interests, by the per cents of the articles made which belong to them

	Both Schools			H. M. School			E. C. School			Both Schools						H.M	E.C.	Both
Age	8-9	10-11	12-14	8-9	10-11	12-14	8-9	10-11	12-14	9	10	11	12	13	14	8-14	8-14	8-14
Average number of articles	8	7	6	7	7	6	14	7	5	6	7	7	6	6	7	7	7	7
Number of boys	12	24	27	10	13	11	2	11	6	9	13	11	9	10	7	34	29	63
Wood (1) *	26	46	48	29	49	49	12	41	47	27	44	47	38	46	56	42	42	42
Wood (2) ‡	14	21	5	17	19	9		22	3	19	13	29	10	3	3	15	10	13
Wood total	40	67	53	46	68	58	12	63	50	46	57	76	48	49	59	57	52	55
Paper (1)	8	7	5	9	8	11	2	7	7	7	3	13	12	7	7	9	6	8
Paper (2)	11	6	2	8	8	4	24	5		7	6	10	5			7	4	6
Paper total	19	9	7	17	16	15	26	12	7	14	9	23	17	7	7	16	10	14
Cloth (1)	9	5	4	8	4	3	11	7	4	8	8	2	3	2	9	5	6	5
Cloth (2)	1	1		2	3				1	2	3				2	2		1
Cloth total	10	6	4	1	7	3	11	7	5	10	11	2	3	2	11	7	6	6
Reed and raffia	7	5	3	6	5	1	11	7	4	7	9	1	1	6		4	5	4
Cord, yarn, etc.	7	3	5	6	3	1	10	3	7	7	4	2		9	5	3	6	4
Metal	1	3	11		3	21	5	3	4		3		15	3	16	5	4	5
Other	12	16	13	12	3	7	5	9	17	3	10		13	13	13	7	13	10

*Used Constructively. ‡Used as single piece.

TABLE III B. GIRLS. Showing the relative importance of the different interests, by the per cents of the articles made which belong to them

	Both Schools				H. M. School			E. C. School			Both Schools							H. M.	E. C.	Both
Age	8-9	10-11	12-14	15	8-9	10-11	12-14	8-9	10-11	12-14	9	10	11	12	13	14	15	8-14	8-14	8-15
Average number of articles	8	8	8	5	6	6	7	11	9	9	8	8	7	8	8	6	5	6	9	8
Number of girls	17	26	37	5	10	8	18	7	18	19	13	16	5	14	12	16	5	39	46	85
Wood (1) *	2	1	2		1	5	4	4	4	1	2	4	9	5	3	1		3	3	3
Wood (2) ‡		1							1				1							
Wood total	2	2	2		1	5	4	4	5	1	2	4	10	5	3	1		3	3	3
Paper (1)	6	2	3	5	7		6	5	4	1	6	3	2	2		6	5	5	3	4
Paper (2)	19	12	8	4	18	12	6	20	13	9	19	14	9	7	7	7	4	6	12	11
Paper total	25	14	11	9	25	12	12	25	17	10	25	17	11	9	7	13	9	11	15	15
Cloth (1)	38	40	37	66	33	37	32	43	42	40	39	32	31	29	49	35	66	36	43	39
Cloth (2)	8	11	18	9	13	3	19		10	18	9	5	6	22	12	17	9	13	12	13
Cloth total	46	51	55	75	46	40	51	43	52	58	48	37	37	51	61	52	75	49	55	52
Reed and raffia	10	7	9		7	7	5	14	7	12	11	4	13	9	8	7		6	10	8
Cord, yarn, etc.	8	12	9		9	3	3	7	6	14	9	16	2	8	7	10		4	13	9
Metal														1						
Other		3	9	10		10	14			4		3	9	12	7	9	10	10	2	5

* Used constructively. ‡ Used as single piece.

with the boys—25, 14, 11 per cent; (2) Something of an increase in the use of cloth—46, 51, 55 per cent (not fully supported by the separate record of the Ethical School).

Since all but one of these changes come within a range of 10 per cent, the general averages may be taken as fair indications of the relative suitability of these different materials to the needs and powers of the children during this whole period, and they offer direct suggestions of some value regarding the comparative attention to be given in the school room to work in these different materials. These points hardly require detailed comment, being sufficiently suggested by the figures themselves, as are also the differences between boys' and girls' materials.

Materials. General Averages

	Wood (1)	Wood (2)	Wood (Total)	Paper (1)	Paper (2)	Paper (Total)	Cloth (1)	Cloth (2)	Cloth (Total)	Reed and Raffia	Cord and Yarn	Metal	Others
Boys	42	13	55	8	6	14	5	1	6	4	4	5	10
Girls	3		3	4	11	15	39	13	52	8	9		5

II. THE EARLY INTERESTS AND EDUCATION OF 72 TALENTED ENGINEERS

Introduction

It will hardly be questioned that the lines of school handwork now in use give some general motor training which is of value to the child, and some knowledge of tools, materials and processes which is different in degree or quality from what he would otherwise acquire; or that these various acquisitions, skill, knowledge, inventiveness, aesthetic appreciation, habits of social action, and the like, so far as developed thereby, would increase somewhat the child's value to society.

But this is probably as strong and definite a statement as would meet with general acceptance. As to the extent of such results, we have no definite knowledge, and there is the widest difference of opinion regarding their relative values as compared one with another or with the regular school subjects. Each of these elements of value is exalted as the main purpose of the work by the adherents of one or another system. More numerous still are those who hold the opinion that any and all of these values are too insignificant in comparison with the regular school studies to justify their entrance into the curriculum. We may as well admit that we know little about the real social significance of these aims and less about the efficiency of the means used to obtain them.

We have no positive evidence that the school handwork affects a child's general motor control seriously, or even appreciably. We do not know whether or how far the elements of knowledge which a child gains through handwork differ in kind or degree from those gained through an equal time given to observation and study. We know very little of the relationship between the lines of ability required or cultivated by handwork and those which belong to the other school subjects. The known facts here are so few that one need consult only his personal

taste and inclination in deciding whether to go with him who says that it is the best general student who excels in constructive work, or with him who claims that it is just the boy stupid at his books who will lead his class in these more concrete and practical lines.

The situation is the same in regard to the specifically economic values of manual work. We do not know whether the adult efficiency of men in any walk of life is affected appreciably by the handwork now found in the school, and can only guess at the comparative importance from this point of view of the different kinds of work now in vogue. It would indeed seem probable that if the manual work were much increased and specialized it would materially affect the future efficiency of those children who are destined to earn their living in the manual occupations, and it might perhaps have equal significance for those who are to become industrial leaders and organizers. But the school, in this country at least, has not dared to offer enough special work to justify the expectation of any such results in a marked way, for lack of knowledge as to what children ought to receive it. Any way of ascertaining in advance what children would or should enter industrial occupations would probably make possible advantageous adaptations of their early education. Such problems will doubtless become subjects of serious study, and when this is done we may expect results regarding all of them such as will have decided influence on educational practice.

Tests will be devised which will develop facts regarding the influence of handwork upon general motor ability and its efficacy in developing constructive insight, inventiveness, and the like; the correlations of skill and success in manual lines with those in other lines may be easily determined; following the later records of children from different types of schools would give suggestions as to the influence of the curriculum on choice of occupation; a study of the boyhood characteristics of men in different occupations ought to indicate ways of judging what type of occupation a given child would incline to choose when grown, and furnish suggestions regarding what sort of specialization at school is desirable;—or at least it would prove the impossibility of any such fore-knowledge. The following

section deals with material of this last sort bearing upon a single set of occupations.

The desirability of a considerable opportunity for specialization was admitted after a long struggle so far as the colleges were concerned, and more recently secondary schools have also been developing an elective system. But in connection with the elementary school the question has hardly been discussed, in this country at least, the assumption being that this period must be given wholly to lines of work which are supposedly essential to all callings alike. This is however an assumption rather than a proved fact, and the possibility of advantageous specialization within these school years seems at least a question worth considering. Perhaps the broadest basis for any specialization here would be the division of the children into two classes; those who are to engage in constructive and mechanical occupations, and those who are not. In this case the problem of selecting the right pupils for industrial occupations and of giving them the right kind of special training, is at present identical with the general specialization problem as regards the elementary school. The class of workers-with-materials apparently would need to be divided into: (1) those who in subordinate positions perform the actual operations upon the materials, and (2) those who invent new methods and processes and successfully organize industrial effort.

The present study deals only with this second class, and is a consideration of facts regarding the boyhood environment, education, activities, and interests of men of marked constructive talent, with a view to determining what boyhood characteristics, if any, give promise of constructive talent in the adult, and what elements of education and experience, if any, regularly precede the manifestation of this ability in the adult.

While one would expect the main significance of such study to lie in its answer to the question of how definitely and in just what ways boyhood may be expected to indicate adult abilities, still it would be a rather extreme emphasis upon innate equipment as the only factor in the production of genius which would find no suggestions for education in the facts about to be examined regarding the boyhood of these engineers. Even Gal-

ton, whose Hereditary Genius gives such striking evidence in support of the view that men having certain types of inborn genius are bound to attain ultimately a given degree of such success regardless of environmental influences during childhood,[1] dismisses mechanical talent with these words:

> "I do not, however, see my way clear to making a selection of eminently gifted engineers because their success depends in a very great degree on early opportunities."[2]

Such an admission—or assumption—from such an authority would in itself seem a sufficient warrant for the attempt to ascertain just what the early opportunities are which produce eminently gifted engineers.

The following material was obtained by means of a questionnaire which is reproduced on the following page. It was sent to one hundred leading members of the American Society of Mechanical Engineers. As a suggestion regarding the degree of ability here represented it may be stated that some half-dozen (of those who replied) are millionaires, two of them many times such. It was estimated that the list included no one who, if salaried, would receive less than $7,500, while the average salary-rate was placed at $12,000.

Occupation..... Initials(*Omit if You Prefer*).....

At what age did you enter upon it?..... .....

Did you choose it then because it seemed necessary?.....

Because it seemed the most profitable?..... ....

Because of liking for just that kind of work?..... .....

Where was your home during boyhood?..... ... .

Country.....Village.... .....Town(*Over 1000 Population*).....City..... .

With what lines of mechanical work were you thrown into close contact, if any?..... ....

[1] Galton, *Hereditary Genius*, pp. 37-49.

[2] " " " p. 323.

In what lines of ability or taste were you considered exceptionally gifted during this period?.....

Please number the following studies in the order of your preference for them as a boy:

Arithmetic.....History..... ...Geography.....Literature.....

Science .....

In which ones was your work exceptionally good? .....

" " " " poor?.. .. ..

At what age did you leave school?..... ... .

What kinds of handwork did you do previous to your 17th year, and at what ages respectively?

Were you much or comparatively little interested in this work?.....

....

....

Did father or mother possess exceptional manual skill?..... .. ..

Father's occupation?.... ....

If you can recall them, please mention below, six things made or built by you previous to your 17th year?

If unable to recall age, please state between what years: e. g. 8-11, 12-14. 15-16.

ARTICLE	AGE	APPROX. SIZE	PURPOSE	REMARKS
....	.....	....	.....	....
.....	.....	....	....	....
....	.....	... .	... .	....
.....	.....	....	... .	.....
... .	.....	.....	....	....
....	....	....	....	....

How far in your judgment did the doing of such work as a child affect your choice of life work or your success therein?... .....

If your experience has led you to any conclusions respecting the place of handwork in the Elementary School, will you please indicate them on the other side of this sheet.

Method of Tabulation

Of these 100 men, 22 were found to reside in Greater New York, and these were selected as a test group with the hope of making the returns absolutely complete within its limits. A second letter to the six who ignored the first was all that proved necessary to accomplish this. Thus the New York group represents the full 100 per cent of returns, and is valuable as a check upon the results to be obtained from the whole body of returns, which included 72 replies. As will be seen, however, the two classes agree very closely; sufficiently so to justify the assumption that the percentages would not differ sensibly if the returns were complete, *i. e.*, that the 28 who failed to reply did so for accidental reasons and not because of any fundamental differences with respect to the characteristics we are to study.

The names were also separated into three groups thought to represent somewhat different types of mechanical ability, group A including those whose success was primarily due to exceptional constructive and inventive ability as such; group B, those who combine large constructive ability with the ability required to organize and conduct successfully a large constructive or manufacturing enterprise; and group C, men whose success, although along strictly constructive lines, has been due primarily to their powers of organization rather than to their scientific or mechanical ability.

The differences between these classes are not large nor regular, but the results are given in this form as helping to show the limits of variation within the group as a whole. The fact of such similarities, joined to these differing types of talent, suggested that the boyhood characteristics which were found common here might have no special application to men of engineering ability but might belong to men of similar talent in

almost any occupation. As a test of this, thirty men equally successful as lawyers were asked to answer the same set of questions. The results will be given beside those of the engineers. While all means failed to extract replies from more than nine of the lawyers, these returns seem worthy of some regard because they are so uniformly negative in regard to the mechanical element in their make-up. It would doubtless be the most unmechanically minded of this group who would be the least likely to attempt to answer such questions, so that it seems fair to assume that we have here the records of that part of the thirty which possesses the strongest mechanical interest, and that the complete returns would show (if possible) still less of the characteristics of the engineers than do those of the nine lawyers who replied.

Their reports are tabulated in the same manner as those of the engineers and are given in a parallel column. Though so meagre, they seem to the writer a sufficient indication that the early evidences of mechanical talent are not to be found to any extent in boys who are to become talented lawyers. Whether the lawyers or the engineers are the more highly specialized type, cannot be determined without a study of still other professions.

As the New Yorkers were distributed quite evenly through these three classes, it was necessary to make, in reality, six separate classes instead of three. The results with these classes support the general averages in most cases and are not recorded separately in the text. The figures are in every case the percentages of answers upon the total number (of sheets returned) within that class; in other words, each class record reads as if based on 100 replies. The number of replies in each main group is as follows:

A	19	New York (complete)	22
B	30	Lawyers	9
C	23		
Total	72		

These returns may be considered under the heads of (1) environment, (2) special interests and abilities, (3) the handwork actually done by them, (4) their views and opinions regarding the place of handwork in the school.

Environment

Under this head we may consider the information regarding location of home, parents' occupation, personal contact with constructive and mechanical work, etc. The percentages show the number living in country, city, etc.

	Total	N. Y.	A	B	C	Lawyers
Farm	21	18	16	23	17	0
Village	12	14	5	20	9	11
Town	26	9	21	23	35	0
City	53	78	58	43	61	89

If the distribution of the population at the time of the boyhood of these men be taken into account, the contrast between city and country is still further heightened. Only three of them are under forty years of age, and the average age is estimated at between fifty-five and sixty. So their boyhood would center in a general way about the year 1860. At that date the cities of this country contained 16 per cent of the population.[1] This 16 per cent apparently furnished 51 per cent of the mechanical engineers of the grade of ability which we are considering. As the proportion of urban population has doubtless more than doubled since that time (being 22 per cent of the whole in 1880 and 29 per cent in 1890)[2], it is seen that merely upon a basis of numbers to select from the city's present advantage over the country in furnishing these men is very much increased. Add to that the undoubted fact that it is on the whole the best of the country population which the city has been adding to itself during these forty years, and we cannot but conclude that the proportion of talented engineers-to-be who are now living out their

[1] Mayo Smith, *Statistics and Sociology*, p. 369.

[2] Ibid.

boyhood on the farm is far below this 21 per cent, and that the cities are at present producing far more such than the 53 per cent of 1860.

Whatever may be the present situation, the fact that forty years ago the large city furnished 53 per cent of such men as against 21 per cent from the country contrasts strongly with widely held views concerning the exceptional value of farm and country life as education, and concerning the quality of mind that it develops. In so far as this type of ability is held to be a thing inborn, these figures indicate that the city succeeded several decades ago in winning the larger proportion of the best blood—the best, that is for this purpose. Regarding their bearing on early opportunity as a factor in the production of mechanical ability, one would have said that this would be just the kind of ability to profit in a peculiar degree from the environment and experiences of farm and country life. Thinking of its varied contact with the physical world, its demands of all sorts for amateur construction, building repairs and the like which must often be met by novel and ingenious uses of the tools and materials lying at hand, one would be quite likely to conclude that this life would be far the most effective in developing an acquaintance with materials and a versatility in discovering and adapting means to ends which would count in an exceptional degree toward a constructive or mechanical career. Evidently, however, the farm has no great significance here. It would seem either that environment is an unimportant factor compared to inborn genius and that the city has sometime since possessed itself of the families that contain most of the genuises, or else that, advantageous as the country environment appears to be, the city somehow surpasses it as a soil for at least this particular kind of talent. When we come to examine the features of mechanical environment most often mentioned, we shall see indications that the city does furnish certain important elements of experience which the country lacks.

Fathers' Occupations

	Total	N. Y.	A	B	C	Lawyers
Mechanical	57	59	47	57	65	0
Farmer	12	5	16	17	4	0
Non-mechanical	30	45	37	27	30	100

The general average of 57 per cent of mechanically employed parents against 30 per cent who were not is maintained approximately in the sub groups, and, as is natural, corresponds in a general way to the proportion of parents having mechanical skill. (68 per cent yes, 24 per cent no.) Of course this somewhat better chance which the son of a mechanically employed father evidently has of gaining distinction in the same line may be attributed to heredity or environment according to one's taste. The fact that the parents of mechanical skill are a little more numerous than those of mechanical occupation, gives emphasis to the heredity factor.[1]

Extent of Mechanical Environment

The question, "With what lines of mechanical work were you thrown into close contact, if any?" brings the most suggestive facts regarding environment. The following list gives the lines of work mentioned first or most prominently by each man,—some men having mentioned several:

	Total.	N. Y.	A	B	C	Lawyers
Mechanical environment	84	82	90	80	87	11
Farm	4	0	5	10	0	22
Non-mechanical environment	12	18	5	6	13	67

These answers may repay a more detailed analysis.

[1]With the lawyers, five fathers were the same, two were clergymen, one a banker, one not ascertained.

	Cases		Cases
Machinery	45 (63 %)	**Other Mechanical**	15 (21 %)
Machine shop	24	Carpentry	6
Steam engine work,	5	Blacksmithing,	2
Steam ship bldg.	3	Railroad,	1
Engine building,	2	"Saw everything I could"	1
Rolling mill,	2	Foundry,	1
Carriage factory	2	"Saw various factories"	1
Sugar machinery	1	"Boiling in vacuum"	1
Bolt factory,	1	Masonry,	1
Factories,	1	"General"	1
Iron works,	1		
Textile machinery,	1		
Steam saw mill,	1		
Pattern making,	1		
		Non-Mechanical	10 (14%)
		Farm,	3
		"None at all"	7
		Blank,	2

In some cases more than one line of activity was mentioned. Farm and carpentry work were mentioned three or four times each as subordinate factors, and factories in the same way seventeen times.

Eighty-four per cent then had some direct contact with mechanical work, 63 per cent with machinery in one form or another, and, if we include the engine work and rolling mills, exactly 50 per cent give first place to their contact directly with machine-shop work,—the special line in which nearly all of them achieved their success. The occupation which ranks next to that of the machine shop is carpentry with only 8 per cent—this in spite of the obvious fact that the number of boys having contact with carpentry work would exceed many times the number having contact with machine-shop work.

This striking and detailed similarity between early environment and the field of adult success may be explained in at least three ways. It may be held that the mechanical elements in the environment have been sought out by the boy himself in response to innate craving. The spirit of the reply, "Saw everything I could," is reflected in a number of answers. It would seem that city-bred boys in general would have an approxmately equal chance at machine shops, etc., and therefore that the city-bred lawyer who reports so little mechanical environment could probably have had such opportunities as readily as the city-bred engineer (provided that the father of the later were not himself a machinist, which he was not in 39 per cent of the cases of strictly machine shop environment). From this point of view the early environment becomes in a sense an early record of natural and enduring mechanical interests and abilities, and evidently a fairly detailed and reliable record in at least half the cases of large mechanical success.

This early acquaintance with mechanics may, on the other hand, be looked at as a training which contributed in a direct way to the later success of these men, and it is to be said here that many of those who add comments on school manual work speak very appreciatively of their boyhood contact with shops and factories. In the third place, it may be thought of not as a direct cause of the success but as the means of leading into mechanical occupations boys of such ability as would perhaps make them equally successful in many other lines of work. Whether such environment serves as a means of training or as simply the means for an intelligent choice of occupation, it may be considered a definite educational asset for any boy. An illustration of its importance is found in one record of a lawyer's son who reports "no mechanical environment whatever;" he graduated from college at 19, studied law three years, practiced two years, and then went to an engineering school, graduating and getting to work at 28. A number of men, as will later appear, value school handwork chiefly as a means of discovering one's natural tastes, some of them questioning, and with reason as it seems to the writer, whether the kinds of work generally carried on help in this way to any great extent.

The fact that 50 per cent of these men had contact with definite machine-shop work shows a detail of correlation between environment and success in engineering that was hardy to be expected in ability of this rank, though it might be natural enough with the ordinary machine-shop hand. It seems to support in a considerable degree Galton's view of the importance of early opportunity. It would be interesting to know whether leading men of other constructional occupations, such as architects, mining engineers, or textile manufacturers, had during boyhood an equally intimate connection with the line which they now follow, apart from any connection with it which their fathers might have had.

This detail of correlation throws added light on the relation of farm experience to engineering ability—or rather the lack of relation—which has already been discussed. Of the 15 men who are recorded as having lived on a farm, only three report the farm activities as the sole or leading mechanical experience of their boyhood. The other twelve had or found access to neighboring saw-mills, factories, and the like. Thus the real effectiveness of the farm as an environment productive of engineering ability should be rated at 4 per cent rather than the 21 per cent as indicated by mere location, the most obvious explanation being that farm experience, while strong on the general constructive side, is too far removed from engineering to contribute much toward the success of an engineer, or to satisfy his interests. The city with its factories and machine-shops evidently meets either or both of these requirements much more effectively. That so few (13 per cent) make any mention at all of carpentry, the most generally accessible type of constructive work, is an added emphasis upon the relation between actual machine shop experience during boyhood and the making of a successful engineer.

The following table gives an idea of the correlation between mechanical enviroment and the occupation of the father:

Fathers' Occupations

No. of cases	Environment of Boys	Machinists & Manufacturers	Other mechanical	Non-mechanical
36	Machinery environment,	61%	11%	28%
24	Other mechanical environment	54%	8%	37%
12	Non-mechanical environment,	25%	17%	58%

Thus of the 36 boys who went from a definite machine-shop environment into the machinist's profession, only 22 (61 per cent) had fathers who were machinists, the other 14 (40 per cent) procuring this experience independently of the father's occupation. The fact here shown that nearly half of those recording no mechanical environment had fathers who were employed mechanically, would suggest that their denial of such experience be taken with some reservation and that the mechanical environment class may in reality be considerably more than 84 per cent of the whole.

Special Interests and Abilities

With regard to interest taken in actual performance of mechanical work during boyhood, the answers affirming such interest generally do so with a positiveness and detail which marks it as the dominant one of the period. The figures run very closely parallel, even in the sub-groups to those on mechanical environment. A number failed to reply to the question, as is indicated by combining the two sets of figures.

	Total	N. Y.	A	B	C	Lawyers
Mechanical Interests	83	82	89	83	83	11
No Mechanical Interest	8	9	11	7	9	67

The answers relating to the lines of exceptional ability shown in boyhood may be mentioned here. Doubtless modesty

was one of the reasons for the 20 per cent of omitted or evasive answers. The answers given are as follows:

	Total	N. Y.	A	B	C	Lawyers
Exceptional Mechanical Ability	57	55	52	66	48	0
Exceptional Ability (other)	14	18	21	7	17	33
No exceptional Ability	10	5	21	3	9	33

Less than one-fifth of the 57 per cent who plead guilty to the possession of exceptional mechanical ability mention any other youthful specialty and we shall later find still more evidence to indicate that these boys as a class were far from universal geniuses. The non-mechanical lines were:

Mentioned as co-ordinate with early mechanical talent: Freehand drawing 4; music, chemistry, mathematics, 1 each.

Mentioned as the only lines of early talent: Freehand drawing, music, botany, willingness to work, sticking at work, knowledge of animals, plants and fishes, "organizing plans of all kinds," "memory and declamation," "eating, growing and reading," 1 each.

Several of the ten who deny that they had any special talent at all, describe things made at fourteen or fifteen years of age, which from the point of view of the writer's experience and observation would indicate very decided mechanical ability. The writer is tempted to venture the guess that nearer 90 per cent than 57 per cent of them were, even as boys, gifted mechanically.

Ability in School Work

The comparative interests and abilities of these men in the regular school studies show a definite and detailed correlation with their mechanical tendencies.

As a group they seem to have been a strong but poorly balanced set of students. Not one claims to have been poor in all studies, and only 3 per cent admit themselves exceptionally

good in all. Twelve per cent rank themselves as average in all and one omits the question. The remainder admit some exceptional strength or weakness—generally both—in their school work. Omitting all equivocal answers, such as "arithmetic if any," we find that 81 per cent admit exceptional strength in some study and 60 per cent some exceptional weakness, while 56 per cent place themselves in both groups.

The lawyers, on the other hand, seem a much better balanced group. Fifty-six per cent admit with various apologies that they were good all around students (against 3 per cent above) and not one says he was "average in all." These facts may be stated in tabular form:

	Engineers	Lawyers
Weak in all	0	0
Average in all	12	0
Strong in all	3	56
Strong in something	81	100
Weak in something	60	44
Both strong and weak	56	44

The following table shows how this strength or weakness divided itself among the different studies:

Exceptional Strength

	Total.	N. Y.	A	B	C	Lawyers
Science	41	32	49	33	43	0
Arithmetic	48	36	58	40	48	44
Geography	11	13	11	13	9	0
History	8	5	0	13	9	56
Literature	3	0	5	3	0	22
				(Classics)		56

Exceptional Weakness

	Total	N. Y.	A	B	C	Lawyers
Science	1	0	0	0	4	22
Arithmetic	10	13	5	7	17	22
Geography	6	0	5	7	4	0
History	7	5	5	10	4	0
Literature	25	9	37	20	26	0

Arithmetic is seen to have a decidedly varied record. While it is the subject in which most men report special strength, yet it is second only to literature—though by a long interval—in respect to weakness. So its position is perhaps less definite than that of science in which 41 per cent reported strength but only 1 per cent weakness. Thus, while strength in either arithmetic or science would not in itself go very far toward suggesting that a given boy would ultimately belong to this class of engineers, exceptional weakness in science would seem to be a very decided bar to his ever doing so. Exceptional strength in literature would also seem to be something of a bar, being possessed by only 3 per cent. The lawyers' records form a strong contrast here also, their only weakness being in arithmetic and science, while most of their strength is in history and the classics.

Relative Preference for Studies

The responses regarding relative preference for and interest in the school studies show a remarkably definite interest rank for each one in the collective engineer-mind. The question was: "Number the following studies in the order of your preference for them as a boy." The following tables show the number of times (raised to 100 cases) each rank was assigned to each subject, and should be read both downward and horizontally. The more significant numbers are in italics.

Engineers

	Total					N. Y.				
Rank	1st	2d	3rd	4th	5th	1st	2nd	3rd	4th	5th
Science	*36*	*37*	8	*1*	*0*	*45*	36	0	5	*0*
Arithmetic	*49*	19	11	6	*6*	*45*	18	14	5	9
Geography	10	14	*28*	17	10	14	14	*28*	14	9
History	4	8	24	*36*	14	5	9	23	*28*	18
Literature	*1*	6	*7*	15	*49*	*0*	9	15	18	*41*

Lawyers

Science	*0*	*0*	11	*33*	*33*
Arithmetic	22	11	22	0	*44*
Geography	0	11	*44*	33	0
History	*56*	11	11	11	*0*
Literature	11	*56*	0	11	*0*

Though arithmetic has the largest number of firsts, it is clear that science is the subject most generally preferred, since 73 per cent give it first or second place and only one ranks it lower than third on this scale of five, arithmetic having twelve below this point. The unpopularity of literature is as noticable as the preference for science, since 49 per cent give it the lowest rank against one who places it first. History and geography lie between these and have clearer relative rank than one would expect, the one having a decided maximum in the 4th place, and the other belonging almost as definitely in the third.

With the lawyers the order of preference is exactly inverted in every detail, with the exception of the somewhat natural lead of history over literature. Arithmetic has the largest number of fifths but also quite a number of admirers, fully sustaining the rather irregular position it has held heretofore. Science is fifth here in exactly the same sense in which it was first with the

engineers, having no firsts nor seconds and the largest total of fourths and fifths.

Geography is condemned by both lawyers and engineers to the same dead level of mediocrity. As taught thirty years ago, it evidently did not involve enough science to arouse either the hostility of the one class or the enthusiasm of the other.

The interest evidenced by the engineers in science has something of a counterpart in the interest of eminent scientific men in mechanics. Of those studied by Galton, a considerable number possessed very marked mechanical aptitude and taste.[1] The two professions certainly seem to have a great deal in common, and it is quite likely that many or most of the men in either would succeed fairly well in the other. It would be natural to suppose that a man would turn to the one or the other according as theoretic or practical interests were dominant with him, and this view is supported with some definiteness by the reports of both classes regarding actual work done. For the scientists, while describing some interesting productive construction done during boyhood, speak much oftener of a tendency to "experiment"; while, as we shall see, the engineers report very little pure experimentation, practically all of their work being productions of concrete things, with "tinkering," "repairs," etc.[2]

Constructive Work During Boyhood

A more concrete notion of their mechanical interests is to be obtained from the statements of these men regarding the constructive work which they actually carried on as boys.

Of the 72 men, 57 mention or describe work done. Four have done none at all, 1 "nothing of importance," 2 "cannot recall

[1] *English Men of Science*, pp. 124–126.

[2] The following, from one of the engineers, is an interesting illustration of the combination of these motives: "As to articles made by me during boyhood, they consisted principally of carts, wagons, sleds, etc., used by me and my brother for our own amusement. I might add here that I was never entirely satisfied with any of these constructions until they were subjected to loads and punishments of various kinds until they were destroyed, when the building of a new one came in order."

anything,'' while 8 ignored the question. A list of these articles follows. They are divided into three classes. List (a) contains those which display in a striking way mechanical taste and mechanical ability; things the making of which would have little or no motive for the unmechanical boy and would prove too difficult for any who lacked exceptional mechanical ability. List (b) includes the toys and articles connected with play which the average boy is likely to make or try to make for his own use,—doubtless with less success than the present group. List (c) is of the articles useful from an adult point of view. The number following the name of the article means primarily the total number of times the article was mentioned. But in all the more serious projects, it means also the number of men who mentioned it (unless the contrary is stated.) Many of the smaller articles (*i. e.*, carts, boats, tops, etc.) were usually mentioned in the plural and where this was done the plural is retained in the lists.

(a) Special Mechanical Work

64 projects, 32 boys

Steam Engine 24
(21 boys, 2 others in 17th year.) 1 in.—2 in. cylinders.
One, made at 9 years, was ''no good for lack of exhaust.''
Same boy made one successfully at 15 years.
The earliest success was at 12 years.

Electrical appliances 15
(6 boys)
Telegraph lines 3,
2 of them 1 mile long
Dynamo 2
Telephone 2
Frictional Elec. Machine 2
Leyden jars 2

Turning lathe 5
(One a converted flax-spinning wheel.)

Working models of machines, etc. 10
Weaving machine
Mowing machine
Hay press
Toy saw mill at 9 years
—''run by means of spinning wheel — would saw bread''

Telegraph relay 1
Telegraph self-adjusting relay 1
Microphone 1
Arc light 1
Induction coil 1
Printing Press 2
Hand fire engine 2
Spring automobile 1
Bridge models 1

Very large kites 1

Boat models 7
Full rigged brig 3
Model of steamer 1
Side wheel steamer model 1
Propeller model 1
Tug model 1

"Much experimental work, parts of machines, etc." 1

Water wheels 4

Perpetual motion machine 2

(b) Other Play Articles

67 projects

Sled 9
Carts and wagons 9
"Goat and calf wagons" 1

Boats (for use) 9
Row boats 7
Sail boats 1
Foot power boats 1

Boats (toys) 8
Animal houses 4
Animal traps 2
Bows and Arrows 4
Kites 3
Cross bow 3
Pop gun 1
Squirt gun 1
Pistol 1
Gun 1
Bicycle 1
Tin keyed bugle 1
Horse shoe nail 1
Cannon 1
Chess men 1
Carving birds 1
Tricycle 1
Violin—"learned to play it" 1
Railroads 1
Wooden velocipede 1
Dams 1
Peg tops—"outspin any I have ever seen" 1
"All sorts of things ever made by a boy" 1

(c) Things for Use

60 items

Fences 2
Fret saw work 2
Wheel barrows 27
Yarn frame 2
Turned articles 2
Tinkering 2
Tool chests
Desk
Ladders
Taps and dies
Cellar stairs
Rat traps
Coal scuttles
Silk reels
Cider mill
Go-cart for baby
Core points
Pipe patterns
Grinding machine
6 room house (17 years)
Porch to home
Altered house
Barn—"built wholly by boys under 17 years."
3 in. obj. telescope
Gun stock
Jig saw
Mechanical fly brush—"in use many years"
Register for seeds
Cogs for main wheel
Bolster
Spoked wagon wheel
Compound-lever cheese-press—"used many years."
Improved gavel fork
"Tables, benches, lounge, cabinet, closet, fences, board walks, out buildings, tombstones,—toys never."
Cabinet
Setting grates
Laying brick
Steel tools
Ox yokes
"Would use and repair any kind of machine"
"Mostly repairs"
"Repairs"
Was making "a living" after 12 years
Ran loom half the year 12-15 years
Textile work in factory after 12 years

To the writer the preponderance of the steam engine is the most striking feature of the first list,—or of any of them. Some of the individual records are worth quoting verbatim, *e. g.*—

No. 2. "Beam Engine (steam) 1-2" x 1" cylinder. Age: 14-15 years. Purpose: "To see it operate."

Remarks: "Surreptitiously made furnace in outhouse, to cast cylinder. Stole the fuel and the bricks with which furnace was made. Made taps and dies with 3 cornered file originating thread."

No. 47. "Engines,—small,—from 15 years up. Purpose: "Chiefly as means of utilizing a foot power engine lathe and to indulge my propensity to 'make things'."

No. 60. "Steam Engine,—Cylinder 1 1-2" x 4". Age 12 years. Purpose: "To play with. Have it yet."

This last is the only case of an engine made at an age as early as 12 years. The maker is now vice president of one of the largest manufacturing establishments in New York State.

The significance of such work seems about the same on the side of early abilities and on that of early interests. As to the ability required: The writer has seen a number of boys quite gifted mechanically make the attempt with great care and patience but without success. This, and his recollections of the trials and pitfalls encountered by a quite ingenious friend who was barely successful with his engine (of the simplest type) at 18 years, convince him that the making before the 17th year of engines like those recorded, proves the possession in boyhood of mechanical ability of a very high order. As the early interests indicated, the steam engine is in a peculiar degree the most typical product and the most important tool of the mechanical engineering profession. While the engines of these boys were sometimes utilized later on in sawing wood or running churns, the purpose is generally stated as "mainly for fun"; "to satisfy my propensity for making things that would go," etc. So it may be fairly said that those who made them had shown before the age of 17 years not merely a pronounced taste for mechanics in general, but a very clearly specialized taste for mechanical engineering in particular.

Thus of these 72 men, 21 produced 24 engines before reaching their 17th year. Two others made them during the 17th year. The uniformity here is emphasized by comparison with the remainder of the lists which show such great variety. Even the boat, which as we have seen in the preceding chapter is so

decidedly the standard project of the average boy, falls far behind the engine here: (boats 16, engines 24).

The conclusion seems justified—on the safe assumption that modern environment has not so changed as to prevent it—that nearly 1-3 (29 or 32 per cent) of the boys who are to attain the rank of these men as engineers will make steam engines before their 17th year. Further than this, the writer knows of not a single case outside of this list where such a thing has occurred; and until he locates at least one case in which a man in another profession or a less successful machinist has during boyhood succeeded with this same piece of work, he cannot but assume that the making of a steam engine by a boy before the age of 17 is proof positive that the boy is destined to become an engineer and to obtain a rank corresponding to that of the men in this class. So that what we might call the "steam engine" test would seem both to be any boy's passport into this class and to be a means of picking in advance from a fourth to a third of its future members.

The first list of work, in addition to the work of these 21 engine builders, includes projects made by 11 others which in their peculiar mechanical appeal, and in the difficulties of their construction suggest machinery-interests and machinery-talent of almost if not quite an equal grade.

That only six men mention electrical work of any sort seems surprising. However, during the boyhood of most of them electricity was but little in use except for the telegraph. It is interesting to note also that boys generally at the present time appear to take much less interest in electrical than in steam toys, as evidenced by the far greater demand for the latter as premiums from the publishers of the Youths Companion.[1] The seond list includes the more ordinary toys and things useful in play and sport. These are the kind of things which any boy might try to make, though success with a number of them, such as rowboats, bicycle, tricycle, violin, etc., would indicate much more than average constructive ability.

List (c), containing the articles for real use, is seen to be rather smaller than either of the others but by far the most varied—which was the case with the school children's work.

[1] *Pedagogical Seminary*, Vol. 6, p. 650.

Seven men represented only in these two last lists record work (bicycle, house, barn, etc.) of a type which seems to justify placing them with the 32 in the first list so far as exceptional constructive ability of a general sort is concerned. Their work differs only in its failure to indicate that taste for engines and machinery which is an equally prominent characteristic of the work recorded in the first list.

Of the lawyers, one built a model of Caesar's bridge across the Rhine, and another printed a school paper. Three report "no handwork at all," one "recalls none" and three leave the space blank.

The comparison of the work of these 72 engineers with that of the 63 school boys already studied, is somewhat interesting though not wholly fair to the latter, since their reports were on all the handwork done in one year while the engineers doubtless picked out the three or four most worthy efforts of their whole boyhood. The facts are too obvious to require comment.

	I. Machinery & Mechanical Class	II. Toy Class	III. Utility Class	"Vitality" element
Engineers, ages, 8-16	35%	34%	31%	84%
School boys " 8-14	0	59%	31%	33%

To sum up the facts indicated by the handwork of the mechanical engineers of this age and rank:

At least 79 per cent did more or less constructive work before reaching the age of 17.

Fifty-four per cent did such work as proves the possession during boyhood of decidedly exceptional constructive ability.

Forty-four per cent of the whole, or 4-5 of this talented section, did work which indicates that this talent and their tastes already possessed a decided bent towards machine construction.

Thirty per cent of all built steam engines, thus proving and defining in a peculiarly distinct and conclusive way both an already developed taste for mechanical engineering as such and

their possession during boyhood of very exceptional talent for it.

It would seem quite possible that a comparison of the constructive work of these men with their relative rank within the group, might develop some very interesting facts; *i. e.*, most of the engines might prove to have been made by the more eminent half of the group. Unfortunately, however, it has not been posisble to procure such a ranking according to ability as would make this possible.

The question regarding the influence of their boyhood constructive work upon choice of occupation and success therein was poorly stated and the answers are not always clear, but are sufficiently so to indicate great variety of opinion. Some assert positively that it was a very important factor in both, some that it had no influence in either respect, being entirely an effect rather than a cause. Some assign it a decided influence upon choice alone, some upon success alone.

The following are a few examples:

"If I put it in dollars, would estimate that *each* of the six years of manual labor as a boy (age 10-17 years) was worth to me $100,000." "It had everything to do with both." "To the fullest extent." "Yes, it determined the whole course of my professional life. It made the making of things second nature." "Not much in the choice but materially in the success." "It undoubtedly caused me to take up mechanical work as a profession." "The work was an effect not a cause: was a manifestation of my natural tendencies." "I do not imagine that it had any influence." "Not in the slightest," etc.

All told, there are 22 who assert its influence upon choice against 13 who deny such influence, and 18 who think it affected their success against 11 who think the contrary. Of course the weight to be given to these opinions is largely a matter of speculation, but the fact that strong majorities affirm the influence of this work may have some significance if the writer's view is correct that people generally find it very difficult to look upon any one influence or phase of environment as a determining factor in after life.

Opinions Regarding the Value of Manual Training

Sixty-six engineers approve of handwork in the elementary school and two disapprove of it. Forty-two of them responded by letters of from one hundred to eight hundred words in length, which contain facts and suggestions of great interest, some of which seem to have rather direct bearing upon school practice. While ten of them mention the traditional values, such as manual skill, moral training, etc., the value most emphasized is the assistance which it might give a boy in finding his proper work. The following are a few typical extracts:—

(1) I believe thoroughly in having a work-shop connected with the public school, as I think it helps very much to develop latent talent.

(2) It may develop some talent which would otherwise be hidden.

(3) I have noted in my many years experience that very young boys usually have a preference for some special line of investigation which if encouraged and properly directed may cause them to develop into remarkable men. If a young man fails to select or be guided in his preference until past a certain age, he is liable to become lost and entirely at sea with no definite object in view, and finally takes up the first thing that presents itself, regardless of his fitness for that line of work.

(4) Of the opinion that the elementary schools like the older schools should give opportunities for developing the natural gifts or likings of the child, and further that forcing children to do that for which they have no gifts or likings does not do so very much good—beyond the few things they will always regret not knowing in after life, notably the "Three R's."

(5) I believe that the importance of handwork of a great variety and wide range of character is greater in education than has ever even been claimed. The object of it should be to give the pupil real experience in the work of his life while he is still in school.

It is clear that work aiming in any large way at this "development of latent talent" must necessarily be work "of great variety and wide range of character" and in the writer's opinion it is the lack of this and the consequent relative inefficiency toward this end that is one of the most serious faults of school handwork, as generally carried on. This is in effect the criti-

cism of one of the two engineers to decline to indorse such school work. He says:

I have been fairly successful in my mechanical career, but I never could have been a success in a manual training school as my natural craving for large things would have made it impossible for me to have applied myself.

The only other point emphasized with any unanimity concerned the relation of early *observation* to mechanical achievement. The experiences related by six men would seem to contain suggestions for the school that are of very great importance. To quote from the letters of some of them:

(1) My actual work was undoubtedly an incentive to apply my decided taste for mechanical work later, but it was rather watching mechanics at their work that led me on. For instance, though I have not at all observed the operations carefully since I was, say ten years old, I know I could fit a horseshoe or set a buggy tire to-day now that I am strong enough, though I learned *how* it was done then. When I came to fire and run a locomotive and work at locomotive repairs, it was a good deal like harnessing a horse you had seen harnessed a hundred times. . . . I spent my boyhood time in such ways constantly—whole days in engine rooms of mills, etc.—but I actually made and finished few things of importance, if any . . . . . I vote for anything that will develop "mechanical intuition;" and watching and thinking and trying to do this.

(2) (After indorsing the manual training idea in a general way). . . in my own case, I feel that my constant love for seeing machinery at work, and learning by questioning and observation the what and why of things had most to do with my taking up engineering.

(3) I was fond of watching the machinists in the factory and spent as much time there as I was allowed, with the result of quickening my power of observation until I had the faculty of carrying in my mind complex mechanisms.

(4) We need practical men, to be sure, and there are characters which are distinctly mechanics. These must practice the mechanical arts and must take delight in the execution of work. The future engineer needs no such dexterity . . . . What I consider of eminent importance for the future engineer would be much observation especially if it can be done under a competent teacher. With a bright student this develops into a comprehensiveness that can never be over-valued.

These replies seem to the writer to suggest a very strong possibility that the "school excursion" properly developed and systematized might become in the case of at least a few children, the most broadly determining factor in their elementary education.

It may seem surprising that none make any allusion to the place of mechanical drawing as a school subject. Two, however, speak of freehand drawing as follows:

(1) I think freehand drawing . . . . very important as it teaches a boy to express his conceptions clearly. I think *everyone* should be taught to draw, just as to write, although only those of natural talent can become either great authors or great artists.

(2) I believe drawing the most important of all. Nothing helps architect, engineer, mechanic, more than the ability to sketch rapidly his ideas on paper.

The following from a man eminently successful both as engineer and manufacturer, is perhaps the most comprehensive of all the letters received:

I have no experience in teaching—only in using those who have been taught. My ideas so far as they go on this subject are about as follows:

1. Manual training and constructive work should be taught and be as *compulsory* as arithmetic from the kindergarten up to ——— a certain point which seems to vary with each individual and can only be "stabbed at" by the careful and individual attention of the teacher.

2. The point to stop manual training as a part of the *enforced* curriculum and let it become *elective*, may be somewhere *short* of the high school, and I think it is.

3. Manual training is as natural and necessary to the humans as hiding or running or chasing is to the wild animal's young. All humans need some of it. Some humans need and benefit greatly by a lot of it, while others need it to a certain point beyond which it is an absolute waste and injury to them.

This is the only definite recognition of the importance of opportunity in the school to specialize away from as well as toward mechanics.

The two who refuse indorsement to school handwork write as follows:

(1) Notwithstanding my love for mechanical work and engineering, I do not favor instruction in manual operations in

schools or colleges, believing that the time can be spent to much better advantage in the ordinary course of study. This does not, of course, apply to manual training schools, where special instruction is given in some particular trade or occupation which the student proposes to pursue as a life work.

(2) I have never been opposed to handiwork as taught in manual training schools, but I have never been in favor of it. I consider it of very little value. I believe that any boy inclined toward the mechanic arts will find a way to satisfy his cravings in the most practical manner. . . . I consider the workshops of the nation the best mechanical training schools; in them the science is "up to date" and everything is conducted on a plane relative to the commercial value of the product.

Educational Applications

The value of this study to education is in the light it may be thought to yield on these two questions, (1) How—if at all, may the boy of exceptional mechanical talent be recognized as such during boyhood? (2) When recognized, what special education should be permitted or encouraged during boyhood?[1]

Regarding the first we have the following facts: Of 72 leading engineers, 83 per cent took great interest in mechanical work, 57 per cent admit exceptional ability therein, most of them (and some others who made it not) substantiating this admission by records of work done. Forty-four per cent report work which shows exceptional talent for and interest in machinery, while 30 per cent made actual steam engines. Science was a study liked by 72 per cent and thoroughly disliked by none. Literature was the favorite study with only one and the least favored by 49. Arithmetic, geography and history, each rank definitely as second, third and fourth respectively. Ability in these studies runs closely parallel to taste. Comparatively few (12 per cent) were good all-around

[1]Cf. Galton: "We may therefore rest assured that the possession of a strong special talent is a precious capital and that it is a wicked waste of national power to thwart it ruthlessly by a false system of education. But I can give no test which shall distinguish between a taste that is destined to endure and a passing fancy, further than by remarking than whenever the aptitudes seem hereditary they deserve special consideration."
English Men of Science, p. 196.

students, most of them showing no special abilities except mechanics, science and mathematics, and very little interest in other matters—in anything pertaining to literature, history or art.

The agreement within the sub-groups is such as to justify the assumption that all these statements would hold true in a general way for any chance group of more than twenty engineers of the same rank, provided their boyhood occurred during the same period,—and it seems safe to assume further that they would apply to those boys of the present time who are destined to become engineers of that rank.

As to whether these are facts peculiar to engineers, we have only partial evidence. They are seen to be flatly contradicted by the boyhood characteristics of talented lawyers in every case except the one of city rearing. A study of other professions is needed.

On the whole, it would appear that we might select in advance something like half of the future engineers of this grade; at least one-fourth, by the "steam engine test" alone, another fourth perhaps by consideration of their general mechanical and scientific interests, abilities and the exclusiveness of these.[1]

On the question of the early specialization to be allowed such boys, there are these facts:—Eighty-four per cent of the engineers had during boyhood a considerable contact with things mechanical, 63 per cent had contact with machinery and 50 per cent with the machine shop itself, (though 42 per cent of the fathers were in non-mechanical occupations). Only 21 per cent were reared on the farm and four-fifths of this farm group mention more definite contact with machinery than the farm itself afforded.

Nearly all approve of school handwork most often on the ground of its assistance in developing "latent talent," this aim seeming to involve the demand expressed by some that it should be work of great variety. This great variety may not be easily

[1]The records considered make it sufficiently evident that talented engineers as a rule do not have during boyhood that great variety of successive and equally absorbing interests which would seem to belong to the boyhood of talented psychologists, if the boyhood of Professor Münsterberg is considered a typical one for that profession.
(See *Atlantic Monthly*, May, 1899.)

obtainable in schools generally and indeed might not be so desirable except for this type of boy. However, it would seem at least that this boy might well be encouraged to strike out on lines perhaps impracticable for the bulk of the class, instead of following a narrow and prescribed course. It would seem that shops of the elementary school should be provided with a special equipment including such things as foot lathes, small forge, anvil, crucibles, etc., to furnish such boys opportunities for the range of work demanded by their abilities and interests.

Their emphasis upon the value of observation as equal if not superior to that of actual work, would suggest a responsibility on the part of the teacher for making possible and encouraging such boys (if not the whole class) to spend a large amount of time in such shops and factories.

As to the regular school work of such boys it appears that they took little interest in such subjects as literature and history, and were consequently weak in them. Not one expresses any personal gratitude felt in later years that he was forced to do this work —though two or three do speak in more general terms of the value of being made to study hard at thi gs regardless of preferences. One, recording his weakness in history, says, "I had great difficulty with such work as Roman history that I could see no use in"; and other replies already quoted imply hearty belief in the value of early specialization, with little fear of its consequences. On the whole, such specialization would seem advantageous for this type of talent and rank of ability.

Summary

On the psychological side this study furnishes nothing more than a quantitative statement of interests the existence of which was already fully recognized. We know, for example, from common observation that small boys like to make things merely for the sake of making them. But the figures under play-imitation measure this as a "20 per cent interest" just before the twelfth year and less than a 5 per cent interest after it. It is further shown that at the age of ten years, four-fifths of a boy's play construction has passed beyond the stage of mere play, and aims at an ulterior purpose of some sort. This purpose is more often connected with play than otherwise. The close agreement in these cases between the records of the two schools taken separately seems a sufficient basis for assuming that the estimates given are not far from correct.

While these figures have little direct practical application to school work, the lists of articles given suggest specific projects for school handwork and give an idea of their relative popularity with children. With reference to the record of girls' work little need be said, as the interests there suggested are well recognized in many schools. With the boys it is seen that there is much variety in the play-imitation class, the class which belongs mainly to boys under eleven years. This would imply that the selection of a subject for work is not a matter of serious importance at this age; that any common occupation or object may be taken indifferently, and that any phase either of primitive or of modern life which can be brought in a vivid way before children will stimulate initiative construction. Consequently handwork need not be made an independent subject, but may properly be subordinated to any line of study which may for other reasons find place in the curriculum of these years. The play-utility list, on the other hand, names only a few objects. Boats alone make one-third of the whole, and the next third includes only four other articles, animal contrivances, wagons, balls, and houses. Croswell's list, as has been shown, agrees exactly on

this point except that his colder winters cause sleds to take the place of animal contrivances.

If the 12-14 year old boy so regularly chooses to make these things the school should evidently recognize this interest as far as possible—as far, that is, as may be done without sacrifice of educational ends. The teacher may well study with care the mechanical and constructive possibilities of the ten or so objects which rank first to discover how far and how well he can utilize them. To the writer it seems quite obvious that in the making of courses of study in handwork, much more attention might be given to the interest of the child than is done at present. Whether the aim uppermost in the mind of the teacher is to develop mechanical ingenuity, to vitalize work in physical science or to give a general acquaintance with typical industries, he will find an abundance of material adapted to his purpose in the work preferred by the child. For instance, reproductions in miniature of the boat or wagon may appeal to the toy-interest, and at the same time establish connections with a large number of industries. The problem of motive power may be introduced and suited accurately to the age, ingenuity, and attainment of the child; the subjects of railroad and water transportation may also be brought in in this connection. The vitality classification strongly encourages attention to motive power as well as the facts brought out in the boyhood work of the talented engineers. Of course facts regarding a group of such men must not be applied too generally. Still it seems to the writer that many of these suggestions for the education of the engineer would be fully as applicable in the case of the mechanic. The ordinary man whose best future lies in mechanical work has probably a less insistent craving for it than the future engineer, certainly less ability to push his way into it against odds. So the opportunity for large variety of work and experience during boyhood may be even more valuable to the mere machinist than to the engineer in directing him to his proper field of work.

Vita

The writer of this dissertation, Ernest Beckwith Kent, was born in Michigan City, Indiana, November 18, 1873. After taking the degree of A.B. from Iowa College, Grinnell, Iowa, in 1894, he served as Director of Manual Training in the Indianapolis Public Schools from 1897 to 1900. In 1901 he received the degree of A.M. from Columbia University and the following year was Fellow in Manual Training in Teachers College. He received the degree of Ph.D. from Columbia University in the year 1903.