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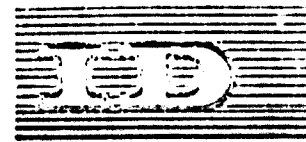
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SHORT TERM INPLANT TRAINING
IN PRODUCTION ENGINEERING

by

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We regret that some of the pages in the microfiche copy of this report may not be up to the proper legibility standards, even though the best possible copy was used for preparing the master fiche.

Production engineering, as a subject, has a distinct place of its own in industrial activities and this shows up rather prominently in the field of implant training. A production engineer may pick up his ideas for developing and manufacturing a product from any of the technologies and engineering disciplines i.e. mechanical, electrical, chemical, ceramic, or metallurgical etc. He may blend or substitute these without any avowed attachment to any so long his objectives are achieved. In designing a product,- laying down the fits, tolerances, material specifications and process control particulars;- in production planning and control, in inspection and in packaging;- in all these he is guided entirely by considerations of technical practicabilities,- considerations of cost, quality and business opportunities involved in the process. In the ultimate analysis,- production engineering is essentially product-oriented, seeking optimum benefits through the combination of different production technologies,- cost, quality and business opportunities. A trainee in the field of production engineering is interested in all these diverse activities in the plant, following heterogeneous disciplines which make the manufacture of the product a feasible proposition in a given industrial situation.

In India, every year nearly thirty-five thousand engineering graduates and diploma holders are passing out from colleges and technical schools. Most of them are joining various industrial

undertakings as graduate apprentices and supervisory trainees, running through a period of inplant training in production engineering to make themselves familiar with the practical and operational aspects in the related fields. In a number of undertakings,- either due to changes in product policies, or adoption of more advanced production techniques, or as a part of simple job rotations, technical executives and supervisors are also exposed to a brief spell of inplant training in the requisite areas. Various foreign governments and international agencies often extend their generousities by providing short-term in-plant training opportunities to the production engineers from the developing countries in learning the manufacturing processes of a wide variety of industrial products. The volumes of such training facilities that could be made available to the production engineers of the developing countries, for disseminating the required technical knowledge through inplant training, are rather meagre as compared to the actual physical needs. Generation of maximum possible multiplier effects in such short-term training therefore is an issue of some importance as also of urgency,- if more effective use of such facilities is to be made for serving the objectives for which these facilities are given. This would mean that each person who receives the training, should not merely be able to learn and multiply the techniques he had assimilated,- but what is even more important - that such a process of learning must be constantly modified and tempered by the physical realities and limitation of his own plant or country, so that in terms of technical practicability, cost and quality, these activities become feasible industrial propositions there.

In this research paper, I have tried to locate the critical areas in the process of implementation of such inplant training, offering suggestions primarily to those who are sponsoring and supervising the programmes in the large and midium scale industries where by and large systematic trainings in production engineering are mostly organised. The suggestions made in this paper though relevant for all inplant trainings in production engineering in general,- special attention has been paid to draw out the major needs of the production engineering trainees from the developing countries.

In locating the weaknesses and making observation on them, apart from my own experience, I have received valuable information and suggestions from a number of Works Managers and Training Superintendents of various large and medium scale industries in India and abroad, both in the public as well as in the private sectors, professors, research scholars and, above all, trainees themselves. I must not fail to acknowledge the personal benefits that I derived by discussing some of the relevant aspects, particularly with Professor N. Corlett, Head of the Department of Production Engineering, University of Birmingham, who during his visit to this country last May, had called on me on a similar mission and to Shri P.L. Sahgal, my day-to-day counsellor and colleague, - who is the Industrial Adviser to the Government of India - an authority on production engineering problems of the light engineering industries in general and machine tool production in particular.

I. AIM OF THE TRAINING

The aim of the short term inplant training in production engineering is to impart applied knowledge concerning the manufacture of selected product or products in all relevant aspects, to technical personnel already having the basic qualifications and experience in their professions, with a view to promote maximum possible industrial development, both in quality and in quantity, through the generation of requisite multiplier effects. These are to be achieved, through the reproduction of such knowledge in the practical field by the production engineers on completion of the training, with such modifications and adjustments that might be necessary, to conform to their own respective technical and business situations.

II. CRITICAL AREAS OF TRAINING

The deficiencies and weaknesses of inplant training in production engineering, are manifested in a variety of ways, - though by and large, most of these owe their origins to lack of a clear definition of purpose and lack of proper organisation

and methods in implementing these. Following significant and major weaknesses, however, stand out among others, as the common critical areas in a large number of such in-plant training courses:-

(a) Sponsors as well as the trainees often look up to in-plant training as being of a sort of general orientation value - without proper plans to make sure, that the knowledge thus gained would have to be translated into physical realities of production later on. Many go through the training programme in a perfunctory manner, without the requisite degree of interest or seriousness.

(b) In several cases - the position is even worse - when the trainees as well as the sponsors treat training as a sort of respite, if not a holiday from the monotony of daily work routines.

(c) Such training could, no doubt, be an interesting and enjoyable period of respite from monotony, but this must necessarily be along and not against the training objectives,-by making the trainees inquisitive and self-motivated in the process of assimilation. This calls for certain amount of planning and organisation, which are not always properly attended to by the executives and senior supervisors busy with their day-to-day functions of production in the factory. It is not infrequently that one sees the ugly sight of inplant trainees watching the factory operations with philosophical detachment or even sleepy eyes without any serious interest;- or treading along the shop floors in groups along with the supervisors busy in explaining things to them - like a "tourist guide". Such mockeries in the name of training are by no means rare. It is worth while to recall here the almost classic words of Dr. Lawrence Lowell, President, Harvard University;- as follows:-

"There is only one thing that will train the human mind and that is the voluntary use of the mind by the man himself. You may aid him, you may guide him, you may suggest to him, and above all you may inspire him, but the only thing worth having is that which he gets by his own exertions,- and what he gets is in direct proportion to what he puts into it."

(d) There is a gulf of difference between understanding a production process on a conceptual plane, and assimilating and digesting it thoroughly, particularly the practical aspects, on a physical plane, requiring considerable amount of personal involvement and critical examination of each element on the part of the trainees. Insufficient appreciation of this difference often leads to inability to set up the production processes on the shop floor in a systematic manner later on, - even by otherwise intelligent trainees with excellent academic qualifications, - who had grasped well the broader ideas of the issues involved.

(e) In many cases, even when the trainee had fully assimilated the production process on a physical plane, - he was unable to cater to the design variables or production variables involved in order to conform to the facilities that could be made available in his own plant or for meeting the consumer preferences of his own country. This resulted in the trainee asking for similar facilities to be provided in his plant as seen during the period of training, before work could commence. Such demands are often made without adequate exploration or attempt at improvisation of alternative methods, for making the most of the opportunities that were available or could be made available without incurring any undue extra expenditure. For example, a production engineering trainee saw in a foreign country milling cuts like slotting, slitting, parting or grooving being imparted by very fine abrasive wheels, using a wet cutting machine in a particular production process. On return he wanted same facilities to be provided before he could commence work - which was just not practicable in India then, due to the non-availability of such wheels, and also the machine in sufficient number from the indigenous sources, and a rather tight foreign currency situation, - thereby reaching a deadlock.

(f) Most developing countries, depend on imported materials for production work to a much greater degree as compared to the developed ones. Apart from this, the disadvantages of the economies of scale and the time lag in imparting and distributing these, caused serious bottlenecks. Material substitution therefore is an issue of considerable importance for such countries.

(g) All production engineering trainees, irrespective of the technologies involved should have a reasonably satisfactory background in engineering drawing and designs. Mere ability to read drawings and designs passively is not good enough, - and what is needed is ability to critically examine, modify, substitute and supplement the existing patterns by better ones, no doubt seeking specialised assistance on ad hoc basis, if necessary. In the case of chemical engineering and similar plants, the emphasis naturally is on design^{and} fabrication work concerning plants and equipments, which often have to be improvised, modified and replaced.

(h) Other major weaknesses of the trainees are in the field of production tooling, process control devices and plant layout, — inclusive of ability to modify methods, balance, adjust and supplement the flow lines requiring some reasonable understanding of the principles and practices of work study.

(i) There have been instances when production engineers, after training, had displayed initiative and imagination in reproducing the production techniques seen elsewhere, duly modifying the same to conform to the facilities available. Difficulties had, however, arisen in selling the products, because of high costs or inappropriate qualities which would sell through a given market. Some analytical understanding of costing and value analysis, Cost reduction and integration of the same in technical activities, would go a long way in removing such weaknesses.

III. RECOMMENDATIONS

(a) Recommendations for consideration by the Promoters of In-Plant Training:

Promoters of such in-plant training may be an international or a national organisation or an industrial undertaking interested in serving its aims. Depending upon the circumstances they have to bear a part or the whole of the expenses involved in the process. Naturally their primary concern would be to seek maximum possible value for the resources invested. In order to facilitate this, it might be worth while to consider the following suggestions:-

(1) Determination of the specific area of training, in terms of development and modernisation plans in advance:

Arranging training programme on broad notions, in isolation from the specific plans for developing and modernising industrial activities, often leads to tragic results. For example, providing a highly specialised type of inplant training in a steel foundry, or providing training in the manufacture of calcium cyanamide from calcium-carbide to the production engineers of a country which does not possess such industries, nor likely to develop these in the near future, either due to the lack of the requisite infra-structure, or any other reason, is rather wasteful and should be avoided. It is a good thing, to start the whole process of organising the training by obtaining data from the sponsoring agencies - as to their actual needs, in terms of various items of such plans. The next step would be to organise specific programmes, covering such of the common areas of actual needs earlier intimated, for which sufficient number of trainees could be fruitfully mobilised and trained in this manner. In short, inplant training, should be field-oriented and not imposed from above on the basis of a hunch or some general appreciation of the requirements, which might^{or might}/not be appropriate.

(ii) Prior notification of the basic qualifications and experience which the trainees should possess by the sponsors:

Little is achieved by providing such training to persons - who because of inappropriate educational qualifications, experience,

and age,- or any other physical or mental disabilities,- are unable to assimilate and reproduce the production engineering techniques on a physical plane. It is therefore essential that the promoters announce in advance, the minimum essential and desirable qualifications for participation in the courses, and ask for the recommendation of at least two if not more persons for each seat offered along with their curriculum vitae, so that some selection could be made, if necessary, in consultation with the training establishments. Notwithstanding the special and peculiar nuances of production engineering involved in the manufacture of different products,- all short-term inplant trainees should have a minimum basic qualification in the relevant technology. They must understand designs including material substitution problems, and production tooling work and also should have a minimum of practical experience in production work. Some basic knowledge of work study, cost analysis and quality control would be very desirable if not essential. Side by side, due weightage should be given to the candidates, who are likely to generate multiplier effects, by propagating their knowledge to a number of firms rather than contributing the same to only one - i.e. trainers, consultants, nominees of institutions engaged in the advancement of technologies, etc. If best possible use is to be made of the rather short period that is available for such training,- from which again multiplier effects are sought to be generated - then these seem to be the basic pre-requisites for a successful execution of the ⁱⁿplant training in production engineering.

(iii) Choice of Training Establishments:

Training establishments should not be chosen merely on account of the business reputation of the firm or of their products,- but on their training capabilities. The point which is being emphasised here is that mere largeness of the firm's business or their technological sophistications are not synonymous with training capabilities. The firm must have a properly organised training cell, capable of arranging inplant training in production engineering with facilities for design analysis, analysis of production processes and their variables, tooling, production

planning and control, cost and value analysis. Highly automated industries are not generally suitable for training of the production engineers from the developing countries, because apart from wide disparities in technologies, - many of the elements of production involved in transforming the inputs into output, are not readily discernible for analysis and assimilation by the trainees. To a lesser extent this is equally applicable to the production engineers from the developed countries particularly those who are still in their formative stages. It is desirable for a competent technical officer, on behalf of the promoters, to visit the training establishment, to make sure that requisite facilities - organisational and technical are available, unless of course such capabilities are beyond doubt, on the basis of reliable information from other sources.

(iv) Payment to the Training Establishments:

It is true that a number of large industrial undertakings very generously agree to provide inplant training facilities to the overseas production engineers free of cost. There is no reason why these should not be availed of, so long the basic organisational and technical facilities are available there for this purpose. But it so happens - that quite a number of such generous offers, as praiseworthy as these are, often do not have the appropriate facilities. It would be better to pay fees to an industrial undertaking with proper facilities, than to avail of a free offer from an undertaking without these, - however well reputed otherwise they might be.

(v) Motivation and Certification:

A certificate of satisfactory completion of training, provides an useful and effective element of motivation - particularly to the trainees from the overseas countries. Any commendable performance or useful suggestions made by trainees in the course of analytical work - on any topic, - right from product design up to packaging, could be suitably endorsed in the certificate. A small cash reward or a gift could be a valuable adjunct in such a process of motivation.

On the other hand, it should be an explicit and binding part of the terms for the training that a participant could be sent back home in the event of persistent neglect, inattention or misconduct, at the discretion of the training establishment or the promoters of the training, without assigning any formal reason. No doubt, it would seldom be necessary to take such a harsh step,- still it is better to incorporate such a provision in the terms of training to cater for the cases of such remote possibilities.

Normally certification of the trainees or disciplinary actions on them, should be the prerogative of the training institutions, but in case of inplant training, promoters have overall administrative responsibilities. It so happens,- that the programmes are often split amongst several establishments for covering different areas; thereby necessitating discharge of such responsibilities by the promoters. In any case,- promoters should always be approached by the training establishment for a final decision to terminate the training, even when the entire training is confined to one establishment only.

(vi) Follow up:

It is essential that the promoters of the training programme not merely screen the trainees before admission,- but also verify their subsequent activities, ~~of the trainees,~~ say for a period of three years,- to find out as to what extent the knowledge picked up during the training period is put to actual use. This aspect apart,- such follow up often provides information - which might be of value in adding, modifying and shifting emphasis amidst various topics in the training programme. It often happens ^{that} some of the ex-trainees,- never bother to reply to such follow-up queries. Apart from making a gentleman's agreement with the trainees - to furnish the promoter with the necessary information,- perhaps their co-operation could be better secured, by making them the associates of the technical club of ex-trainees with a half-yearly or annual journal. The training establishments naturally are also interested in the follow-up reports. Rather than expecting the ex-trainees to send another set, perhaps important extracts could be sent to them by the promoters.

(b) Recommendations for the training establishment:

(i) Scrutiny of the proposal:

The management of an industrial undertaking, in consultation with their training cell must scrutinise all training proposals received from the promoters in the context of the background of the trainees, the area and the depth of the training, and its duration. They should suggest such alterations and adjustments as might be considered necessary so as to conform to the requirements and the facilities available, for making the proposal more realistic and fruitful, as joint partners in the process, - rather than treating the promoters as customers, - believing that they "could do no wrong". It is often more time-saving and fruitful for the training establishments, to prepare an outline of the training scheme in conformity with the broad requirements given by the promoters and the qualifications and background of the trainees, duration, area of coverage etc., particularly by those industrial undertakings where regular training cells with professional trainers are in position - rather than asking the promoters for too many details.

(ii) The Training Programme

It so happens in practice, that the details of ^{the} background and other particulars of the trainees are available to the training establishments only a few days before training is scheduled to commence. It is therefore not practicable to cater for the special requirements of individual trainees at the planning stage - though this aspect also should be covered later on, by making necessary modifications to the programme.

At this broad planning stage, each trainee should be identified by an alphabet, viz. if there are twelve trainees, the letters A to L could be used for this purpose. Trainees are not to be kept bunched up groups but scattered in different work centres to the maximum extent possible. Even in inplant training - a few group sessions for general topics, film shows etc., - more particularly during the initial stages are necessary. Except for this, - trainees are to be dispersed and distributed to the different

work centres and placed under the care of the supervisor in charge for allocating and supervising the discharge of the specific tasks given to them. After setting apart the periods for the general group sessions - the inplant work should be organised by rotating the training through the pre-determined work centres allocating sufficient time to each, which will ensure satisfactory coverage to the training programme, both in area as well as in depth.

In the inplant work it is neither necessary nor practicable, that all trainees should start their training from the commencing stages, so long the trainees are familiarised with the whole picture of production in a general sort of way at the outset. After this, little is lost if one goes to the machine shop, the other to the foundry and the third one in the packaging room to do their in-plant work. At this broad planning stage, it is easy to sequence and queue the alphabets representing the trainees for the desired periods in various centres in a systematic manner - making allowance for marginal adjustment later. Some extra periods should be set apart for special coverage of those areas in which trainees are specifically interested.

(iii) Trainees to be treated as participants in factory work and not as visitors:

This is an issue, which is often treated rather lightly and yet it exerts powerful psychological impetus in inplant training. In an effective inplant training, - one cannot afford to be just an "on-looker". One has to plunge and identify himself in the stream of factory activities, in observing, analysing, verifying, and wherever practicable even in handling and operating the products and the processes. The trainees should always be made to feel that they are a part of the factory and subject to same facilities, and disciplines as its employees. In many factories, where the supervisory staff wear distinguishing overalls - or identification marks, - it is desirable that the trainees should be given similar insignia.

(iv) The basic structure of an inplant training in production engineering:

The differences in the technological contents of product or process oriented inplant training and ^{the} differences in ^{the} training requirements, with variations in the areas of emphasis, - do not allow the preparation of any standard syllabus which would be applicable to all. Even when repeating a course - after a period of time - it is desirable to have a fresh look at the old plan, modify the same in the light of experience gained, the technical advances made during the intervening period, and the background of the fresh batch of trainees.

Notwithstanding the above facts, - it is nevertheless possible to construct a broad structure, - as a sort of basis for the syllabuses of all such product-oriented inplant training courses, so as to provide a starting point, upon which additions, modifications and shifts in emphasis that are considered necessary to meet the individual peculiarities could be made. It is in this context that the following broad and brief structure is being indicated:-

1. Study of the performance requirements of the product from the users' point of view with some indications of the trends of the consumer preferences in the market, wherever practicable.
2. Design Analysis, Value Analysis, Material Specifications and Variables, fits and tolerances, finish and aesthetics.
3. Production Analysis together with the Variables and Tool Engineering.
4. Production layout - flow lines - balancing and work simplification in general.
5. Production Planning and Control and Critical Path Studies.
6. Packaging.
7. Inspection, quality control - trials.
8. Cost Analysis and Reduction.

The weak areas experienced in such a training had been indicated earlier. It is desired to re-emphasise here the great importance of design and production analysis, including tool engineering for such training, without a thorough grasp of which the main benefits of the training are lost.

The above basic structure is more or less aimed to meet the requirements of inplant training in production engineering in the light engineering industries - which in most countries account for most of the trainees in this field. Suitable substitutions or modifications of the area of coverage have to be carried out naturally for other industries. For example, in chemical industries - ability to design, fabricate for improving or adjusting the flow, ~~or at least for the simpler areas of the flowlines~~ for balancing the output and for improving the performance in general, - are important aspects of training. Similarly, in ceramic or metallurgical industries, understanding of the relevant areas of fuel engineering in some depth - is of decisive importance in such training.

(v) Rough notes and preparation of a Log Book covering the whole training:

As mentioned earlier, it may not be possible to run the trainees through the inplant training exactly in the same order. It is also not possible to prepare a tidy and presentable log book with sketches and notes, on the basis of rough notes taken down by them on the shop floor. Trainees would therefore be expected to prepare a fair loose-leaf log book covering all the work centres through which they have passed, - recording their observations and suggestions with diagrams. To facilitate systematic presentations in this, - it would be desirable to indicate to the trainees the lay-out, sequence and method of preparation of this log book at the very outset.

(vi) Involvement of the trainees in the production engineering problems of the factory and seeking suggestions for improvements:

One of the most effective ways of stimulating the interest and the critical faculties of the trainees, is to invite ~~on their~~ ^{their} analysis of the existing methods at different work centres and invite

suggestions towards improvements. Supervisors in charge of different Work Centres should be fore-warned about this, and told to play the role of a big brother in encouraging this;- keeping the ultimate objectives in view;- and not to be sensitive about uninformed or unintelligent criticisms. It so happens, that some of the bright trainees with fresh looks and outlooks,- often offer criticisms and suggestions which are far from unintelligent. A number of these are in fact appreciated and adopted by *quite a few* the production managers. It is true some of the suggestions and technical solutions offered by the trainees are often over-ambitious,- more biased towards the "ideal" rather than the "real",- but a forward looking management should be able to stomach these,- rather than dampen their enthusiasm by harsh criticism. Trainees should offer all such suggestions in the "Log Book" in writing,- while recording their activities at each centre.

(vi) A personal exercise for each trainee for translating some performance variables, into design and production variables, at the concluding stages of training:

During the concluding stages of the training, each trainee will be given a product akin to the one seen during the training period, but with some performance variables. The trainees would be expected to translate these performance variables into design and production variables. In order to avoid over-loading them with work in the context of short-time that is available, the performance variable should not involve redesign of the whole product, but confined to a small and limited areas.

(vii) Award of Prizes:

Prizes could be awarded to the trainees who gave good accounts of themselves in the presentation of the log-book and in translating the performance variable problem mentioned above, or in any other area as might require special emphasis.

← (c) Recommendations for the trainees:

Whatever qualifications and experience that might be stipulated for the trainees by the promoters,- in a heterogeneous group of this nature - its members in practice often present widely

varying standards, largely emanating from the differences in technical institutions attended, - and in the area and the depth of their experiences. The problems of such uncontrollable variables are substantially reduced, if due attention is paid to the following points from the very outset:-

(i) Stress on high standard of technical proficiency

It must be impressed upon the trainees, that the proposed inplant training is a highly concentrated and tough one - designed to provide opportunities to the trainees to attain complete mastery of production work in a particular line, - which called for exacting standards of technical proficiencies and a lot of exertions on the part of the trainees.

(ii) Preparatory exercises for the trainees

Before proceeding on training, - the trainees must visit one or two plants engaged in similar fields of production, like the one on which the training had been organised, to study and isolate the critical areas - and carry out an exercise covering the topics indicated under para ^{III (a)} (iv) above - "Basic structure". If there is no factory working in the similar fields in the area, then efforts should be made to carry out the exercise with the help of whatever shop level information that could be obtained on various processes involved in production - supplementing the same with the help of technical literature. Such an exercise, before proceeding on training, is a major factor in contributing towards its success, by making the trainee eminently conscious of what to look for in the course of training, - and also look for in terms of the practical problems in his plant or in his country. In view of the basic importance of this issue, there is good logic in making it a pre-condition for acceptance in the training, requiring the trainee to send the relevant papers to the training establishment in advance.

Under

^{III}
~~(III)~~ PREPARATORY STUDIES - WORK STUDY, VALUE AND COST ANALYSIS:

A number of otherwise highly qualified technical trainees are often found to be without the knowledge of the basic disciplines of Work Study, Value and Cost Analysis. In view of the overall

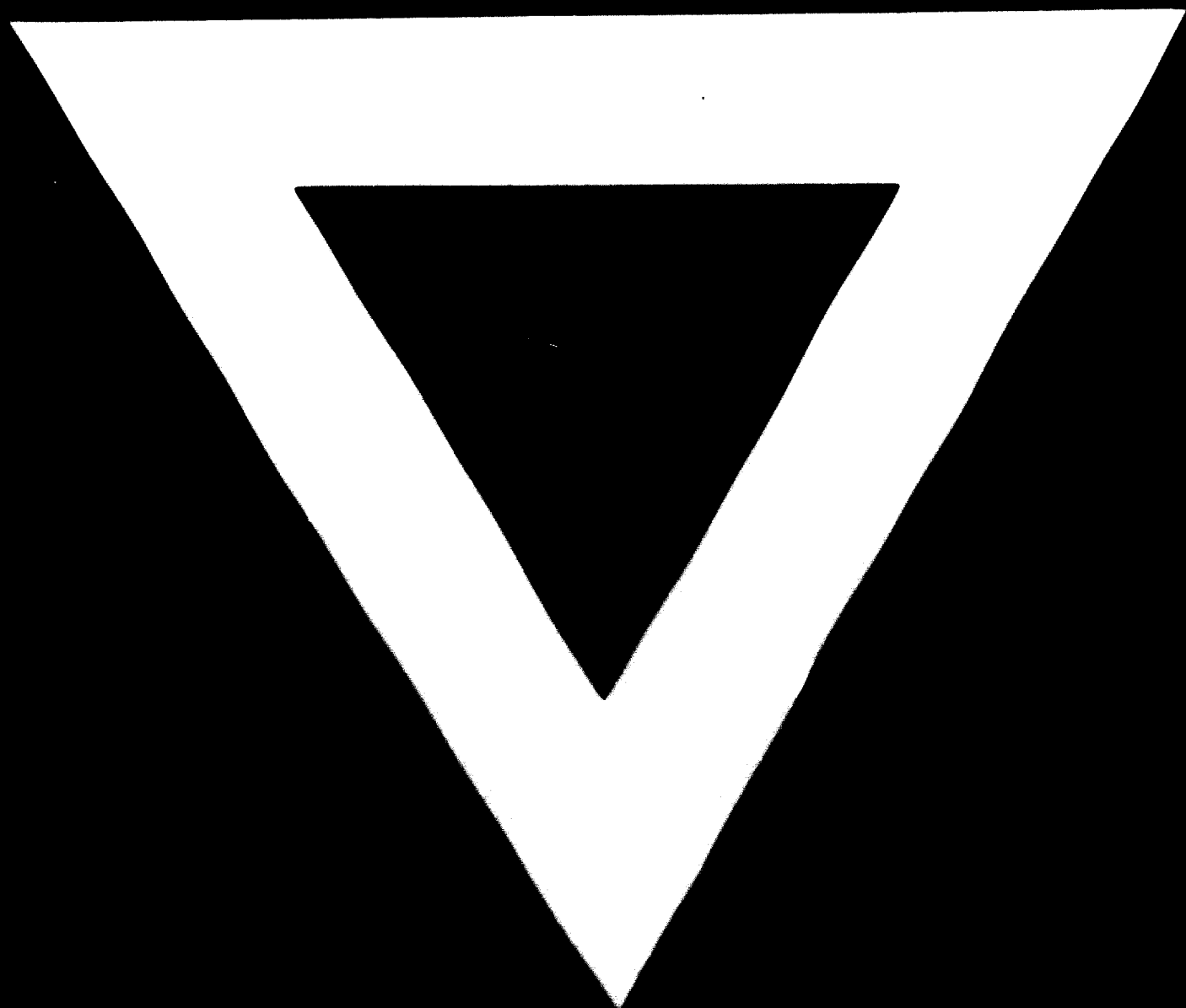
importance of these areas and the short time that is required in picking these up, the trainees should be reminded to run through these in a satisfactory manner, before proceeding on training. They are naturally expected, to run through other areas also, - if they felt that they had been out of touch - and there needed some brushing up.

(iv) ~~(v)~~ EMPHASIS ON THE COMPETITIVE ASPECTS OF THE COURSE:

The trainees should be impressed upon about the competitive elements involved in the course, particularly with reference to log book, design, production analysis, tooling - and any other area which the promoters would like to emphasize, depending upon the availability of funds for the award of prizes.

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