Improving Modular Sewing Line Efficiency through Multi-Skill Labor System

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Abstract
With the high levels of competitions in apparel industry and the production efficiency problems in India's apparel industry, multi skill development has been deemed as one of useful tools for entrepreneurs to promote production efficiency and to build up competitive for more reliable and efficient, technology management in the apparel industry for multi skill labor is essential.

In this work, current/existing problems of India's apparel industry are studied. However, the main focus is on the production efficiency and multi skill development in sewing production line. Onefull sleeve-shirt production line using multi skill system in a companyis selectedas a model for this study. The parameters considered are: Staff, Machines, Productionsystem, Products and Data.

Especially in modular sewing line multiskills labour system is very essential because without this system target point of the production (output) quantities are not possible to deliver in right time.

Moreover, the existing multi skill system applied in this subject also is reported in order to develop the new designed and automatedmulti skill system which utilizes information technology (IT) tools. Furthermore, the new automated multi skill system applying technology management for highly reliability and performance of the multi skill system.
Keywords: Multi Skill, Labour Skill, Technology Management, Production Line Efficiency an Automated Multi-Labor Skills System, modular sewing line.

1. Introduction.

India's apparel sector is experiencing the intense price competition from the countries with low cost suppliers such as China and the countries in the South Asia region. Meanwhile, it is also losing its competitive edge in the world market due to the higher production costs, as manufacturers continue to rely on old production technology, labor problems and no other improvement systems.

The work forces in textile and apparel industry are about one million and the number of factories is about five thousands factories. According to the studies on the industrial restructuring program of United Nations Industrial Development Organization (UNIDO), the Ministry of Industry's Office of Industrial Economics (OIE), India's apparel industry faces the major problem of efficiency and labor skills. The efficiency of India's apparel industry is only in the range of42% to 52% compared to of the best practices in this industry which is 85%. For the labor problems, operation skills per operator of India's apparel industry are only 1 to 2 skills per operator where as those of best practices in this industry are 5 to 6skills per operator. It shows that India's apparel industry falls very far behind best practice in all indicators of productivity causing in losing its competitive edge in the world market. Moreover, MostIndia's apparel industries are lack of using IT to improve efficiency and worker skills.

According to these major problems of India's apparel industry nowadays. Developing multi skills for apparel sewing workers is a significant way to solve these major problems to improve the efficiency of India's apparel industry. Nevertheless, there should be some tools to bring about the efficiency of multi skill system. Those tools are information technology (IT) that can help in section of database, data entry, incentive calculation, system process and calculation, and system result and reports in order to gain more efficiency, convenience, rapidity, and accuracy of multi skill system.
The need of multiskill operators on a production floor. Whereas multiskilling is required to balance the flow of work and to cover absenteeism, there are always different viewpoints on this. Of course, a specialized work force is more profitable than multiskill operators are, however specialized or multiskilled, operator contribute more in the production. And this is the reason for multiskilling and the extent of multiskilling required.

2. Methodology

In this research to design the technology management tool to develop the multi skills labor to increase the production efficiency of India's apparel industry and define the possible ways to apply the multi skill system through information technology management to improve the production efficiency for overall India's apparel industry.
This research work opts to define the sample of the experiment to be only one selected company, which is currently applying manual multi skill system, in apparel industry. Moreover, the study will be focusing on one sewing production line of full sleeve shirt in this selected company for 3 months. Inconsequence, Laguna clothing Pvt. Ltd. was selected as the subject for the experiment.
This study applied 5 steps methodology as following:
1) Gather the information of the existing manual multi skills system that the selected company currently applies.
2) Study the functions and sections that information technology (IT) can improve multi skills for workers.
3) Design the information technology tools to support multi skills for sewing workers for the selected apparel company.
4) Develop a prototype of the designed multiskills system applying information technology.
5) Making analysis and summary of output and outcome from researched prototype including doing calculation of the cost and benefit in applying a new automated multi skill system.

3. Conceptual Model:

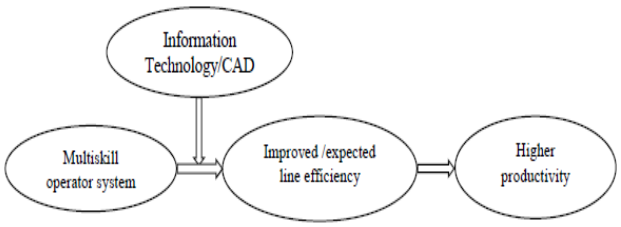

Fig 1: Conceptual Model for Garment Industry

3.1) Skill Set: Enabling Multiple Operations

The different skill sets such as a straight stitch on a flat surface vis-à-vis joining two concave and convex shapes, then we may categorize their difficulty levels and also group several similar operations into a skill set.

The table 1 alongside lists some skill sets, their difficulty level and examples of operations.

Skill set	Difficulty level 1-easy 5-difficult	Examples of operation
1.flat top stitch	1	Front placket, pocket hemming
2.flat assembly seam	2	Shoulder, back, yoke
3.seam with guide or folders	2	Front placket, bottom hem
4.special operation	3	Button holes, bottom stitch
5.shaped top stitch	3	Collars, cuffs, flaps
6.seam on special machine	3	Multi needle chain stitch, FOA(feed of the arm)
7.shaped assembly	4	Sleeves attaching, collar attaching

Table1: some skill sets, their difficulty level and examples of operations.

It is humanly impossible to perform different skills with equal level of efficiency and consistency in different activities.

The category of seam can be classified not only in terms of difficulty of execution, but also the diversity of handling. A multiskilled operator may perform different operations of the same category with similarity of execution, given the same movements and same finger dexterity.

3.1.1. Flat/Straight Top Stitch Category:

Operator who does top stitching on collar must be able to perform in cuff or flap as well.

3.1.2 Special Operation:

Operator handling button holes can also do button attaching or bar tacking.

3.1.3 Shaped Superimpose Joining Stitch:

Categorizing operations based on skill set has its limitations and is feasible to a point. Operators, however, have to adapt those skills to varying operations. As an example, a person who can top sew a cuff should be capable of top sewing a shoulder seam also. However, the first application is handling a small piece and the second a very large component. In this case the operator needs to learn different handling skills as sewing never represents more than 20% of the work content.

3.2. Multiskilling: Subset of an Operation

If a skill set means "generic skills" such as sew straight seam, sew 3 pieces together, etc. then there is no limit to how many can be listed down. The operator should be taught all actions necessary to perform certain operations. This can be 3-4 skills in a simple operation like joining shoulders to may be 9-10 in a more complex operation like sleeve setting in blazer. Some examples of the generic skill sets can be:

- Sew two pieces together
- Align at machine foot
- Sew multiple small bursts while pivoting in-between
- Sew concave to convex curve
- Apply easing
- Match notch marks during sewing
- Precision stop with needle down
- Use guide
- Match patterns (possibly)

Consider patch pocket attachment on shirt front. Here the operator is required to handle two pieces together, sew multiple bursts while pivoting in-between and precision stop with needle down; thus three skill sets are required for a single operation. In another operation for a princess line seam in ladies top, the operator is required to sew concave to convex curve, match notch marks during sewing and also maybe matching patterns for plaid fabrics.

3.3. Training to Make Multiskill:

A multi skill operator is someone who can perform in preparation and assembly section as well, and can handle folders and guides. When it is necessary to teach multiple operations such as in team working, then theoretically there is no limit but the operator must be taught one operation (set of skills) at a time. However, the more you teach the longer the training time, more the training cost and lesser the performance. Paul suggests "You should not teach more than two simple operations or one complex operation at any time."

Only when the operator is thoroughly competent with one set of skills, i.e. achieves quality of 90 plus per cent on a consistent basis that the supervisor should be prepared to teach a 2nd operation as the original skills will be in his long-term memory. All that would be lost by changing the operation is speed, which can be picked up again.

As the operator learns and performs 'multiple' generic skills, he/she gradually becomes a 'floating' operator or 'floater' as commonly known.

A floater has a significantly less 'rating' than any specialized 'single-skill' operator; so the more operations an operator does, the more his performance drops. You need to teach an operator only those

operations that he is required to perform and these should be limited to an absolute minimum. In this scenario, one cannot set any benchmark as there are too many variables like:

- Ability of operator
- How good is training system
- The number of operations necessary for the operator to do
- How similar (or diverse) are the skills

Some managers make rules such as "good at one operation, able to do a second job competently and can do a third, if necessary" and accordingly put performance levels for them. However, these are usually arbitrary and without any factual or practical foundation. An effective and organized training system should have a recruit in the production line, dependent upon ability and complexity of operation within 4-6 days. If the person has to be taught two or more jobs then the time scale is expanded dramatically.

Fig: 2.An operator does not require specialized training to use folders for operations

The operator can, of course work full time on sleeves to cover absence as long as someone else is available for his second task. In practice it may be better to multiskill two operators but either way the principle is that there is no need to retrain all five, at least three can be single skilled; the production balance has shown the extent of versatility needed.

Another case of reference is when sleeve insert using an over lock is immediately followed by side and sleeve seam. In this case most operators can be trained for a single operation only and a small number in both. Even when performing one operation, the dual skilled workers monitor production levels, and accordingly do one or both jobs as required. This situation should be relatively simple as both operations use the same machine and similar skills. How well this works, is of course dependent upon how good the supervisors and managers are at monitoring production, making decisions and utilizing operators.

3.3.1. Whoshould be Multiskilled?

Fig3: An operator handling multiple workstations

Again, the line balance should be counterchecked. There are two options, train them in the next job in the production sequence or search for a job that utilizes similar skills as with the previous over lock example. The first option may involve training on two types of machines with vastly different handling skills but makes balancing easier as the operator can readily switch from operation to operation without moving along the section. This is of course absolutely crucial when modular manufacturing is being used. The second option certainly makes multiskilling easier and quicker as fewer skills need to be taught.

The basis of systematic operator training is that an operation is not taught; operators are trained in the skills necessary to perform the operation.

The previously quoted sleeve insert operator can be deployed on closing armhole sleeve lining as the same type of machine (single needle post) and sewing skills (joining two curved fabric pieces) are required. Similarly an operator attaching pockets to a blouse front would easily adapt to top-sewing cuffs or collars.

So far, the manager should have identified the need to multiskill from operational requirements as identified from the Production Balance. The next consideration should be absence cover.

A partial solution to absenteeism is the intelligent use of those operators where the balance requires them to regularly perform two operations.

For the system with conveyor, barcode sticker will be put on each hanger and move on the conveyor rail into barcode reader which was set on the rail. The output produced by each operator/operation will be read immediately when hanger passes to the reader and all necessary data will transfer automatically to a main server computer.

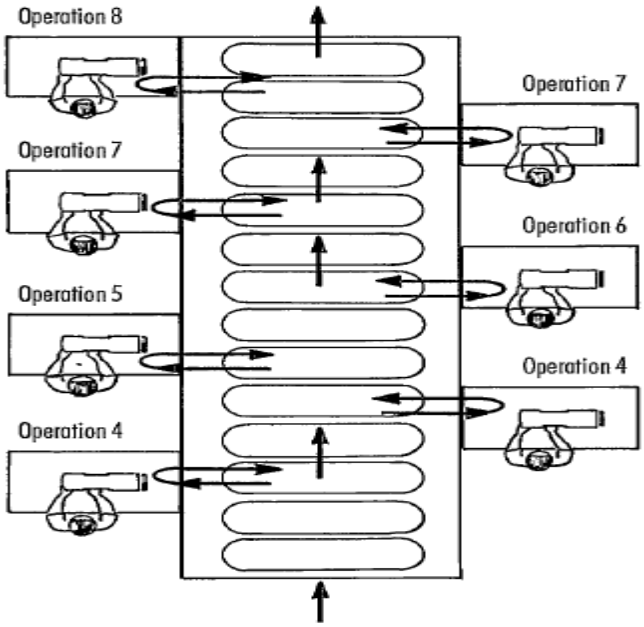

Figure 4: A straight line production system with a belt-driven conveyor. Operations 1, 2 and 3 are preparatory tasks

I. Tracking line balancing and production planning from the actual output and skills records of each operator. Production supervisor and/or production controller can look at the screen to check number of production produced from each operator or operation, and number of work in process (WIP) in case of using conveyor system .This is very useful to fix the problem of bottle neck and manage the line balancing at any time because data are shown by real-time and the whole production line output can only be seen in one screen. Supervisor can find out easily on the screen for the bottle neck processes and critical operations while production are running and some operators may have to move around to fix that processes.

Operators should have multi skills performance in order to replace each other's jobs and to help reducing bottle neck problem. Otherwise the total output from production line cannot hit the target and it finally causes more production cost and fewer margins.

II. Keeping record and calculation of productivity/testing results and incentive for operators. Records of each operator's outputs will be kept in the database for adjusting automatically the skill level. Each skill level can be measured by how much quantity workers can produce each process at specific period of time (such as produced piece per hour). Skill level 3 is the best skill and skill level 0means no skill at that operation (Figure5).

The total skill mark of each operator will be counted and compare automatically to an incentive system for promoting the income. Then each sewing operator can enhance the income by taking the training course to improve the skill and skill marks.

III. Tracking and evaluating the performance and improvement of each operator and operations. This is to see an improvement of skill performance of each operator and total performance of factory. The comparison can be made according to each period of time such as every 1 month, 3 months or 6 months.

IV. To design the training course for developingmulti operator skills according to productionrequirement. From figure 5, it shows the critical process involved in, sewingoperation from number 1 to10, which only a few workers can do efficiently at skill level 3. So the training courses may arrange for these processes to serve the production requirement and to secure the lack of some skills in the future. In conclusion, the study provides the result of implementing information technology for multi skills system in terms of recording, networking and output tracking that affects production efficiency and finally the company

margin. Consequently, for a bigger picture it leads to the increase of revenue and margin ofIndia's apparel industry as well if the system can apply widely to an industry.

Operations / operator	Join shoulder	Set collar	Finish collar	Set sleeve	Sleeve top	Side seam	Cuff attach	Serge bottom full	Bottom hem	Operator score(45)
Ambala	3	3	3	3	3	3	3	3	3	27
Bhanu	3	3	3	3	3	3	3	2	1	24
Chetan	2	2	3	3	3	3	2	3	1	24
Dhanu	1	2	2	3	1	2	2	2	1	16
Eswaran	2	3	3	2	2	2	1	2	2	19
Fatima	4	3	3	2	2	3	3	1	2	23
Geeta	4	4	4	3	3	3	2	2	2	27
Hema	5	5	4	4	3	3	3	3	2	32
izoch	4	4	4	5	5	2	2	1	2	29
Skill score	28	29	29	26	25	24	21	19	16	

Fig5: skill matrix of shirt assembly line

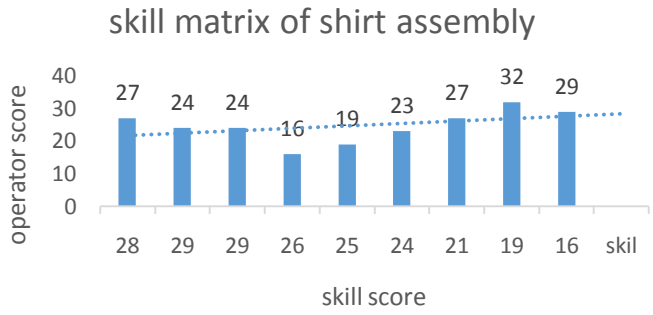

Fig6: skill matrix of shirt assembly

3.3.2. Cross training:

Operators in modular manufacturing need to changes multiskilling training. Multi skilled operation is one who knows the whole garment process and performance different operations. Skill will have a worker judgement will able to selected quality defects in garment operation and proceeding ones in addition in his/her contribution of good levels to the improvement of working methods and optimization of manufacturing times

Trainer should train then to perform in a different machines.in such a way that they may be able to absorb their separating workloads each time the module is balanced

Multiskilling does not end when the operator has learn how to perform more operations, in fact this is the starting point. This process must be complemented with the learning of the quality

Standards for the different operations, other this the operators should also be trained to become capable of working in teams by motivating and including the team work members to participate in group meetings.

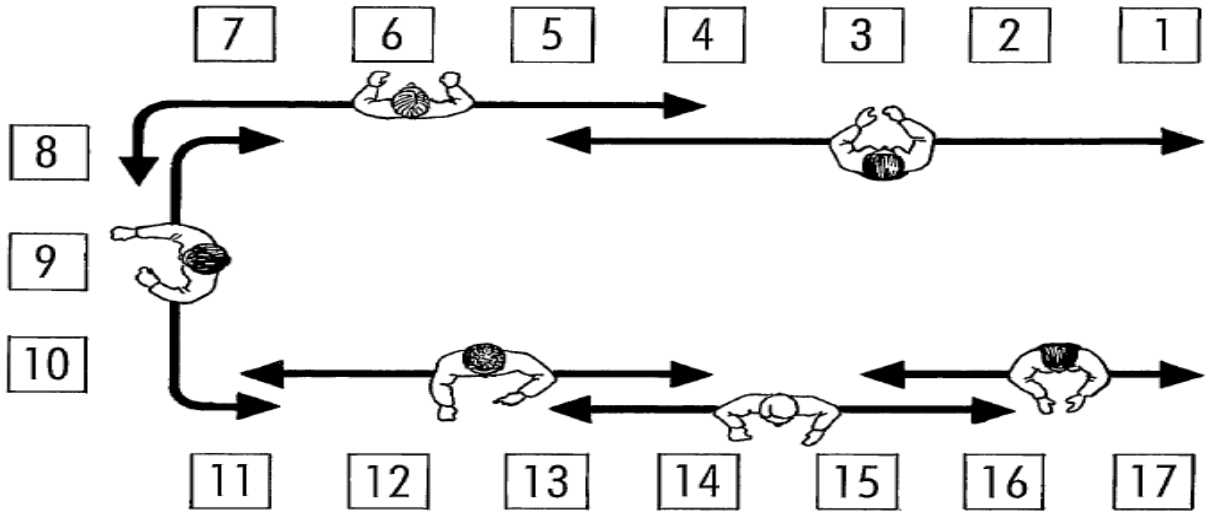

Figure7: example of team-work known as the "modular system". Set up for one style at a time, workers stand and move to adjacent jobs. On completion of a task, each worker moves back to meet the previous one and takes over (often inmid-cycle of the particular operation). The aim of the concept is that a single garment does not stop moving and minimum throughput times can be achieved. The machines are usually on wheels for quick rearrangement of new styles

In a skill matrix operator performance is recorded in efficiency percentage. Skill matrix is also called as skill inventory of the operators. A basic skill matrix is shown in Figure Skill matrix is updated on a regular interval. Or after completion of each style operator's current performance (efficiency %) updated on the database (for manually developed skill matrix).

Operations / operator	Join shoulder	Set collar	Finish collar	Set sleeve	Sleeve top	Side seam	Cuff attach	Serge bottom full	Bottom hem
Ambala	80	76		75					
Bhanu	65	90	72						
Chetan				80	80			72	65
Dhanu	75	82					65		
Eswaran				75	85	62			75
Fatima					75	65			80
Geeta			60			86	85	80	
Hema					68		78	85	
izoch			90				85	95	

Figure 8: A basic Skill Matrix developed in spread sheet

A skill matrix can be made in spread sheet. Or real time shop floor data tracking system can be used for skill matrix development. In the skill matrix, izoch can do sorting of operator performance in various operation and other way in a operation how many operator are there who had earlier worked on and their efficiency level.

3.3.3. On floor training:

First step to start a module is to make the operators multi skilled operators need to be trained on common and critical operations of a group of products as per the module needs

3.3.4. Daily performance bulletin:

Operator name				Operation		
Section				Week ending		
Supervisor				Trainer name		
SMV				Length of time on present time		
Best number last week				Quota set per hour		
Best percentage last week						
Quota set per day						
Production record						
	MON	TUE	WED	THU	FRI	SAT
1-HOUR						
2- HOUR						
3- HOUR						
4- HOUR						
5- HOUR						
6-HOUR						
7-HOUR						
8-HOUR						
9-HOUR						
TOTAL						
EFFICIENCY						

In apparel manufacturing, skills and expertise of a sewing operator is being presented in "Efficiency" term. An operator with higher efficiency produces more garments than an operator with lower efficiency in the same time frame. When operators work with higher efficiency, manufacturing cost of the factory goes down.

Secondly, factory capacity is estimated according to the operator efficiency or line efficiency. Hence, efficiency is one of the mostly used performance measuring tools. So how do you calculate operator efficiency in factory? To calculate operator efficiency you will be needed standard minutes (SAM) of the garment and operations your operator is making. Use following formula and calculate operator efficiency.

3.4. Efficiency calculation formula:

Efficiency (%) = [Total minute produced by an operator/Total minute attended by him *100]

Where,
Total minutes produced = Total pieces made by an operator X SAM of the operation [minutes]
Total minutes attended = Total hours worked on the machine X 60 [minutes]

Example: An operator was doing an operation of SAM 0.50 minutes. In an 8 hours shift day he produces 400 pieces. So according to the efficiency calculating formula, that operator's overall efficiency

= (400 x 0.50) / (8 X 60)*100%
= 200/480*100%
= 41.67%

3.5.On-Standard Operator Efficiency:

Operator efficiency can be expressed in more specific ways, like 'On-Standard Efficiency' instead 'over-all efficiency'. An operator may be attending all hours in a shift but if he has not been given on-standard work to do in all hours, he will not be able to produce minutes as per his capability and skill level. In this case, to know operator's on-standard efficiency following formula is used.

Operator on-standard efficiency (%) = Total minute produced /Total on-standard minute attended *100%

Where,
Total minutes produced = Total pieces made by an operator X SAM of the operation [minutes]
Total on-standard minute attended = (Total hours worked – Loss time) x 60 [minutes]

Example: An operator was doing an operation of SAM 0.50 minutes. In an 8 hours shift day he produces 400 pieces. Operator was idle 'waiting for work' for 30 minutes and his machine broke down for 15 minutes in hours shift. So according to the efficiency calculating formula, that operator's on-standard efficiency
= (400 x 0.50) / {480 – (30 +15)}*100%
= 200/435*100%
= 45.98%

3.6. The benefits of an operator skill matrix are enlisted below.

- It keeps record of all operations an operator had done in the past and efficiency level in each operation.
- Engineers / line supervisors need minimum time to find and select most efficient operators for an operation from the pull of operators.
- For line balancing, operators can be selected according to work content. For example – where an operation is required 50% less time than pitch time, engineers can select an operator whose efficiency level is 50% on that operation.
- When operation clubbing is required (for less work content works), skill matrix gives the information what all operation to be given to an operator.
- When someone is absent, supervisor can easily find suitable person from the skill matrix table and replace.

4. The Outcome of the Study

From this study, applying information technology through multi skills system helps mainly in the function of recording, networking and output tracking.

I) Recording
Information technology enables real-time data recording; therefore, the recording process becomes much easier, more accurate, and timelier. A number of data can be recorded and kept in convenient way, reducing abundant of resources which are human resources, time, and papers.
II) Networking
The web-based application which supports the function of real time barcode reading, data recording, calculation, analysis, line balancing, and production planning allows the entrepreneurs and operators

flexibility to work anywhere and anytime, and all information everywhere is linked together, which makes it possible to summarize, calculate, and
Analyze all related information in real time, creating more valuable information.
III) Output tracking
Information technology tremendously helps in information tracking. Before applying information technology to multi skills system, most information can only be tracked and summarized at the end of the period of day or month because it takes so much time and resources to collect and organize information. After the application of information technology, information can be tracked more easily and in real-time. That information includes the output of each operator and operation, the daily, monthly revenue for each operator and all operators, the average of revenue of the operator, the balancing and bottleneck in the production line and the improvement of skills of the operator.
Information technology gives the outcome tomulti skill system as following:
I) Increase the efficiency of multi skill system.
II) Create the real time and reliability information for production management.
III) Increase the convenience and rapidity in applying multi skill system.
IV) Reduce the resources: human resources, papers, timing in implementing multi skill system.
V) Create the motivation to operatorsin applying multi skill system.
The apparel industry benefits areas following:
I) Increase the number of skills one operator can work.
II) Reduce the bottleneck and increase the line balancing in the production line
III) Production line can be easily controlled and managed.
IV) Increase the overall productivity and also productivity per operator, improving the production efficiency.
V) Increase the revenue for operator.
VI) Reduce the operator turnover problems
VII) Increase higher margin for the apparel entrepreneur and industry.

5. Conclusions:

Due to the benefits gained from the multi labor skills system supporting by information technology as mentioned above, and automated multi-skill labor system.The multi skill system supporting by information technology can significant improve the production efficiency, mainly causing of labor skills problem, of India's apparel industry.
In order to improve the production efficiency bymulti skill system applying information technology in wider range as country level, there should be supported by government for hardware and systems as its high investment and reducing of developmentperiod.

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