

USING LEARNING CURVES TO ASSESS MANUAL SKILLS IN ASSEMBLY HIRING

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This paper presents the use of a learning curve for designing manual and motor skills tests intended for employee selection for an assembly line. The proposed approach addresses the need to assess candidates' manual dexterity, motor coordination and tool handling before they enter training or production. A testing kit consisting of an assembly box, hand tools and an MS Excel-based evaluation sheet was developed. Standard assembly time was determined using the Basic MOST method, and candidate performance was evaluated from repeated measured times. The learning rate was calculated by two approaches, namely the average of gradual improvement and least-squares regression. The results show that the learning curve can serve as a practical decision-support tool in hiring by identifying candidates with better adaptation potential and a higher probability of reaching the required assembly standard. The novelty lies in combining a Basic MOST-based standard time, repeated work-sample cycles, and individual learning-curve estimation in one transparent recruitment model.

KEYWORDS

Learning curve, manual skills testing, motor coordination, assembly line hiring, Basic MOST

1 INTRODUCTION

The world economy has undergone significant socio-economic changes in recent years. The developmental trends that have emerged profoundly affect all spheres of social life, including the economy. The nature of these changes is so significant that the period of recent years, especially the present, is referred to as the era of the new economy [Visnansky 2010, Bercaw 2021]. The educational program aims to ensure that participants master the basic terminology used in the automotive industry and can perform manual operations on the assembly line according to work instructions. They can define and manipulate assembly tools and fixtures used in automotive production. There are many technological changes and developments in automotive assembly lines. The workers are expected to use new technology. It requires workers to learn quickly to prevent performance decrease. Therefore, the organizations must have a good learning program. Learning curve is a method to describe learning capability of an organization as the accumulation of experience. In assembly line it is necessary to hire workers with significant levels of manual dexterity and motor coordination [Appelbaum 2000]. Before we send candidates to training center, we need to find out which ones are suitable to work on assembly line. The purpose of this article is to propose testing process, which helps HR to test candidates and decide who to recommend to assembly line.

This paper aims to propose and verify a practical methodology for assessing candidates' manual and motor skills before their assignment to an assembly line. The main contribution of the paper is the integration of a manual skills test, a standardized assembly task, and learning-curve-based evaluation into one decision-support approach for recruitment. In addition, the paper applies the Basic MOST method to determine the standard time of the test task and compares two approaches to the calculation of the learning rate, namely the average of gradual improvement and the least-squares regression method. The proposed approach enables HR departments and production managers to identify candidates with better adaptation potential and a higher probability of achieving the required assembly performance.

Unlike CV screening, interviews, or one-shot dexterity and work-sample tests, the proposed method evaluates both current manual performance and adaptation across repeated cycles. Its scientific contribution is the integration of a standardized assembly task, an objective Basic MOST reference time, and learning-potential estimation by two approaches. Selection is therefore not based only on the fastest isolated result, but also on the candidate's predicted path to the required standard.

2 LEARNING CURVE

The concept of the learning curve model has been used in industry since the late 1930s. The learning curve model was first reported in the aircraft industry [Wright 1936]. Wright's model is known as the log-linear learning curve model as expressed in equation [Hill 2011, Daneshjo 2022]. In common use there are two basic models for predicting learning:

- The volume-based learning model: The mathematical model for learning assumes learning is a function of the cumulative production volume in units. Learning curve is used primarily for direct cost. Experience curve is used for total cost. Both models are mathematically identical.
- The time-based learning model: This approach assumes that learning is a function of time rather than volume and models learning as exponential decay over time. Moore's Law is known as time-based learning exponential growth model [Morilo 2023].

In this paper, the volume-based learning model is used for further calculations. Fig. 1 shows a log-linear learning curve with 80% learning rate, which means that each doubling of cumulative production leads to 20% reduction in unit cost (time). The area below the curve can be divided into two zones, i.e. learning and standard time zone. These zones indicate the learning stage of organization [Hill 2011, Adler 2001].

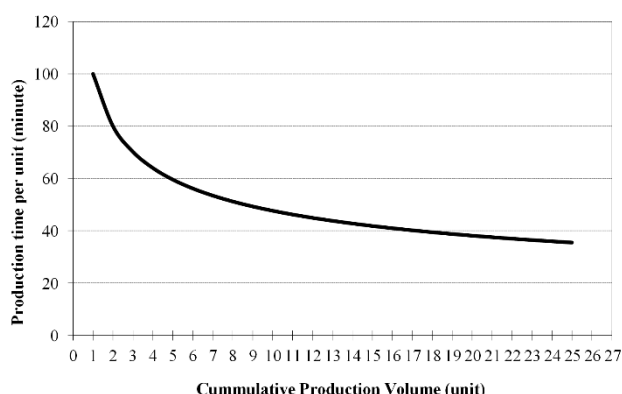


Figure 1. Learning Curve with 80% Learning Rate

b	0.000	0.074	0.152	0.234	0.323	0.415	0.515	0.621	0.737	0.862	1.000	1.322	1.737	2.322	3.322
k	100%	95%	90%	85%	80%	75%	70%	65%	60%	55%	50%	40%	30%	20%	10%

Table 1. Relation between b and k

The example, for an 80% learning curve: If cumulative production doubles from 100 to 200 units, then the hours required to produce the 200-th unit is 80% of that for 100-th unit.

Raw data for the simple example are in Fig. 2.

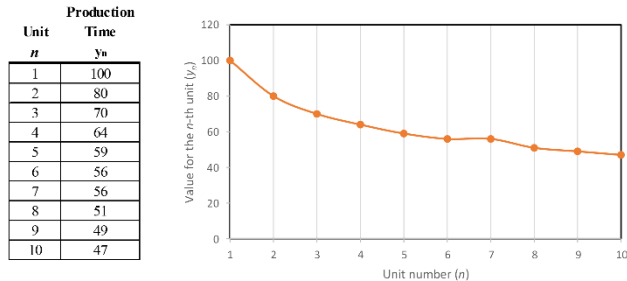


Figure 2. Raw data for the simple example

The basic equation for the learning curve model is:

$$y_n = y_1 n^{-b} \quad (1)$$

Where:

n - Is the unit number.

y_n - Is the performance variable (cost, time, etc.) for the n -th unit.

y_1 - Is the value for the first unit, and $b \geq 0$ is the learning parameter, rate.

Taking the natural log of both sides of the equation (1) yields:

$$\ln(y_n) = \ln(y_1) - b \ln(n) \quad (2)$$

which is linear equation with intercept (constant) $\ln(y_1)$ and slope b . We can then use linear regression to find the intercept and slope parameter. The value for the intercept $\ln(y_1)$ can be calculated as $y_1 = \exp(\ln(y_1))$.

Graph of the line made with the natural log transformation is in Fig. 3.

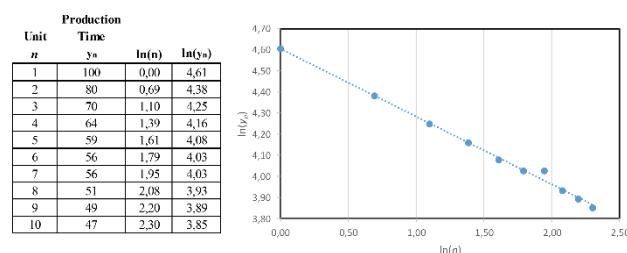


Figure 3. Graph of the line made with the natural log transformation

Simple linear regression for this example problem found that the intercept for the line is $\ln(y_1)=4.605$, which means that $y_1 = \exp(4.605) = 99.996$. The slope of the line is -0.321 , which means that $b = 0.321$ and the learning rate is $k = 2^{-b} \approx 0.800 = 80\%$. The learning curve model for this example, therefore, is $y_n = 99.996n^{-0.321}$. If we know the learning rate parameter, we can compute the learning parameter using $b = -\ln(k) / \ln(2)$. For 80% learning curve, $k = 0.8$ and $b = 0.322$. Conversely, if we know the learning parameter (b), we can compute the learning rate parameter with $k = 2^{-b}$. The relation between exponent b and k , the percentage associated with the Learning curve, is shown in Tab. 1.

3 APPLICATION FOR A LEARNING CURVE IN HIRING

Managers often measure and forecast key performance variables such as:

- Direct labor hours per unit.
- Cost per unit.
- On-time delivery.
- Defects/unit.

These measures and forecasts help to:

- Plan capacity.
- Create budgets.
- Establish realistic targets for workers, managers, and organizational units.

Job performance is defined as the total expected value to the organization of the discrete behavioral episodes that an individual carries out over a standard period. One important idea in this definition is that performance is a property of behavior. A second important idea is that the property of behavior to which performance refers is its expected value to the organization [Daneshjo 2019, Aik 2007, Alfaiz 2024].

Everybody knows that a chain is only as strong as its weakest link. This also applies to an assembly line. Assembly line is only as strong as its individual parts e.g. tools, conveyor belts, material, and workers. Therefore, it is important to recruit suitable workers and assess their skills before sending them to the training center or assigning them to the assembly line. Errors in this decision-making process can lead to longer takt times, more defects, and higher stress. It can also cause worker frustration when the job does not match their abilities. We propose a testing kit to support decision-making in the selection of suitable employees. The testing kit includes assembly box, assembly tools and MS Excel for evaluation.

As stated in the definition, job performance is a property of behavior; therefore, the testing process also includes observation of how the candidate behaves. For example, the evaluator may observe whether the candidate remains calm, follows instructions, and behaves appropriately during the test. Thus, the decision is based not only on time performance but also on observed behavior.

The next section focuses on the testing kit and the measurement of time performance.

Fig. 4 shows the hiring process.

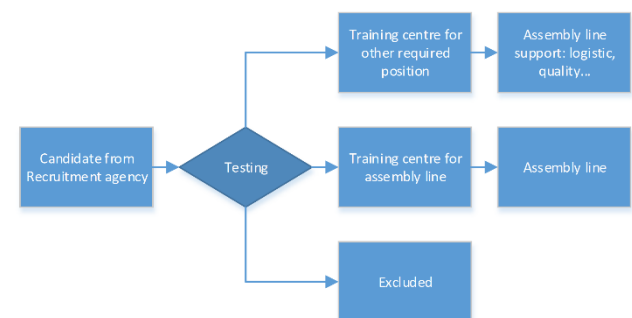


Figure 4. Hiring process

From a practical point of view, the proposed approach can improve the quality of recruitment decisions in assembly production. Instead of relying only on interviews or general impressions, the company can use a structured test to evaluate

manual dexterity, motor coordination, tool handling and learning potential under defined conditions. This may help reduce the risk of inappropriate job placement, decrease adaptation problems during training, and support more stable assembly performance in terms of takt time, quality and operator workload.

4 TESTING KIT

The skills test makes it possible to verify the level of manual dexterity, motor coordination, and tool use, and helps in selecting suitable personnel for assembly work. The objective of the test is to assess the candidate's ability to work with tools, particularly wrenches. Construction of testing box:

- According to Fig. 5 – the rear and top sides are closed.
- 1st row – 3x hexagonal screw, washer and nut M8x35.
- 2nd row – 3x torx screw M6x16-H.
- 3rd row – 3x hexagonal screw and nut M6.
- 4th row – 3 torx screw and washer M5x18

The task:

- Remove the screws and install them on the opposite side of the testing box (12pc.).
- Tighten them so that they cannot be loosened by hand.

Duration:

- Approximately 30minutes.

Rules:

- The screws are mounted on both sides of the testing box so that they cannot be loosened by hand. Required tools are ready alongside the assembly box.
- The candidate places both hands on the table, palms down, with the box positioned between them.
- The HR employee starts the test and the timer.
- The candidate must install the screws from one side of the box to the other as quickly as possible. Screws cannot be loosened by hand.
- After the last screw is installed, the HR employee stops the timer and records the result in the evaluation form.
- The HR employee checks the tightening of the screws; if any of them can be loosened by hand, 30 seconds are added to the total time as a penalty for non-compliance with the standard.
- The candidate repeats the test four times under the same conditions.

The proposed testing assembly box with tools is shown in Fig. 5.



Figure 5. Proposed testing assembly box with tools

Although demonstrated on an automotive fastening task, the workflow can be adapted to electronics assembly (connector insertion and fastening), appliance assembly (mixed fasteners and clips), or kitting/subassembly (picking, orientation, and assembly sequences). The test object and quality criteria remain task-specific, while the transferable sequence is unchanged: define a representative task, establish its standard time, measure repeated cycles, estimate learning, and apply locally validated decision limits.

5 STANDARD TIME ESTABLISHMENT

The standard time was established using the MOST system (Maynard Operation Sequence Technique). This method uses predefined time standards. The main principle of predetermined time standards lies in the recognition that, despite the diversity of human work, many tasks consist of sequences of movements that are repeatedly performed. Research on such movements has shown that, after allowing for worker adaptation, the time required to perform basic movements is relatively consistent. Accordingly, it is possible to statistically determine the time duration values for each of the basic movements [Borman 2003, Daneshjo 2020].

Benefits of using MOST:

- We do not need a timer for the setting of standard time.
- It defines the objectively necessary time required to carry out the work. There is no need to assess the worker's pace.
- All times correspond to uniform performance levels.
- Analysis in Basic MOST is 40x faster than MTM1, whilst using 15 times less paper.
- It is suitable in any environment (automotive industry, electro-technical industry, ...).
- MOST consists of three subsystems: Mini MOST, Basic MOST, and Maxi MOST [Hwaiyo 2004, Borman 2003].

In this study, Basic MOST was used, specifically the Tool Use Sequence Model shown in Fig. 6.

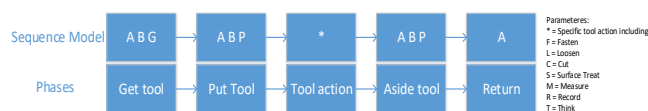


Figure 6. Tool Use Sequence Model

The standard time of proposed testing kit is calculated in Tab. 2, Tab. 3 and Tab. 4.

Notes: Valid for any screw connection with two hand tools (fork-lug wrench, torx-fork)

No.	H	Description	Se	Sequence																Fr	TMU			
1	B	Take the L and R keys simultaneously hand fork and attach it to the inside nut wrench	V	A	1	B	0	G	1	A	1	B	0	P	3	A	0	0	0	0	0	1	60	
				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
2	R	Put the screw on the outer fork wrench and loosen one twist	NL	A	0	B	0	G	0	A	0	B	0	P	6	L	3	A	0	B	0	P	0	90
				1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1		
3	B	Place the key to the next screw, loosen one twist	NL	A	0	B	0	G	0	A	1	B	0	P	3	L	3	A	0	B	0	P	0	100
				1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1		
4	B	Place the key to the next screw, loosen by turning one, put the wrench	NL	A	0	B	0	G	0	A	1	B	0	P	3	L	3	A	1	B	0	P	1	120
				1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1		
5	B	Unscrew the screw connection, max. 16 rotations with fingers	NL	A	0	B	0	G	0	A	1	B	0	P	1	L	16	A	0	B	0	P	0	540
				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
6	B	Clutch over, place the screw, washer and tighten, max. 16 rotations fingers	NF	A	1	B	0	G	3	A	1	B	0	P	6	F	16	A	0	B	0	P	0	810
				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
7	B	Take the L and R keys simultaneously hand fork and replace the internal screw wrench	V	A	1	B	0	G	1	A	1	B	0	P	3	A	0	0	0	0	0	0	60	
				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
8	L	Put on the outer nut fork wrench and tighten by turning one	NF	A	0	B	0	G	0	A	0	B	0	P	6	F	3	A	0	B	0	P	0	90
				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
9	B	Place the key to the next bolt connection, tighten, turning one	NF	A	0	B	0	G	0	A	1	B	0	P	3	F	3	A	0	B	0	P	0	100
				1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1		
10	B	Place the key to the next bolt connection, tighten, turning one, put the wrench	NF	A	0	B	0	G	0	A	1	B	0	P	3	F	3	A	1	B	0	P	1	120
				5	5	5	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1		
Total consumption of time:														1,25	75,24	2090								
														Minutes	Seconds	TMU								

Table 2. Basic MOST analysis work with fork-lug wrench

Notes: Applies to working with torx wrench

No.	H	Description	Se	Sequence																		Fr	TMU			
1	R	Grab Torx wrench, turn to grub, relax max. 25 rotations with fingers	V	A	1	B	0	G	1	A	1	B	0	P	3	A	0	0	0	0	0	0	0	1	330	
2	L	Catch over, place the grub screw into the hole, screw max. 25 rotations with fingers	N	A	0	B	0	G	0	A	0	B	0	P	6	L	3	A	0	B	0	P	0	A	0	330
3	R	Catch over, place the grub screw into the hole, loosen max. 25 rotations with fingers	N	A	0	B	0	G	0	A	1	B	0	P	3	L	3	A	0	B	0	P	0	A	0	330
4	L	Catch over, place the grub screw into the hole, screw max. 25 rotations with fingers	N	A	0	B	0	G	0	A	1	B	0	P	3	L	3	A	1	B	0	P	1	A	0	330
5	R	Catch over, place the grub screw into the hole, loosen max. 25 rotations with fingers	N	A	0	B	0	G	0	A	1	B	0	P	1	L	16	A	0	B	0	P	0	A	0	330
6	L	Catch over, place the grub screw into the hole, screw max 25 rotations with fingers, put the wrench off	N	A	1	B	0	G	3	A	1	B	0	P	6	F	16	A	0	B	0	P	0	A	0	350
Total consumption of time:																						1,20	72,00	2000		
																						Minutes	Seconds	TMU		

Table 3. Basic MOST analysis work with torx wrench

From one side to other side	Minutes decimal	min:s
1st raw	1.25	01:15
2nd raw	1.20	01:12
3rd raw	1.25	01:15
4th raw	1.20	01:12
	4.90	04:54

Table 4. Total standard time for testing assembly box

The standard time for the testing assembly box was calculated as 4 minutes and 54 seconds.

6 TEST EVALUATION METHODOLOGY

Using the measured data from four test cycles for each candidate, it is possible to calculate the improvement rate, the exponent b , and the learning percentage k . In Tab. 5 and Tab. 6 measurements and their evaluation are shown.

Four test cycles were selected as a practical minimum for recruitment screening. This number allows candidate performance to be compared after the number of task repetitions increases from one to two and from two to four. Consequently, improvement can be evaluated between cycles 1 and 2, cycles 2 and 4, and across the complete interval from cycle 1 to cycle 4. At the same time, four repetitions keep the total test duration within approximately 30 minutes and reduce the risk that fatigue will substantially influence the results. The measurements are therefore sufficient for an initial assessment of a candidate's learning potential, although they are not

intended to represent a fully developed and statistically stable individual learning curve.

Best time – best time from four measurements:

- Maximum fulfillment – the ratio between the standard time and the best recorded time.
- Achieved the Standard - if the shortest time is less than or equal to standard time TRUE otherwise FALSE.
- Achieved min. 90% performance - if the shortest time is less than or equal to 90% standard time TRUE otherwise FALSE.
- Percentage Improvement “1:2” and “2:4” - difference in time consumption between the first and second iteration (second and fourth).
- Average Improvement % - the average value of percentage improvement “1:2”, “2:4”.
- b (1:2), b (2:4), b (1:4) – calculated value of Learning curve exponent.
- Average b – average value of b (1:2), b (2:4), b (1:4).
- Learning percentage – calculated value of learning rate parameter $k = 2 - b$.
- Number of cycles to achieve the standard – estimate number of cycles when candidate will be able to meet standard.
- Probability of achieving the standard – TRUE if the estimated number of cycles required to achieve the standard is less than or equal to 8; otherwise FALSE.
- Test result with interpretation.
 - Excellent – maximum standard fulfillment greater or equal to 115%.
 - Great – maximum standard fulfillment greater or equal to 100%.
 - Good – maximum standard fulfillment greater or equal to 90%, it is assumed that the candidate will meet the standard in a repeated test.
 - Sufficient – maximum standard fulfillment to 90%, or it is assumed that the candidate will meet the standard in a repeated test.
 - Insufficient - maximum standard fulfillment to 90%, or it is improbable that candidate in re-test will meet the standard.

The limits are anchored to the Basic MOST standard time: 100% means direct standard achievement, 90% means that the best time is within 10% of the standard, and 115% provides a 15% performance reserve. The eight-cycle limit restricts extrapolation to one additional doubling beyond the four observed cycles. These are decision-support values and should be recalibrated for other tasks, workforces, or training systems. A sensitivity check shows that changing the projected-cycle cut-off from 6 to 10 does not alter the recommendation split: Candidates 1-3 remain below it (2.5-4.0 cycles), while Candidates 4-6 remain above it (11.7-15.4 cycles). Shifting the 90%, 100%, or 115% bands by about 5 percentage points may change the label of boundary cases. Therefore, category, measured time, and predicted cycle count should be interpreted together.

Candidate No.	1.measurement		2.measurement		3.measurement		4.measurement		Best time	Standard time consumption	Maximum fulfillment	Achieved the Standard	Achieved Min. Performance 90%
Candidate 1	06:23	6,38	06:10	6,17	05:58	5,97	04:15	4,25	04:15	04:54	115,3%	TRUE	TRUE
Candidate 2	06:45	6,75	06:38	6,63	06:17	6,28	04:50	4,83	04:50	04:54	101,4%	TRUE	TRUE
Candidate 3	08:45	8,75	08:04	8,07	06:41	6,68	04:54	4,90	04:54	04:54	100,0%	TRUE	TRUE
Candidate 4	08:15	8,25	09:40	9,67	08:02	8,03	06:20	6,33	06:20	04:54	77,4%	FALSE	FALSE
Candidate 5	09:40	9,67	08:08	8,13	05:07	5,12	06:48	6,80	05:07	04:54	95,8%	FALSE	TRUE
Candidate 6	06:23	6,38	06:10	6,17	05:40	5,67	05:30	5,50	05:30	04:54	89,1%	FALSE	FALSE

Table 5. Measurements of candidate's 1st evaluation

Candidate No.	% Improvement 1,2	% Improvement 2,4	Average Improvement	b(1,2)	b(2,4)	b(1,4)	Average b	Learning percentage	The number of cycles to achieve standard	Is it probable, that candidate will achieve standard by repeating (4 times total)	Test result
Candidate 1	3.4%	31.1%	17.2%	-0.050	-0.537	-0.293	-0.293	82%	2.5	TRUE	Excellent
Candidate 2	1.7%	27.1%	14.4%	-0.025	-0.457	-0.241	-0.241	85%	3.8	TRUE	Great
Candidate 3	7.8%	39.3%	23.5%	-0.117	-0.719	-0.418	-0.418	75%	4.0	TRUE	Great
Candidate 4	-17.2%	34.5%	8.7%	0.229	-0.610	-0.191	-0.191	88%	15.4	FALSE	Insufficient
Candidate 5	15.9%	16.4%	16.1%	-0.249	-0.258	-0.254	-0.254	84%	14.6	FALSE	Sufficient
Candidate 6	3.4%	10.8%	7.1%	-0.050	-0.165	-0.107	-0.107	93%	11.7	FALSE	Insufficient

Table 6. Measurements of candidate's 2nd evaluation

In Tab. 6, the exponent b and the learning parameter k are calculated using the average gradual improvement method. Fig. 7 shows the learning parameter b for Candidate 1, calculated using a least-squares regression line fitted to the measured data. This minimizes the sum of the squared errors between the model and measured data.

Candidates 4 and 5 show irregular data, including decreases in performance time, which may be caused by the 30-second penalty.

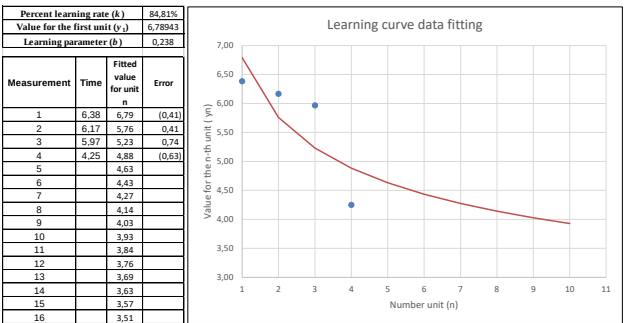


Figure 7. Learning parameter b , for Candidate 1, calculated with least-squares regression line

A comparison of the learning percentage calculated by the average method and the least-squares method (Tab. 7) shows that the difference is not significant.

Candidate No.	Learning percentage k		Difference
	Average of gradual improvement	Least squares regression line	
Candidate 1	81.60%	84.81%	3.21%
Candidate 2	84.62%	86.98%	2.36%
Candidate 3	74.83%	76.60%	1.77%
Candidate 4	87.62%	89.07%	1.45%
Candidate 5	83.87%	78.22%	-5.65%
Candidate 6	92.82%	92.60%	-0.22%

Table 7. Difference between averages and least-squares

In the final interpretation of the results, Candidate 1 has a learning rate of 81.60% and is expected to need 2.5 cycles to achieve the standard time. Candidate 6 has a learning rate of 92.82%, which is better than that of Candidate 1, but is expected to need 11.7 cycles to achieve the standard. Therefore, Candidate 1 can be recommended for further training in the training center and subsequent recruitment.

7 LIMITATIONS

The proposed methodology has several limitations. First, the testing procedure was demonstrated on a limited number of candidates and on one specific type of assembly task, which may reduce the generalizability of the results to other production environments. Second, the evaluation is based mainly on

measured times and learning dynamics during repeated cycles, while actual job performance on the assembly line can also be influenced by additional factors such as stress resistance, teamwork, attention stability and long-term work discipline. Third, the use of a 30-second penalty for incorrect tightening may affect the monotonic development of measured times and may partially distort the calculated learning rate, as indicated in some candidate results. Finally, although behavioral observation is included in the assessment, this part of the evaluation is more subjective than the time-based indicators and should therefore be applied with caution.

Further variability may result from recruitment stress, fatigue, motivation, previous tool experience, handedness, or memorization of the screw sequence rather than general manual adaptation. Evaluator timing, instructions, and tightening judgments may also affect results. Applications should therefore use a fixed instruction script, identical tool layout, controlled rest, recorded prior experience, and, where feasible, automatic timing or a second-rater check. Penalty time and execution time should be stored separately.

8 CONCLUSIONS

This paper presented the use of the learning curve as a support tool for employee selection in assembly production. A testing methodology based on a practical assembly task, repeated performance measurement and learning-rate evaluation was proposed to assess candidates' manual dexterity, motor coordination and adaptation potential. The standard time of the task was established using the Basic MOST method, and candidate performance was evaluated by two approaches to learning-rate calculation: the average of gradual improvement and the least-squares regression method. The results indicate that the proposed approach can support recruitment decisions by distinguishing candidates with a higher probability of reaching the required assembly standard in an acceptable number of cycles. From a practical perspective, the methodology may help reduce the risk of inappropriate hiring decisions and improve the alignment between worker capabilities and assembly-line requirements. At the same time, further verification of a broader sample and in different production settings is needed.

Future research should focus on verifying the proposed methodology on a larger sample of candidates and on different types of assembly operations. It would also be useful to compare the test results with the actual performance of hired employees after their placement in training and real production. Another research direction is the refinement of the evaluation model for cases with penalized or irregular time development and the identification of the most reliable method for estimating the learning rate in personnel selection. Finally, the methodology could be extended by additional indicators reflecting ergonomics, error frequency or cognitive demands of assembly work. Multi-site studies should compare the method with interview-based selection, one-shot dexterity tests, and work-sample tests without learning-curve evaluation. Longitudinal validation should relate predicted learning potential to training duration, time to stable takt achievement, defect and rework rates, and sustained post-employment performance. This would support statistical calibration of task-specific thresholds and quantify the added predictive value of learning-curve analysis.

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