

ANALYZING THE EFFECT OF LINE-CELL CONVERSION ON MANUFACTURING SYSTEMS

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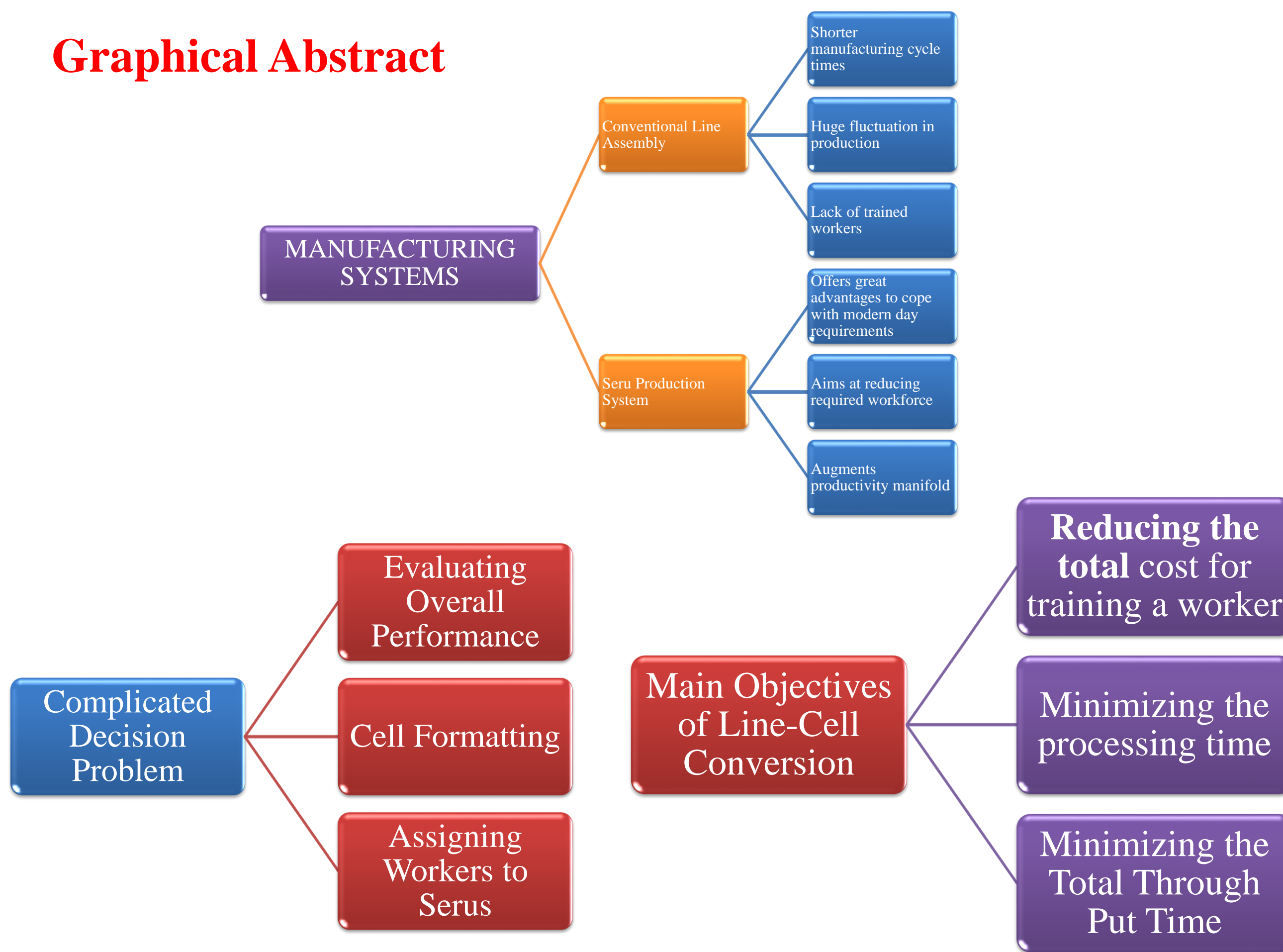
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Objective

The objective of our poster is to convert the traditional assembly line system to a cell system by cross training the workers. For this we are minimizing the total cost required to train workers while simultaneously trying to reduce the total throughput time as well as the processing times.

Graphical Abstract



Problem definition

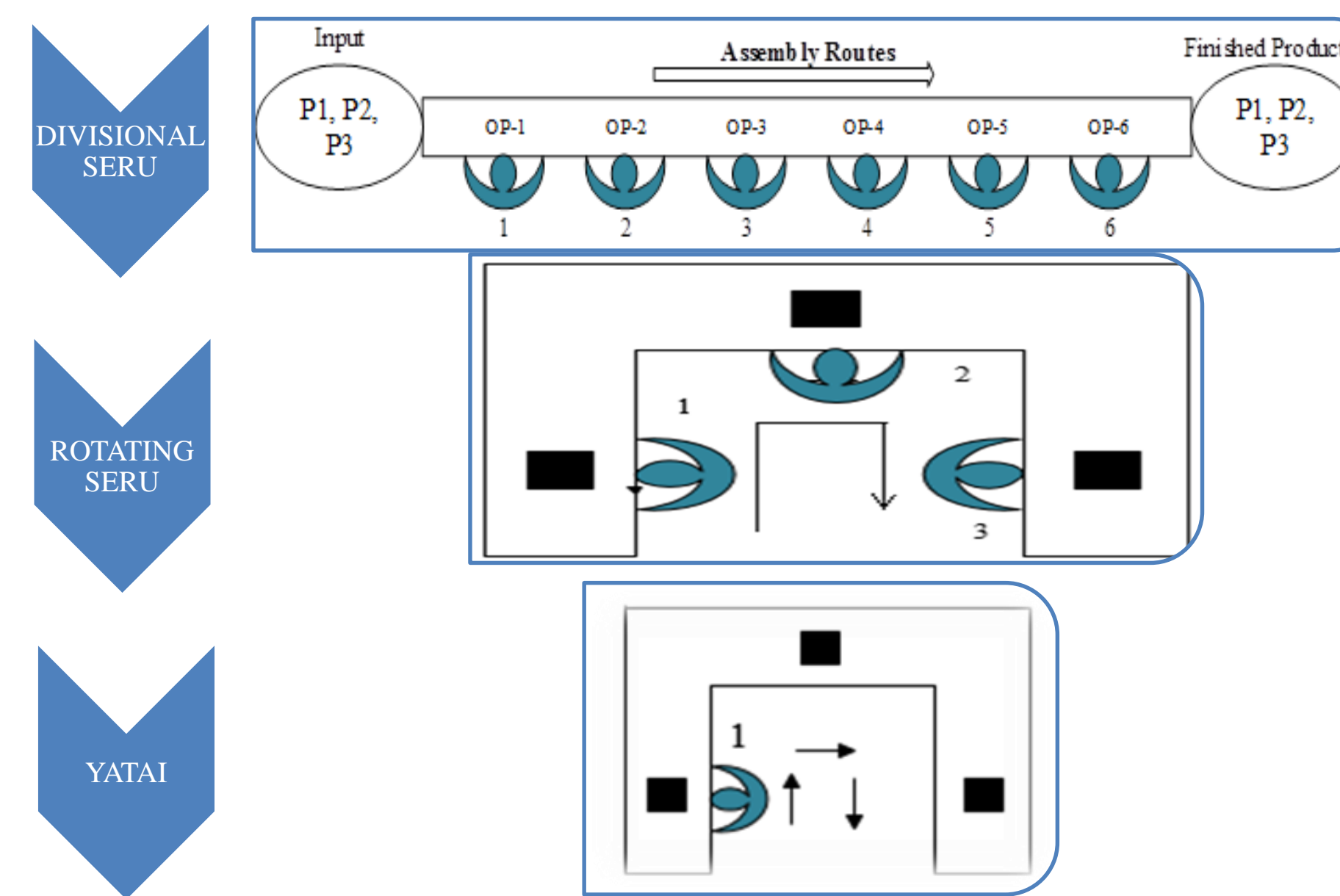


Fig: Transformation of assembly lines into single worker cell systems

Methodology

Table: The standard processing time of each task of each product type before training the worker.

| Product type | Task 1 | Task 2 | Task 3 | Task 4 | Task 5 | Task 6 | Task 7 | Task 8 | Task 9 | Task 10 |
|--------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---------|
| Product A | 81 | 50 | 95 | 93 | 87 | 67 | 79 | 74 | 80 | 95 |
| Product B | / | 73 | / | 78 | 69 | 95 | / | 93 | 54 | 84 |
| Product C | 84 | 82 | 63 | / | 69 | / | / | / | 56 | / |
| Product D | 86 | / | 70 | 66 | 71 | 54 | 89 | 58 | 65 | 91 |
| Product E | 92 | 88 | 88 | 63 | 50 | 63 | 56 | 79 | / | 94 |
| Product F | 82 | 63 | 86 | 95 | / | 67 | 61 | 80 | 85 | 91 |

Table: The data on worker's level on skill before training them

| Workers | Product's | | | | | |
|---------|-----------|----|----|----|----|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| 1 | | 5 | 6 | 7 | 10 | 9 |
| 2 | | 5 | 9 | 5 | 5 | 8 |
| 3 | | 9 | 6 | 9 | 6 | 5 |
| 4 | | 6 | 8 | 8 | 9 | 5 |
| 5 | | 5 | 6 | 9 | 6 | 7 |
| 6 | | 10 | 5 | 10 | 7 | 6 |
| 7 | | 10 | 9 | 10 | 10 | 9 |
| 8 | | 6 | 5 | 7 | 10 | 6 |
| 9 | | 9 | 10 | 6 | 6 | 5 |
| 10 | | 10 | 7 | 7 | 8 | 6 |

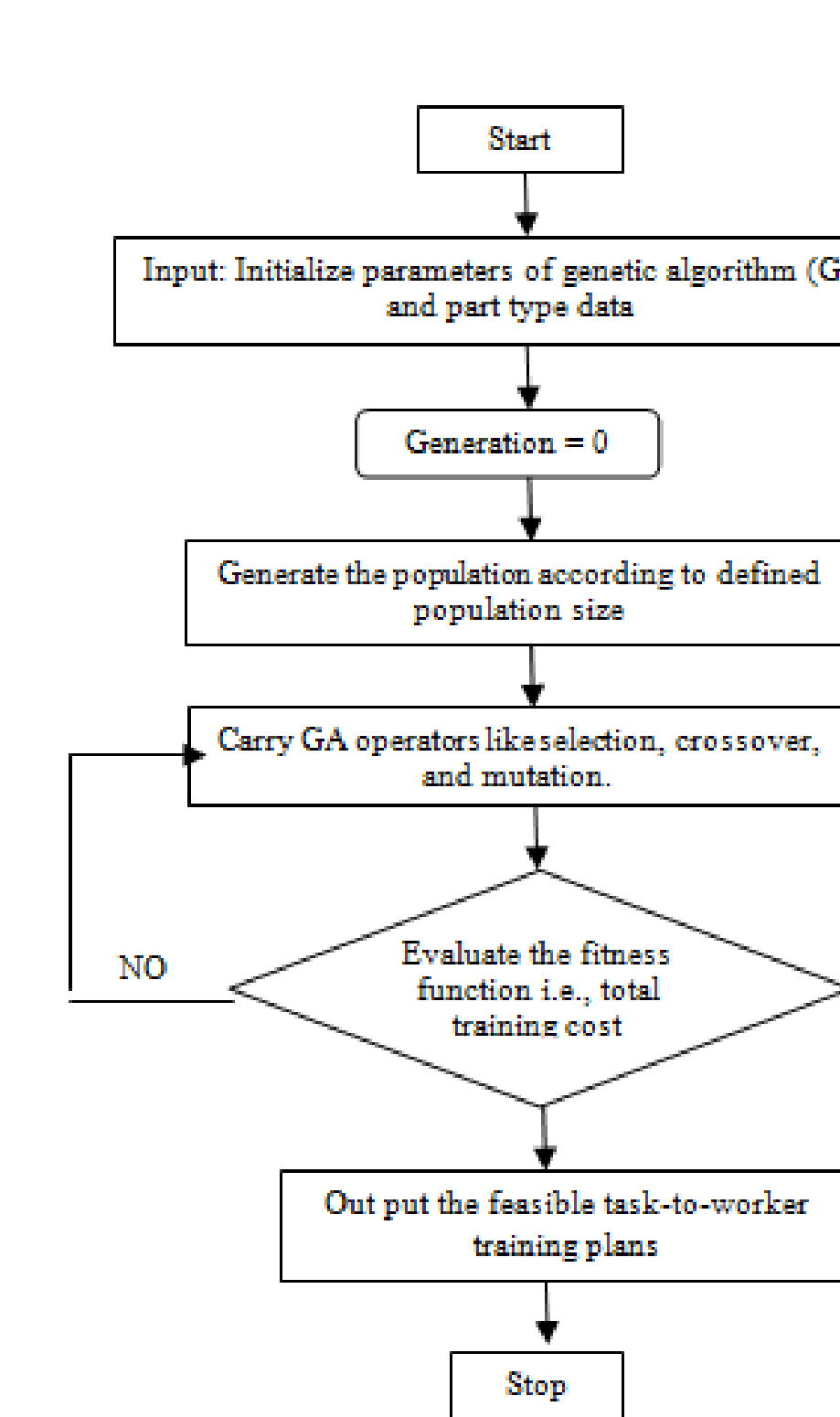


Fig: Problem Solving Methodology

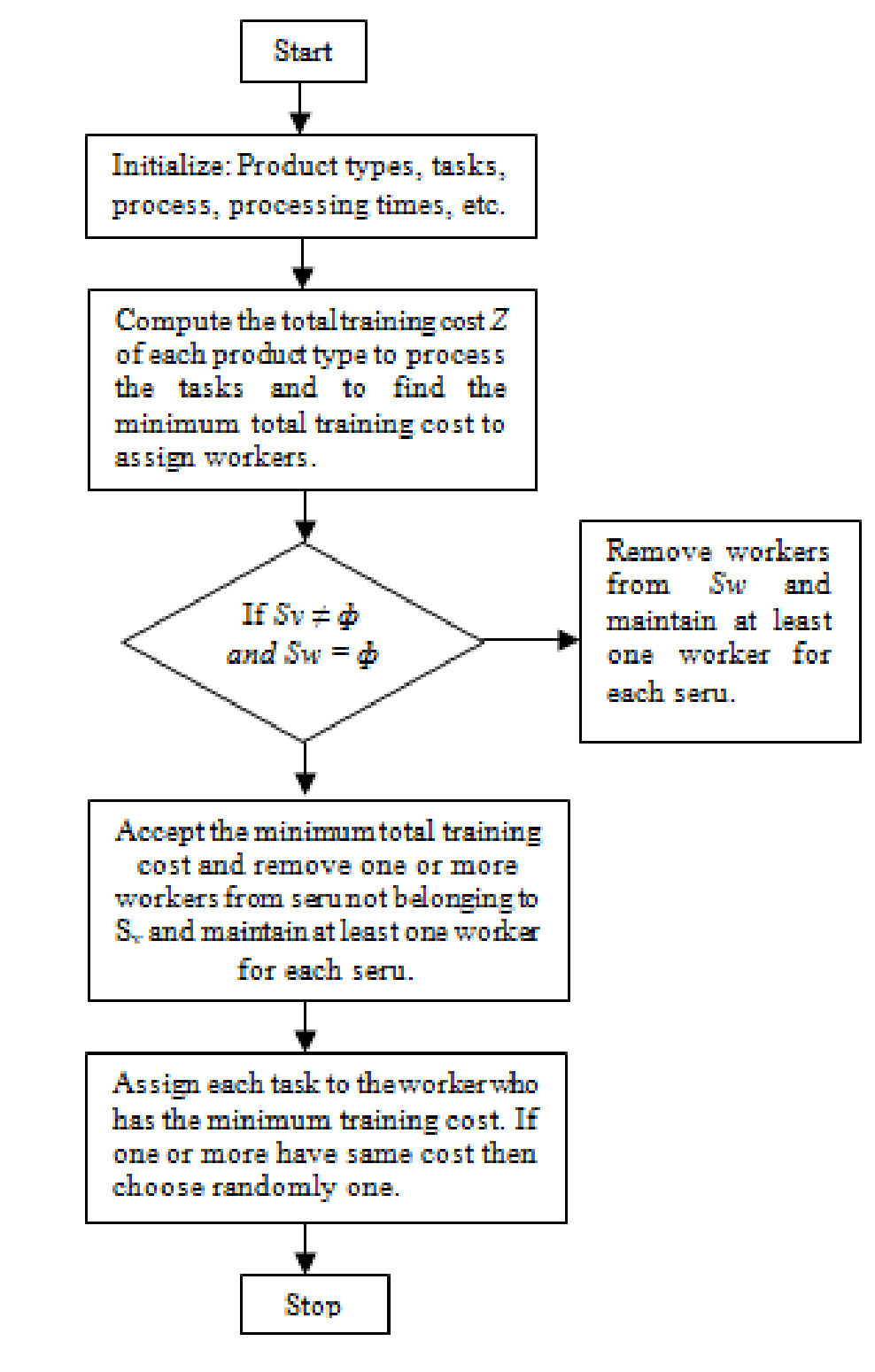


Fig: The Heuristic Algorithm

Results

| Worker | Product type 1 (Seru 1) | Product type 2 (Seru 2) | Product type 3 (Seru 3) | Product type 4 (Seru 4) | Product type 5 (Seru 5) | Product type 6 (Seru 6) |
|--------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|
| 1 | 434 | 497 | 702 | 528 | 233 | 719 |
| 2 | 562 | 606 | 734 | 668 | 824 | 615 |
| 3 | 374 | 729 | 344 | 896 | 545 | 639 |
| 4 | 785 | 553 | 575 | 675 | 391 | 688 |
| 5 | 537 | 685 | 607 | 716 | 825 | 496 |
| 6 | 504 | 605 | 713 | 551 | 550 | 647 |
| 7 | 873 | 801 | 443 | 539 | 341 | 539 |
| 8 | 684 | 575 | 569 | 773 | 608 | 543 |
| 9 | 724 | 450 | 501 | 671 | 646 | 742 |
| 10 | 604 | 374 | 629 | 367 | 487 | 519 |

Table: Total training cost on each product for each worker

| Worker | Seru 1 | Seru 2 | Seru 3 | Seru 4 | Seru 5 | Seru 6 |
|--------|--------|--------|--------|--------|--------|--------|
| 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2 | 1 | 0 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 1 | 0 | 0 | 0 |
| 4 | 0 | 1 | 0 | 0 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 1 |
| 6 | 1 | 0 | 0 | 0 | 0 | 0 |
| 7 | 0 | 0 | 0 | 0 | 1 | 0 |
| 8 | 0 | 0 | 0 | 0 | 0 | 1 |
| 9 | 0 | 1 | 0 | 0 | 0 | 0 |
| 10 | 0 | 0 | 0 | 1 | 0 | 0 |

Table: The adjusted worker-to-seru assignment plan

| Worker | Task 1 | Task 2 | Task 3 | Task 4 | Task 5 | Task 6 | Task 7 | Task 8 | Task 9 | Task 10 | Total Cost | |
|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---------|------------|-----|
| Seru 1 | 2 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 326 |
| 6 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 338 |
| Seru 2 | 4 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 338 |
| 9 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 344 |
| Seru 3 | 3 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 367 |
| Seru 4 | 10 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 367 |
| Seru 5 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 109 |
| 7 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 280 |
| Seru 6 | 5 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 280 |
| 8 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 280 |

Table: All feasible task-to-worker training plans

| Product type | Task 1 | Task 2 | Task 3 | Task 4 | Task 5 | Task 6 | Task 7 | Task 8 | Task 9 | Task 10 |
|--------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---------|
| Product A | 33 | 38 | 41 | 33 | 24 | 39 | 7 | 38 | 45 | 10 |
| Product B | / | 13 | / | 16 | 27 | 14 | / | 34 | 47 | 41 |
| Product C | 25 | 22 | 46 | / | 29 | / | / | 9 | / | / |
| Product D | 42 | / | 25 | 12 | 36 | 21 | 11 | 40 | 39 | 34 |
| Product E | 27 | 32 | 28 | 33 | 5 | 28 | 21 | 17 | / | 39 |
| Product F | 21 | 32 | 18 | 12 | / | 30 | 33 | 38 | 45 | 20 |

Table: The standard processing time of each task of each product type after training the worker

| Workers | Product's | | | | | | |
|---------|-----------|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | |
| 1 | | 1 | 4 | 3 | 2 | 3 | 4 |
| 2 | | 1 | 4 | 2 | 0 | 0 | 3 |
| 3 | | 0 | 2 | 4 | 3 | 3 | 4 |
| 4 | | 4 | 1 | 3 | 1 | 3 | 4 |
| 5 | | 0 | 4 | 0 | 2 | 3 | 1 |
| 6 | | 3 | 2 | 3 | 4 | 3 | 2 |
| 7 | | 1 | 1 | 1 | 4 | 3 | 1 |
| 8 | | 4 | 4 | 0 | 2 | 0 | 0 |
| 9 | | 4 | 3 | 3 | 4 | 4 | 1 |
| 10 | | 0 | 3 | 0 | 1 | 4 | 1 |

Table: The data of worker's level of skill after training the workers

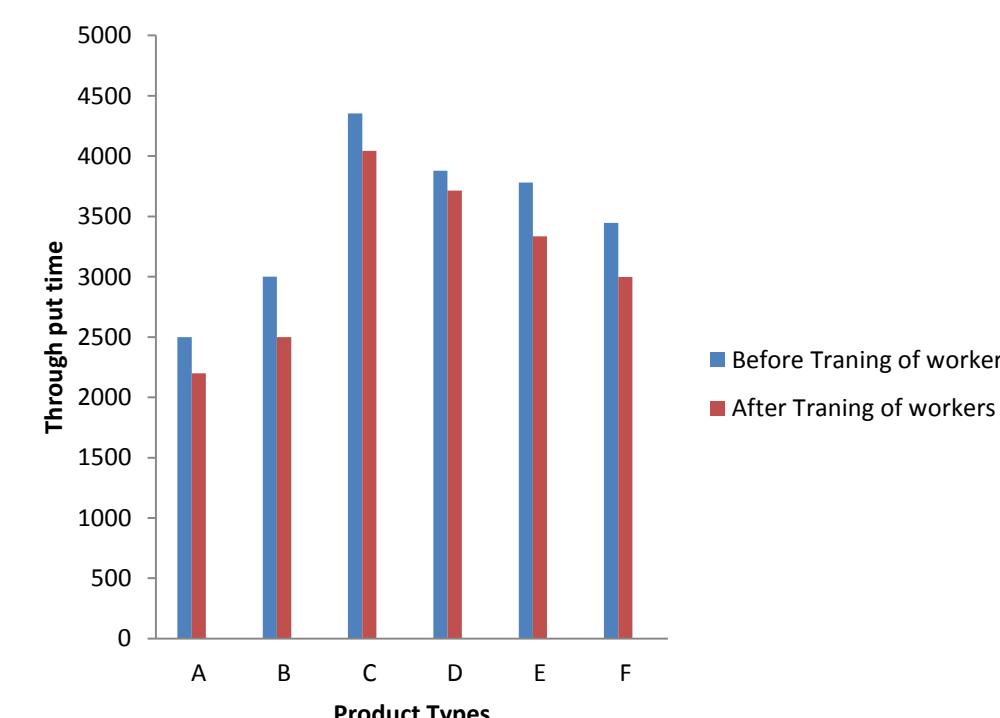


Fig.: Effect on TPT before and after training of workers.

Conclusion

Seru production systems are a new kind of manufacturing systems that initiated in Japan because of the changing market conditions which include high variety and low demand. Although we developed the model successfully, there are still many problems that need to be considered. In this paper we considered the static case but in the real world the dynamic case has to be considered. We also have to take the mental attributes like their efficiencies at different times of the day, their memory capabilities, etc. of the workers in the real time scenario. This paves the way for future research.

References

- [1] Bellgran, Monica, and Eva Kristina Säfsten. Production development: design and operation of production systems. Springer Science & Business Media, 2009.
- [2] Bulfin, R. L., and Daniel Sipper. "Production Planning, Control, and Integration." (1998).
- [3] Cochran, David S. The production system design and deployment framework. No. 1999-01-1644. SAE Technical Paper, 1999.
- [4] Bellgran, Monica, and Christer Johansson. "A method for the design of flexible assembly systems." International journal of production economics 41.1 (1995): 93-102.
- [5] Ulrich, Karl T. Product design and development. Tata McGraw-Hill Education, 2003.