International Journal of Engineering Sciences & Emerging Technologies, August 2012.
ISSN: 2231 – 6604 Volume 3, Issue 1, pp: 74-80 ©IJESET

QUANTIFYING THE TECHNICAL PERFORMANCE OF THE PROCESS IN SYSTEM ENGINEERING USING AN LPP

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ABSTRACT

Software developed in issue with the recent trends has to be modernized and a quality based. Each and every organization develops wide range of products in due with the technological innovations. The innovative methods of organizing the developed product have to be quantified at various stages in the development lifecycle of the product. This Paper proposes a novel and quantitative software readiness criteria to support objective and effective decision-making at process level. The method organizes and streamlines existing quality and reliability data into a simple metric and visualizations that are applicable across products and releases. The system performance can be quantified using evaluation criteria, technical performance measures. The performance criteria will show how the system satisfies its requirement. Evaluation criteria are often called the measures of effectiveness. This effectiveness of the complex problem can be attained by measuring the process duration (compilation time and execution time) of the product models. To meet the requirements of the product the memory allocation has to be considered during the implementation and the performance of the product is measured using an optimization technique which acts as a tool for the measures while applying system engineering in the product life cycle. System engineering plays a vital role in the development of the product lifecycle within its specified phases. An LPP namely the assignment problem is used to find the minimum time, whereas the resultant output is compared with other two LPP models.

KEYWORDS: *Evaluation criteria, Compilation time, Execution time, Memory allocation, System performance.*

I. INTRODUCTION

Systems engineering signifies a formalized approach to identify new methods and research opportunities similar to the way it occurs in other fields of engineering. Systems engineering focuses on analyzing and eliciting customer needs that are required functionality early in the development cycle, documenting requirements, then proceeding with design synthesis and system validation while considering the complete problem, the system lifecycle.

The goal of the system engineering is to support some business function or to develop a product that can be sold to generate business revenue. To accomplish the goal, a computer-based system makes use of a variety of system elements like, software, Hardware, people, database, documentation, procedures[9]. Computer programs, data structures, and related documentation that serve to affect the logical method, procedure, or control that is required. Hardware are Electronic devices that provide computing capability, the interconnectivity devices (e.g., network switches, telecommunications devices) that enable the flow of data, and electromechanical devices (e.g., sensors, motors, pumps)

that provide external world function. People are the Users and operators of hardware and software .Database are large, organized collection of information that is accessed via software.
Documentation is the descriptive information (e.g., hardcopy manuals, on-line help files, Web sites) that portrays the use and/or operation of the system. Procedures involve the steps that define the specific use of each system element or the procedural context in which the system resides. The elements combine in a variety of ways to transform information. For example, a marketing department transforms raw sales data into a profile of the typical purchaser of a product; a robot transforms a command file containing specific instructions into a set of control signals that cause some specific physical action. Creating an information system to assist the marketing department and control software to support the robot both require system engineering [1].

II. SOFTWARE AND SYSTEM ENGINEERING

Software engineering has helped shape modern systems engineering practice. The techniques used in the handling of complexes of large software-intensive systems has had a major effect on the shaping and reshaping of the tools, methods and processes of SE. The integration has been done in models [2].
Systems engineering is an interdisciplinary approach and means to enable the realization of successful systems. It focuses on defining customer needs and required functionality early in the development cycle, documenting requirements, then proceeding with design synthesis and system validation while considering the complete problem with operations, cost & schedule, performance, training & support, test, disposal and manufacturing [3].
Systems engineering with assistance from the other engineering disciplines establishes the baseline system design; allocates system requirements; establishes measures of effectiveness for ranking alternative designs; and integrates the design among the design disciplines. Systems engineering is responsible for verifying that the system developed meets all requirements defined in the system specification and for providing the analysis which assures that all requirements will be met.
SwSE begins after the system requirements have been partitioned into hardware and software subsystems. SwSE establishes the baseline for all project software development. Like software engineering, it is both a technical and a management process. The SwSE technical process is the analytical effort necessary to transform user operational needs [4].
A software system is described as Software system requirements and design specifications. Also Provides Necessary procedures to verify, test, and accept the finished software product. They also have, the necessary documentation to use, operate, and maintain it. SwSE is not a job description. It is a process that many people and organizations perform: system engineers, managers, software engineers, programmers, and – not to be ignored – acquirers and users [5].

III. THE PROCESS

A system engineering process is a process for applying systems engineering techniques to the development of all kinds of systems. Systems engineering processes are related to the stages in a system life cycle. The systems engineering process usually begins at an early stage of the system life cycle and at the very beginning of a project [6]
The purpose of system engineer is to produce system that satisfy the customer's need, increase the probability of the system success, reduce risk and reduce total life cycle cost.
The systems engineering process can be decomposed into,

(1) Systems Engineering Technical Process,
(2) Systems Engineering Management Process

The goal of the Management Process is to organize the technical effort in the lifecycle, while the Technical Process includes assessing available information, defining effectiveness measures, to create a behavior model, create a structure model, perform trade-off analysis, and create sequential build & test plan [2].
Depending on their application, although there are several models that are used in the industry, all of them aim to identify the relation between the various stages mentioned above and incorporate feedback. Examples of such models include the Waterfall model and the VEE model. The system lifecycle in systems engineering is an examination of a system or proposed system that addresses all

phases of its existence to include system design and development, production and/or construction, distribution, operation, maintenance and support, retirement, phase-out and disposal.

IV. OPERATION RESEARCH IN SYSTEM ENGINEERING

Operations research supports systems engineering. The tools of operations research are used in systems analysis, decision making, and trade studies which highlights the role systems engineering plays in complex projects. An Heuristic approach which will optimize the complex problems through various techniques. These techniques and methods leads to feasible solution through LPPs. There are various methods through which optimal solution can be obtained. Like, Least cost method, North west corner rule, Traveling sales person problem.

Operations research, briefly, is concerned with the optimization of a process under multiple constraints. This paper takes into consideration the optimization technique – assignment problem, which helps to have minimal time period and can achieve an approximate solution which is responsible for preparing a decision making system. This decision can be applied to complex programs. It is taken into consideration that constraints at various levels [10].

V. THE ASSIGNMENT PROBLEM

The simple assignment problem helps to optimize, reduce the cost and helps to identify the minimum compilation time and execution time of the product. On the basis of the output, the product will be identified to be an optimized. This will help the software organization to identify the minimum cost of the product and cost taken to complete the process.

An assignment problem is a special type of linear programming problem where the objective is to minimize the cost or time of completing a number of jobs by a number of persons [7].

Assigning modules to programmers as $J_1, J_2, \ldots, J_n$ are the jobs scheduled for the persons $I_1, I_2, \ldots, I_n$.

Table 1: Assigning Jobs

	Jobs			
Persons	j_1	j_2	------	j_n
I_1	X_{11}	X_{12}	-----	X_{1n}
I_2	X_{21}	X_{22}	-----	X_{2n}
---	-----	----	-----	-----
I_n	-----	----	-----	X_{nn}

C_{ij} is the cost of performing j_{th} job by i_{th} worker. X_{ij} is the number i_{th} individual assigned to j_{th} job.

$$\text{Total cost} = X_{11} * C_{11} + X_{12} * C_{12} + \ldots + X_{12} * C_{nn} \quad (1)$$

Mathematically the assignment problem can be expressed as

The objective function is

$$\text{Minimize } C_{11}X_{11} + C_{12}X_{12} + \text{-------} + C_{nn}X_{nn}. \quad (2)$$

This can also be written as:

$$Z = \sum_{i=1}^{n} \sum_{j=1}^{n} C_{ij} X_{ij} \quad (3)$$

Subject to the constraints

$$\sum_{j=1}^{n} X_{ij} = 1 \text{ for all i (resources availability)} \quad (4)$$

$$\sum_{i=1}^{n} X_{ij} = 1 \text{ for all i (activity requirement)} \quad (5)$$

and $X_{ij} = 0$ or 1, for all i to activity j.

5.1 Assignment problem in the software process

Assignment problem is a special type of transportation problem in which numbers of supply and demand nodes are equal. Here in the process we literally, take into consideration the memory space allocated to each program, the compilation time and the execution time. Modules present in the process will have line of instructions Supply from every supply node is one. Every module can be interconnected. Every demand node has a demand for one. Solution is required to be all integers [7]. Table2. Shows Number of Modules (Jobs) versus Lines of code (Demand) which is executed. The Fig.1depicts the general distribution if jobs over modules

Table 2. Assigning jobs Vs modules

Number of Modules (jobs)	**Number of lines of code (demand)**			
	1	2	3	a_i
1	25	67	123	1
2	54	58	120	1
3	45	103	84	1
b_j	1	1	1	

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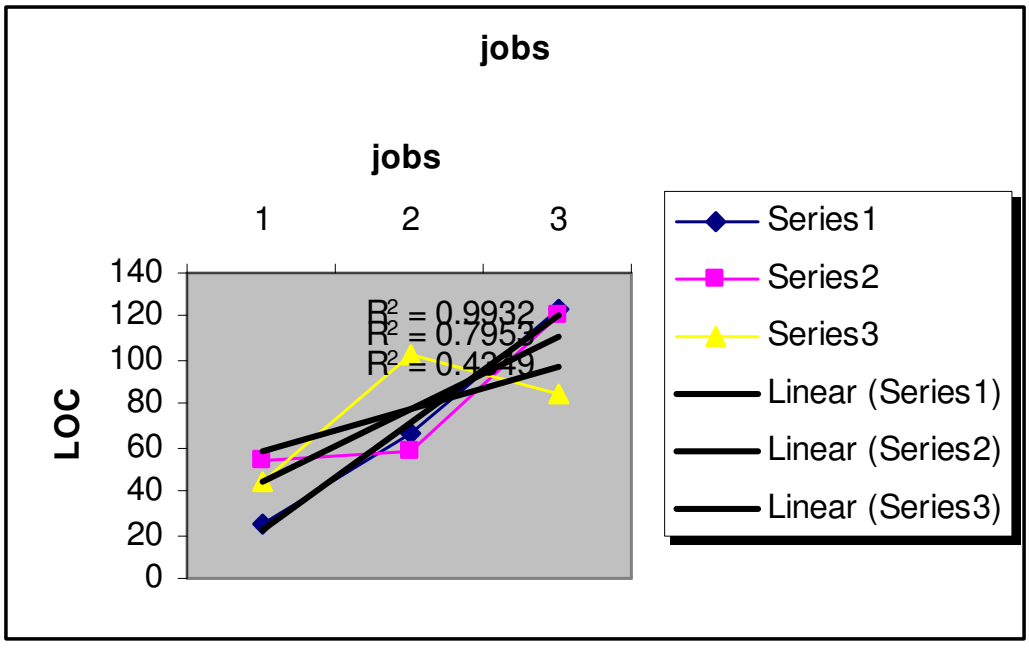

Figure 1: Job Analysis

The squared value of the series3 is minimal and can be evaluated according to the number of codes executed by the programmer and with the specified modules.

5.2 Evaluation of Compilation Time

The time taken to execute the set of instructions of the product on basis of design is the compilation time of the developed product. Each module is tested for its compilation time so that the time for executing the code of instructions is noted. All the modules are integrated and the total product is tested and validates with its design, compilation and execution time.

5.2.1 The compilation time:

The period of time during which a program's source code is being translated into executable code, as supposed to run time when the program is being executed. As well as the work done by the compiler, this may include macro preprocessing as done by cpp. For example, the final stage of program construction, performed by the linker, would generally also be classed as compile time but might be distinguished as link time.
For example, static data in a C program is allocated at compile time whereas non-static data is allocated at run time, probably on the stack

5.2.2 The Execution time:

Runtime is when a program is running or being executable. That is, when you start a program running in a computer, it is runtime for that program. In some programming languages, certain reusable programs or "routines" are built and packaged as a "runtime library." These routines can be linked to and used by any program when it is running.

5.2.3Memory Allocation of the assignment problem:

A sample program which performs the assignment problem in a particular machine is shown in Table.3. It also indicates the total memory occupied by the program in Table 3.

Table 3: Single Output

Machine	Memory allocation (kbs)	Execution speed (ms)	output
1	200176	58000	41

The Single output of a product developed has been executed in java programming language thro series of iterations and ranking. Output for the product developed through the problem is 41, 200176 and 58000ms as value, memory allocation and performance of the developed product respectively.

Table 4: .Cotmpared Output

Programmer	Memory allocation (kbs)	Execution speed (ms)	Output	Optimized result
1	143168	50812	37	1
2	221488	46328	878	3
3	224248	25250	80	1

The outputs from three different processes have been depicted. The three different programmers design the same process with different lines of code. The above Table 4 shows the resultant optimized output using LPP, produced by programmer 1 and 3 are optimal. While the second programmer has high value also depicted through the graph below in Fig .2.

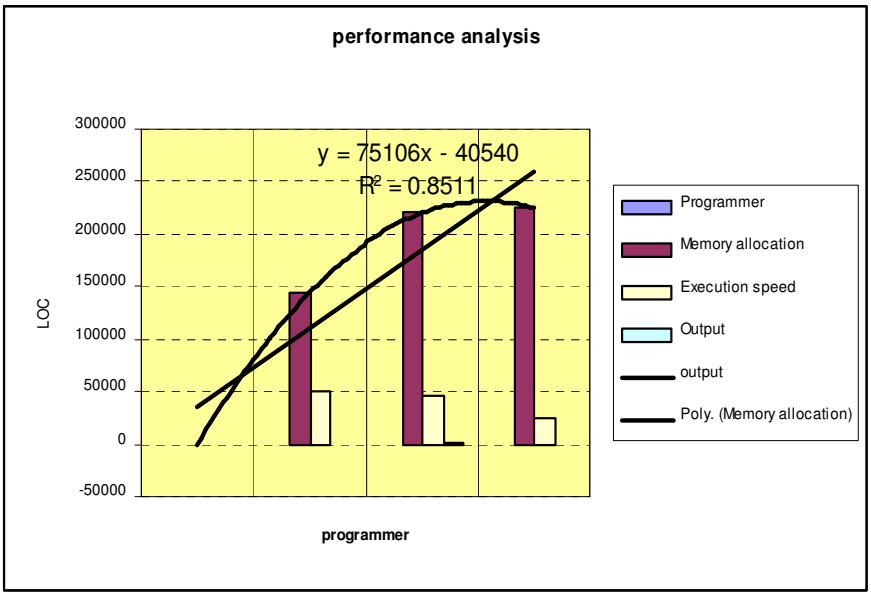

Figure 2: Performance Analysis

All the three program run through the assignment problem shows that first and third has least using mode. The squared value is always less than 1, which will help in optimizing the process performance of the product.

By using the above set of result, this can be run over huge complex problems and process. This will help us to have an optimum value for the process. So the cost of the software product may vary accordingly. The Fig. 3, shows the program result executed in java programming language.

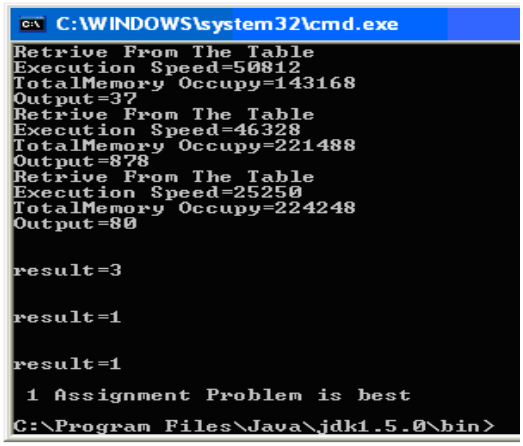

Figure 3: Compared Output

VI. RESULTS AND DISCUSSION

The table 1 Shows the single programmer's output using least cost method, has the performance calculated in milliseconds, the product 's memory size and the total value of the product being executed. Whereas Table 2. shows the compared resultant value of the two LPPs, to prove the better the result.

Also, the Fig.3 has the performance analysis of the programmer versus the number of lines of code executed in various stages. The Linear growth of the performance also measures to be minimal for the product evaluated using assignment problem. Therefore, assignment problem can be employed as a tool of optimization in the product development while using system engineering to quantify the developed product.

VII. CONCLUSION

The paper proposes a new idea for the software developers through the process of system engineering phases. An application of optimizing technique has given a best solution to find the minimum compilation and execution time by making a decision, on applying assignment problem. Applied for three process, the squared value of each is compared with themselves .Also, shows that application of assignment problem to compare the above said time is possible. Therefore a software process can be identified to have minimum cost on the basis of execution and compilation time.

This work can be further carried on with other optimization tools. Process which plays a vital role in the development of the product life cycle has been discussed and the results have been carried out. They may also be applied to various phases of the system lifecycle to reevaluate each phase accordingly.

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