System Level Costs

WHAT IS SYSTEM LEVEL COST?

The System Level Cost (SLC) feature was first incorporated into SEER-H with release 6.0. Prior to that release, SEER-H estimated standalone costs of individual work elements plus the costs of creating suitable interfaces between work elements, referring to such mechanical actions as attaching, aligning, calibrating, adjusting, etc., and electronic actions such as energizing, tuning, continuity checking, calibrating, etc. It did not estimate the sometimes substantial costs of making a group of work elements perform properly as a complete system. The SLC feature permits more complete estimates to be made and is a powerful augmentation of SEER-H. The model for system level costs in SEER-H is based on NAFCOM, an extensive database of aerospace contractor cost information used by NASA and other government agencies.

Use of the feature is optional, and you must judge when it should be applied. Not every situation warrants it. This help section and the section titled When to Use System Level Cost will help you identify the appropriate situations for using it.

We have called this feature system level cost because we believe that is the most appropriate name for it, given common industrial practice. Unfortunately, there is considerable ambiguity surrounding the word system. Especially vague is the distinction between the terms system versus subsystem. People use these terms in many, often conflicting ways. To keep SEER-H users out of this semantic trap, we have created special definitions, as discussed below.

To understand SLC in SEER-H it is first necessary to understand how the term system is defined and used in SEER-H. The notion of a system is inherently confusing because of our generally casual use of that word. One engineer's system may be thought of by another engineer as a subsystem. In particular, a subcontractor may have good reason to consider his product a system, while the prime contractor may have equally good reason to designate it a subsystem. Other terms of art that may contribute to the confusion are:

- Part
- Component
- Subassembly
- Assembly
- Unit
- Group
- Set

In SEER-H we strive to avoid confusion by carefully defining and using only three terms that pertain to functional groupings. They are:

- Work Element
- Subsystem
- System

SLC is an optional feature of SEER-H. You only need to use it if you want to add system level estimates to your subsystem costs.

In SEER-H SLC is the cost incurred to satisfactorily answer the following questions:

- Is the entire system configured according to plan and does it work as designed?
- Does the system work as designed with respect to cooperating systems and its mission?

SLC relates to effort, including both labor and material as appropriate, required to assure a satisfactory answer to these questions. Generally, this effort can be described under one or more of the following five SLC categories that are defined in SEER-H:

- System Engineering and Integration
- Integration, Assembly and Test
- System Program Management
- System Test Operations
- System Support Equipment

SLC may not in every case include all five of the above cost categories. SEER-H enables you to designate only the ones that apply.

SLC can be applied only at rollup work elements. If you decide to add SLC to a collection of work elements, be sure that all of those work elements are children of the same rollup work element. Also note that if you designate a given rollup element as an SLC element, it will calculate SLC based on all of the work elements beneath it. Any work element that is not part of the system you want to designate should not be in any work element branch under that rollup. If you expect to designate any rollup as system level, you should plan ahead to be sure that the work elements under it are those, and only those, that comprise the system.

SEER-H does not directly estimate software costs, but software costs, if any, must be included under a system level rollup in order to get accurate SLC results. Software costs are most conveniently added to SEER-H by using the Add-in work element type. Software costs can be estimated using the SEER-SEM tool.

Definition: System Level Costs

Optional costs you may add at any rollup work element to reflect system level project activity above and beyond subsystem level activities.

Definition: System

In any good dictionary, one can find five or more definitions of *system*. Some of the definitions are similar to the definitions given for *collection* or *group*. They do not emphasize the *purposefulness* of a system. In SEER-H, a project work file generally is created to estimate and assemble costs for one or more *purposeful* collections of work elements. A dictionary definition that accomplishes this fairly well is: *"Orderly combination or arrangement, as of parts or elements, into a whole; specifically, such combination according to some rational principle; any methodical arrangement of parts."*

Even better from the standpoint of industry is this definition: *"Combination of several subsystems, sets, etc. which work together to perform one or more operational functions."* Commonly in industry a system has several or all of the following aspects, not all of which are necessarily unique to systems:

- The components of a system may be physically separated. They are not necessarily all collocated as a single assembly. Subsystems, on the other hand, are generally visualized as comprising collocated elements.
- A system typically includes the support equipment that "touches" it. For example, an aircraft system is generally thought to include its ground support equipment.
- A system typically does not include the infrastructure that "supports" it. Roads, pipelines, utilities, etc., may

be thought of as systems in themselves, but the industrial systems they support are generally not thought to include them.
- Generally a system can be characterized in terms of the mission (unique human purpose) it is designed to accomplish. For example, the mission of a launch vehicle is to transport objects into space.
- The mission associated with a system is not trivial and it is not merely a state of being.
- Multiple systems can operate cooperatively to form a system of systems that performs a sequence or set of collaborative missions. Example of cooperating systems:
  - Launch vehicle (system) -- Transport a spacecraft into space
  - Spacecraft (system) -- Operate in space to accomplish certain objectives
  - Ground station (system) -- Collect information from one or more spacecraft for human use

Definition: SEI

SEI. System engineering and integration (SEI) is an optional element of **system level costs**. SEI in development and in production includes at the system level:

- Translation of operational needs into system requirements
- Specification of system configurations that can meet the needs
- System optimization
- Planning, monitoring, measuring and directing the overall technical program, including:
- Cost/performance tradeoffs
- Support of engineering changes
- Selection of technologies, including trade studies.
- Safety, reliability and quality assurance engineering
- Logistics engineering
- Creation and maintenance of interface control documents

Excluded are all of the above functions at the subsystem level.

Definition: IAT

IAT. Integration, assembly and test (IAT) is an optional element of **system level costs**. IAT in development and in production includes at the system level:

- Integration, Assembly & Test in development at the system level includes labor and material for integration, assembly and test of major test articles
- Integration, Assembly & Test in production at the system level includes:
- Labor and material required to accomplish final assembly of all subsystems into a complete system
- Design and manufacture of installation hardware
- Final factory acceptance operations
- Packaging, crating and shipping operations
- Excluded is engineering effort related to IAT, which is covered under SEI, and all of the above functions at the subsystem level.

Definition: SPM

SPM. System program management (SPM) is an optional element of **system level costs**. SPM in development and in production includes at the system level:

- Effort required for management direction and decision making to ensure that a product is developed, produced and delivered
- Includes direct charges for program administration and the management

of all functions associated with engineering, manufacturing, support, quality assurance, configuration and project control, and documentation

Excluded are all of the above functions at the subsystem level.

Definition: STO

STO. System test operations (STO) is an optional element of **system level costs**. STO in development includes at the system level:

- All test planning and scheduling, testing, and data reduction and reporting for development testing, qualification testing, and any testing to determine the compatibility with the overall system and its intended operational parameters
- This includes operational tests, design verification tests and reliability tests
- It also includes testing to verify acceptability for required mission performance
- These tests are performed on hardware that has been produced, inspected, and assembled in accordance with final design requirements
- Included are design and fabrication of test fixtures needed for the tests

Excluded are all of the above functions at the subsystem level.

Definition: SSE

SSE. System support equipment (SSE) is an optional element of **system level costs**. SSE in development includes at the system level:

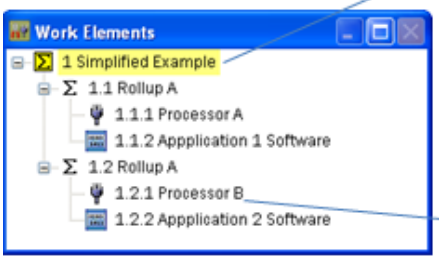
- Labor and material required to design, develop, manufacture, procure, assemble, test, and deliver equipment necessary for system level final assembly and test
- Equipment utilized for integrated and/or electrical checkout, handling, protection, transportation, and calibration, and items such as conversion kits, work stands, equipment racks, trailers, fueling, cryogenic and gas supply equipment, and miscellaneous equipment of all types.

Excluded are all of the above at the subsystem level.

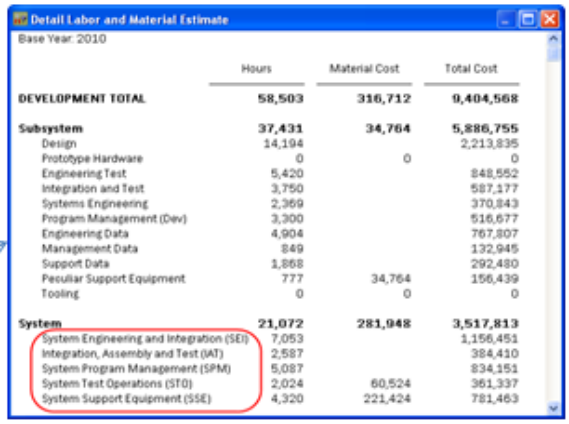
HOW ARE COSTS REPORTED IN DETAIL LABOR AND MATERIAL ESTIMATE?

Example 1:

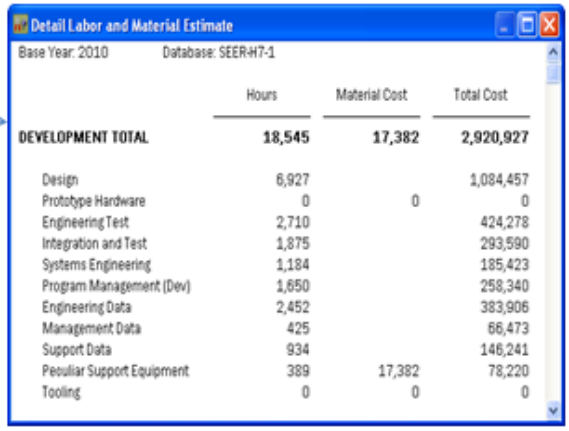
Subsystem level Costs for children elements are summed up at parent rollups (Rollup A, B and Simplified Example) .
System Level Costs are computed at rollups when SLC is turned on (indicated by a yellow highlighted icon).



Subsystem level Costs are estimated at every non-rollup elements (Processor A, B and App 1, 2 Software) .



	Hours	Material Cost	Total Cost
DEVELOPMENT TOTAL	**58,503**	**316,712**	**9,404,568**
Subsystem	**37,431**	**34,764**	**5,886,755**
Design	14,194		2,213,835
Prototype Hardware	0	0	0
Engineering Test	5,420		848,552
Integration and Test	3,750		587,177
Systems Engineering	2,369		370,843
Program Management (Dev)	3,300		516,677
Engineering Data	4,904		767,807
Management Data	849		132,945
Support Data	1,868		292,480
Peculiar Support Equipment	777	34,764	156,439
Tooling	0	0	0
System	**21,072**	**281,948**	**3,517,813**
System Engineering and Integration (SEI)	7,053		1,156,451
Integration, Assembly and Test (IAT)	2,587		384,410
System Program Management (SPM)	5,087		834,151
System Test Operations (STO)	2,024	60,524	361,337
System Support Equipment (SSE)	4,320	221,424	781,463



	Hours	Material Cost	Total Cost
DEVELOPMENT TOTAL	**18,545**	**17,382**	**2,920,927**
Design	6,927		1,084,457
Prototype Hardware	0	0	0
Engineering Test	2,710		424,278
Integration and Test	1,875		293,590
Systems Engineering	1,184		185,423
Program Management (Dev)	1,650		258,340
Engineering Data	2,452		383,906
Management Data	425		66,473
Support Data	934		146,241
Peculiar Support Equipment	389	17,382	78,220
Tooling	0	0	0

At 1. Simplified Example,

Subsystem Level Costs reported are the sum of Subsystem Level Costs from Rollup A and Rollup B.

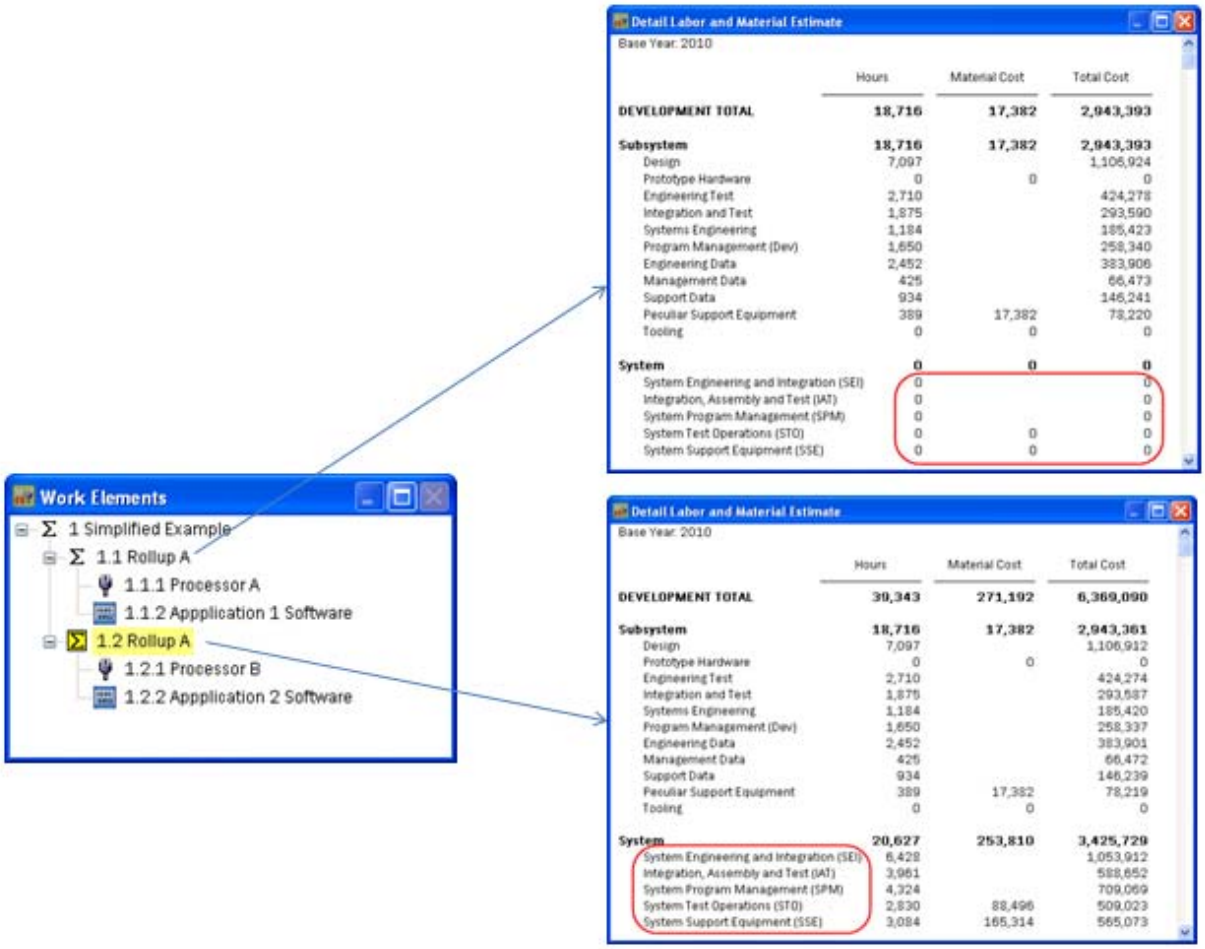
System Level Costs are computed at this level; based on all of the elements beneath it. (i.e. Rollup A, Processor A, Application 1 Software, Rollup B, Processor B, Application 2 Software)

At 1.1 Rollup A (or 1.2 Rollup B)

Subsystem Level Costs reported are the sum of Subsystem Level Costs from Processor A (or B) and Application 1 (or 2) Software.

System Level Costs are not computed at this level.

Example 2:



At 1. Simplified Example,

Subsystem Level Costs reported are the sum of Subsystem Level Costs from Rollup A and Rollup B.

System Level Costs is rolled up from Rollup B.

At 1.1 Rollup A

Subsystem Level Costs reported are the sum of Subsystem Level Costs from Processor A and Application 1 Software.

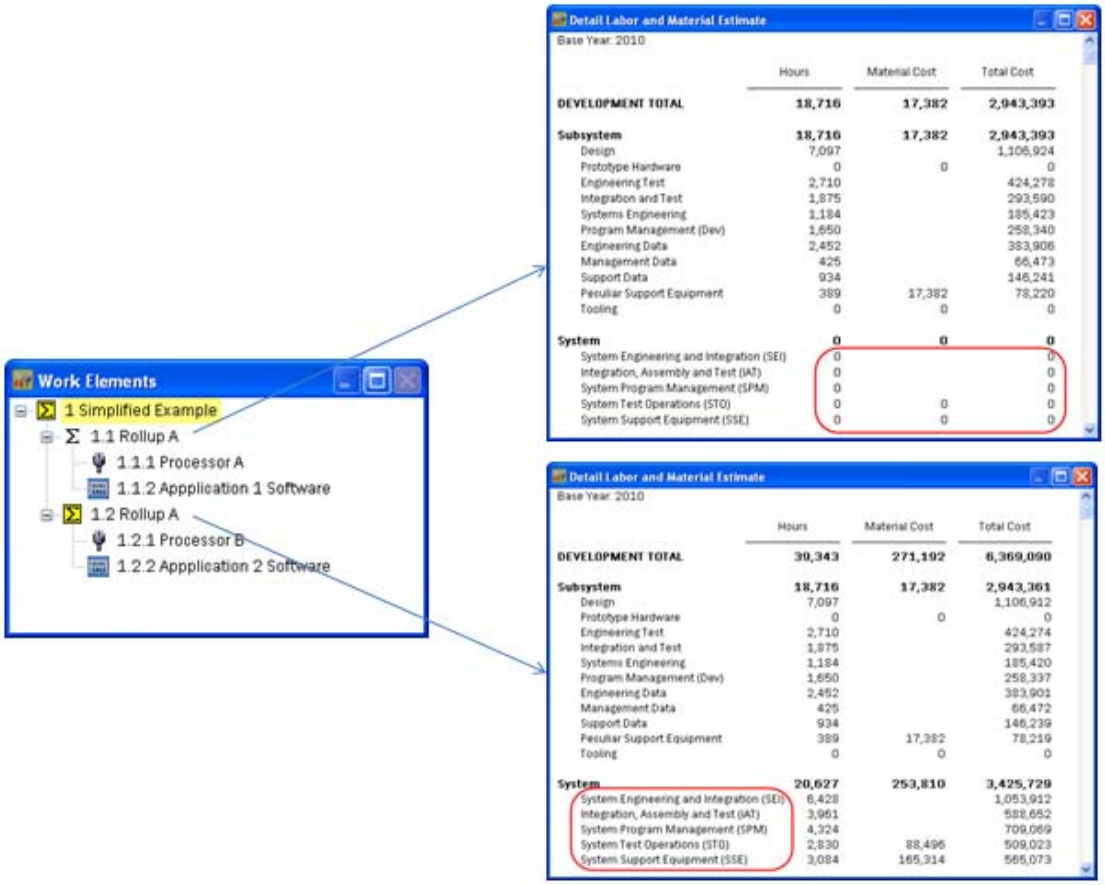
System Level Costs are not computed at this level.

At 1.1 Rollup B

Subsystem Level Costs reported are the sum of Subsystem Level Costs from Processor B and Application 2 Software.

System Level Costs are computed at this level; based on all of the elements beneath it. (i.e. Processor B and Application 2 Software)

Example 3:



At 1. Simplified Example,

Subsystem Level Costs reported are the sum of Subsystem Level Costs from Rollup A and Rollup B.

System Level Costs are the sum of SLC computed at this level and those rolled up from Rollup B.

At 1.1 Rollup A

Subsystem Level Costs reported are the sum of Subsystem Level Costs from Processor A and Application 1 Software.

System Level Costs are not computed at this level.

At 1.1 Rollup B

Subsystem Level Costs reported are the sum of Subsystem Level Costs from Processor B and Application 2 Software.

System Level Costs are computed at this level; based on all of the elements beneath it. (i.e. Processor B and Application 2 Software)