

LCA PIX MODULE

MANUAL

Version 2.0

U.S. Patent Number 6

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Part



1 Introduction

1.1 What is LCAPIX?

The LCA Life Cycle Index Module (PIX) consists of

1. LCAPIX Application and Database
2. Online help and support
3. A Printed Manual

The objective of the LCA-PIX Module is:

- to provide a stand-alone application to analyze processes and determine environmental load centers.
- Develop a comprehensive database for relevant process information in an easily storable, exchangeable, and evaluative format.
- To assist in achieving ISO/RC/4000 Certification using Life Cycle Assessment

1.2 System Requirements

For stand-alone applications of the LCA-PIX Module:

- A PC with 300 mHz or greater
- Microsoft Excel
- Windows 98 or higher
- 64 MB RAM or more
- 40 MB Total Hard Disk Space

1.3 Installation

For Standalone Installation

- The database is installed on the local workstation

For Networked Version

- The database is installed to a server

Part



2 Life Cycle Analysis

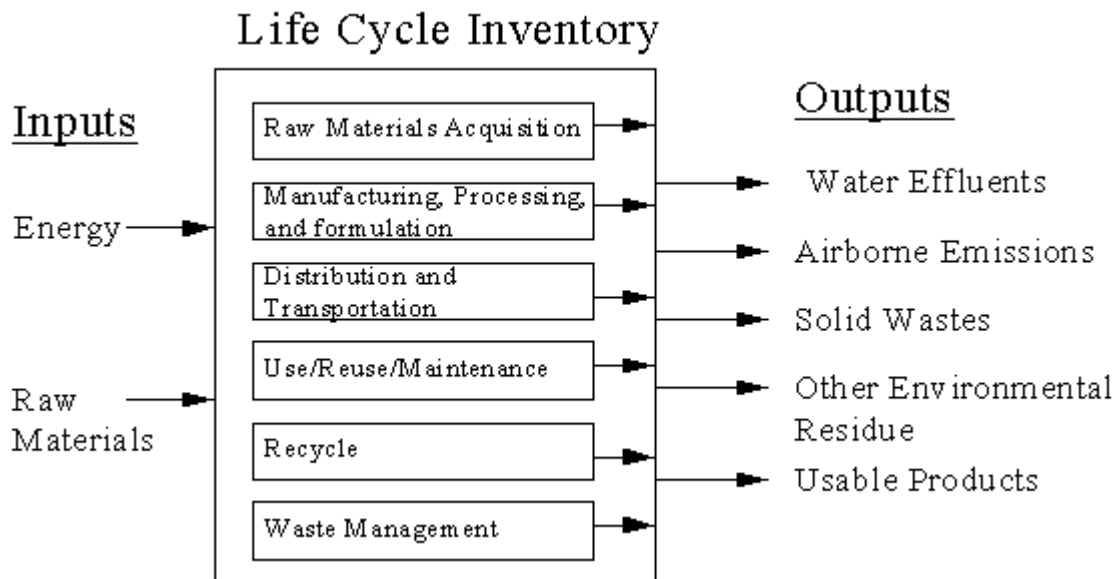
2.1 Overview

2.1.1 Introduction to the Life Cycle Assessment/Analysis Concepts

Life Cycle Assessment/Analysis: LCA can be defined as an objective process to evaluate the environmental burdens associated with a product, process, or activity by identifying and quantifying energy and materials used as well as wastes released to the environment. LCA includes the assessment of the impact of energy and material balances and the release of wastes to assist in determining environmental improvements. The assessment includes the entire life cycle of the product, process, or activity, and encompasses the extraction and processing of raw materials, manufacturing, transportation and distribution, use, reuse, maintenance, recycling, and final disposal.

Figure 1 illustrates the major components of a Life Cycle Analysis. Before LCA Inventory can be undertaken, the scope and the system boundaries of the study must be decided. The major aspects that come under the domain of LCA would then be the inputs, outputs, and various processes and activities within the system boundary.

Figure 1: Major Elements of a Life Cycle Assessment/Analysis.



A complete Life Cycle Assessment/Analysis consists of the following three stages.

Inventory Analysis: an objective quantification of the raw materials, energy requirement, air/water effluent's, solid wastes, manufacturing, processing, formulation, distribution and transportation, use/reuse/maintenance, recycling, and other processes and activities in a previously defined system boundary. The LCA Inventory should be scientifically based, quantitative, appropriately detailed, replaceable, comprehensive, broadly applicable, consistent, and peer-reviewed.

Impact Assessment: is the stage where the Inventory is analyzed for its effect on the environment and includes the following steps:

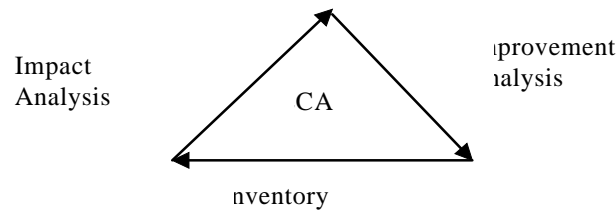
- **Classification:** the definition of the inventoried elements
- **Characterization:** analysis and quantification
- **Valuation:** how the data of different specific categories are weighted and compared for further

interpretation

Improvement Assessment: is the systematic evaluation of the needs and opportunities to reduce the environmental burden. This may involve changes in the product design, raw material use, processing, waste management, etc.

The third stage, Improvement Assessment is not the end of the Life Cycle Analysis, but leads back to the Life Cycle Inventory Stage in a Continuous Improvement-like loop. This relationship (the SETAC triangle) is shown in Figure 2.

Figure 2: SETAC triangle illustrating the continuous improvement nature of LCA.



2.1.2 Valuation Methods and the Environmental Priority Strategy Method

The methodology for conducting the LCA Inventory is common to all systems. However, there are many methods for performing the valuation in the Impact Assessment stage. As the various valuation methods are based on different factors for calculating environmental burdens, and do not have the same baseline for assigning values, comparison between various systems is difficult. It is thus preferable to select one valuation system and express all results in it. Subsequent analysis can be performed by comparing valuations.

EPS Methodology: This method is based on minimizing the environmental burden in terms of Natural Resources, Biodiversity, Production, Human Health, and Aesthetic Values. It assigns burdens in Environmental Load Units (ELU). It consists of the following steps:

- Determine a value based on the effects on or changes to the environment. The value assigned to each material or process is called the Environmental Load Unit (ELU).
- Estimate the contribution to a certain resource depletion, emission, or other activity which contributes to the value of the change in the environment.
- Sum all the ELU's to determine the total Environmental Load Index.

Other Valuation Methods are as follows:

- The **Tellus Method** which is based on reducing costs to protect human health
- The **Ecological Scarcity Method** which is based on reducing each emission to the environment
- The **Environmental Theme Method** which is based on evaluating the environmental burden associated with resources depletion

Part



3 LCA Process Index Module

3.1 Capabilities and Applications

The Process Index Module (PIX) can be used for a variety of tasks including the following:

1. It can be used to compare the environmental impacts of various process options. For example, to compare spray painting vs. powder coating, we can first perform the evaluation for spray painting and then change the painting option to powder coating.
2. We can also use the program to determine the distribution of a resource (e.g. electrical energy) among various processes and sub processes.
3. We can compare the environmental loads for a process at various plants by determining the driver factors for each plant and performing calculations based on plant-specific driver factors.
4. We can compare total environmental load of various product categories and analyze them across various plants.
5. We can build hypothetical or real products, processes, services or even manufacturing plants by using the elemental component process library.
6. We can make geographic specific comparisons of various hypothetical or real products by using plant-specific data and the elemental component process library.
7. It can be used to create a better documented, easily accessible, and more easily comparable storehouse of knowledge.

3.2 LCA Process Index (PIX) Module

The LCA Designer Tool is based on the framework of LCA as recommended by SETAC. It incorporates the 1st two steps of the LCA triangle (Figure 2), i.e., Inventory and Impact Analysis. The Inventory is organized based on processes, elemental components and substances, while the Impact analysis is performed in two steps. First is the **Determination** stage in which the specifications of the product being analyzed are specified, and next is the **Valuation** stage in which the actual calculations to determine the Environment Impact are executed.

3.2.1 Overview, General Concepts and Nomenclature

This section introduces the general methodology of performing an analysis in the LCAPIX Module. The steps of the analysis follow the SETAC methodology (see Introduction to the Life Cycle Assessment/Analysis Concepts) in which first an Inventory is completed, and then during the Impact Analysis Stage the Environmental Impact for all the items in the inventory is determined.

In the Inventory stage, a detailed list of everything that goes into the plant (*e.g. raw materials, energy*), what happens to things inside the plant (*production processes that consume raw materials like welding rods, lubricating oils*), what comes out of the plant excluding the final product (*e.g. gases emitted during production, liquid effluent's, scrap*), how things get to and from the plant (*e.g., transportation by trucks, railroad*), and any other aspect of interest is tabulated.

In the Impact Analysis Stage all the items of the inventory, e.g. metals used in the construction of the product, or gases that are emitted during the production of the product, or energy used in manufacturing processes, are assigned a numerical value indicating impact on the environment. The magnitude of this numerical value depends on the Valuation Method (see Valuation Methods and the Environmental Priority Strategy Method) chosen. Then based on this numerical value (say, for

copper used as a raw material = 28.7 ELU/kg in the EPS methodology as shown in Table 1) and the amount of the inventory item (say, 10 kg of copper is used to make a widget), the total environmental impact of copper can be calculated (28.7 ELU/kg X 10 kg = 287 ELU). **The most important underlying concept in the valuation methods different inventory amount units (e.g., m, m³, km, kg) are reduced to a single consistent unit (ELU in the copper case) so that they can all be compared, added, or analyzed in some other way.** The summation of these numerical values, in a single consistent unit, for all the items in the inventory of a product gives the total Environmental Impact of the product.

Environmental Loads for one unit of Load Category-Substance					
Load Category	Substance	Units	EPS Valuation Method (ELU)	Valuation Method 2	Valuation Method n
Material Non-Ferrous	Copper	kg	28.7	---	---
Energy	Oil	MJ	0.4	---	---

Table 1: Example of the data, and its format, available in various Valuation Methods (also see Valuation Methods and the Environmental Priority Strategy Method).

Let us now see how the LCAPIX Module helps us in getting the Environmental Impact for a product.

3.2.1.1 Processes Hierarchy of a Product and the Baseline Processes

The LCAPIX Module organizes the inventory based on processes as shown in Figure 3.

Figure 3 below.

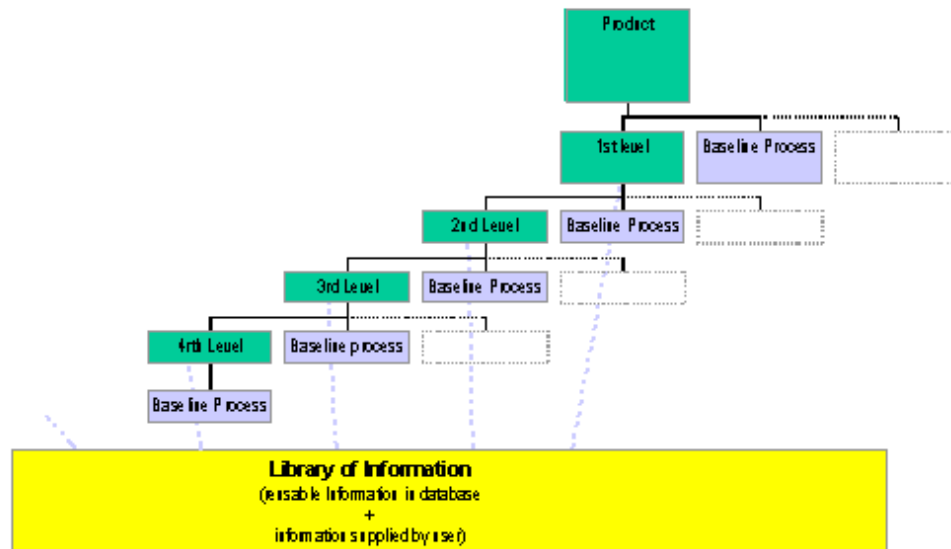


Figure 4: Process Hierarchy for a Product. It can have a maximum depth of 5. The Baseline Process is the lowest level process for each branch and can be at any level of the hierarchy.

The approach followed in the LCAPIX Module to define the inventory is shown in Figure 4. The manufacture of any product can generally be broken down into a set of major processes called the 1st level processes (or in LCAPIX named Machine/Line Process for identification purposes only). It is possible, but not necessary, that some of the 1st level process can be further broken down into 2nd level processes (or sub-processes), and further into 3rd level, and so on.

Note: The definition of this Process Hierarchy is completely under the control of the user, and should be used to represent the manufacturing process of the product in a manner (using breadth and depth) that best reflects the new process hierarchy for their product. But it is advised that users planning to exchange information for a certain product category adopt a common nomenclature for the processes involved in making that product in order to facilitate the exchange of data amongst each other.

There is no limit to the number of processes that can be defined at any level (i.e. unlimited breadth at each level) but the maximum depth allowed for a product is 5, i.e. processes can be defined till the 5th level. It can be readily seen that some processes will be 1 level deep, some 2 levels deep, with a maximum depth of 5. The deepest process of any branch, no matter at what level n the branch stops (implying that the branch is not composed of processes at level $n+1$) is defined as the **Baseline Process**. It can easily be seen from Figure 4 that the deepest level (4th is deeper than 3rd level) process for every branch of the Process Hierarchy is always a Baseline Process. **Every Machine/Line, or sub process, or operation, or task can be expressed as a combination of these Baseline Processes. Even the product is just a combination of all the Baseline**

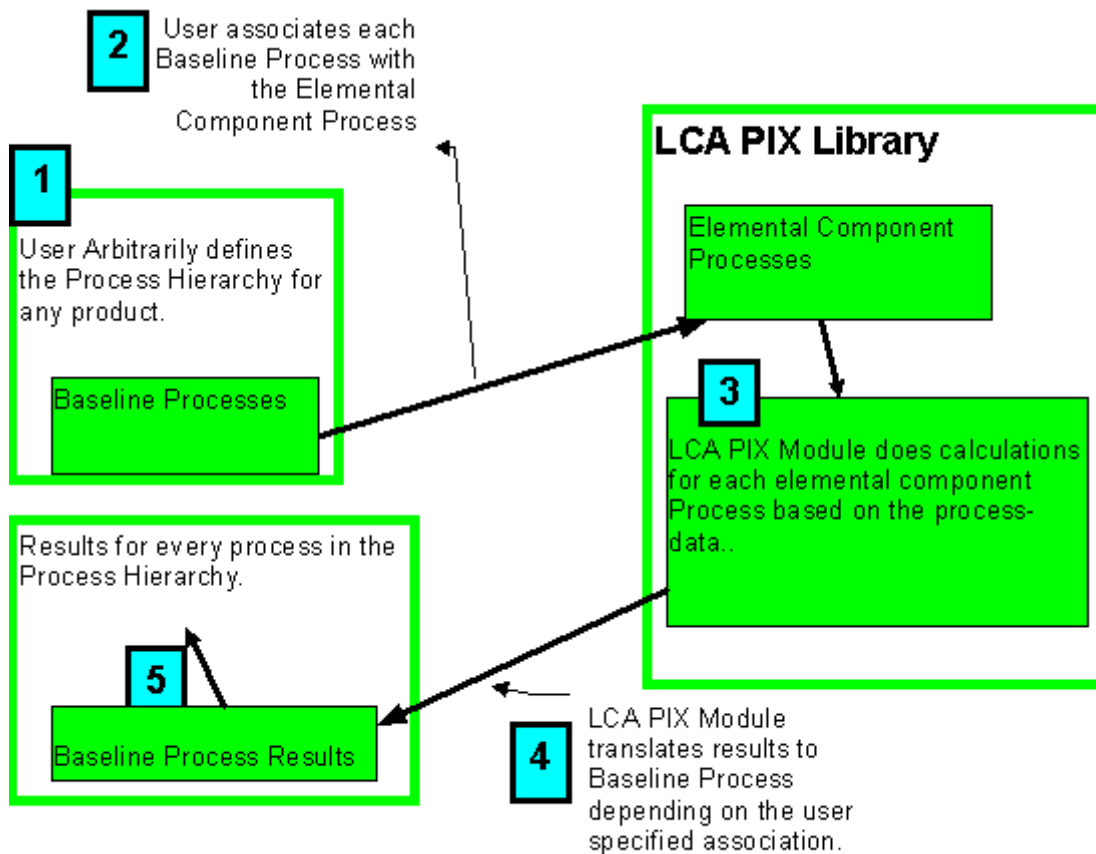
Processes.

3.2.1.2 Baseline Processes and Elemental Component Processes

It was shown in the previous section that the product, and all of the processes used to manufacture it, can be expressed by some combination of the Baseline Processes. Every top-level process can then be expressed in terms of the Baseline Processes, and using our results of the Baseline Processes we can calculate results for the top-level process by simply adding the results for the Baseline Process. Thus, to perform an analysis of the product we need to analyze the process-data of only the Baseline Processes.

But to perform an analysis of the Baseline Processes we need process-data. The LCAPIX program performs not have process-data about the Baseline Processes because the user can arbitrarily define them, give them any name, and decide how deep they will lie. In other words, the Baseline Process defined by the user is completely new to the LCAPIX Module while the LCAPIX Module can perform calculations only on the processes that it has in its library which are called **Elemental Component Processes**. So, the next step for the user is to tell the LCAPIX Module which of the Elemental Component Process in the Module's library best represents the Baseline Process. Once this is performed, the LCAPIX Module performs the calculation on the Elemental Component Processes, then transfers the results to the Baseline Process that was connected to it by the user, and uses the same results to express the results for all the top-level processes that were defined by the user in the process hierarchy by simply summing the appropriate Baseline Process. This entire procedure is shown in Figure 5.

Figure 5: Connecting the User-Defined Process Hierarchy to the database of the LCAPIX Module.



It is thus apparent that the LCAPIX Module can perform analysis only on a Process if it is present in its library as an elemental component. More processes, data, and further updates will be provided for registered users. Further, it is very easy for users to add their own Elemental Component Processes, if they have the process-data. The user added process-data may be used if either they represent more specific process-data of the manufacturing process than the average process-data in the LCAPIX library, or if there is no satisfactorily equivalent Elemental Component Process for a Baseline Process defined by the user. This ability of the user to easily add Elemental Component Processes is one of the most powerful features of this package, and is discussed further in Case 3: Adding Elemental Component Processes.

3.2.1.3 Specifying the Size of the Product to be Analyzed

In addition to the name of the processes that are used to make the product, the LCAPIX Module also requires the user to enter information specifying the size of the product as shown in Figure 3. The information required from the user depends on how the Elemental Component Processes are defined in the LCAPIX Module library. As the users will be developing Elemental Component Processes for their specific applications it is important to understand how the process-data is stored in the LCAPIX library.

To recapitulate, the overall goal of the software is to calculate Environmental Impact of a product using Environmental Load data based on some valuation method as shown in Table 1. The same Table is reproduced below with additional examples as Table 2:

Table 2: Examples of the data, and its format, available in various valuation methods.

Load Category	Substance	units	Environmental Loads for one Category-Substance	
			EPS Valuation Method (ELU)	Valuation
Material Non-Ferrous	Copper	kg	28.7
Material Ferrous	Silver	kg	22000
Emission Particles	Copper	g	500
Emission Gas	SO ₂	g	0.0368
Energy	Oil	MJ	0.4
Transportation	Train	km	0.01
.....

There are some important things to note in this Table:

1. Copper appears twice in the Substance column and has two different values depending on whether it is used as a raw material (Material Non-Ferrous) or if it is emitted into the air (Emission Particles). This is understandable as copper used in a product has a much lesser impact on the environment (and on human toxicity) compared to copper particles which are emitted into the air. Thus, before the Environmental Load can be assigned to an item, we must specify its Load Category and only the Load Category-Substance pair can have a unique Environmental Load value.
2. Note that the Substance column includes items like train and SO₂. It must be remembered that the Environmental Load value is a defined value and can be defined for anything. Thus, a Substance is anything for which an Environmental Load value exists in some Valuation Method, or for which a user can define an Environmental Load Value as discussed in Case 3: Adding New Substances. (*Note: In the case of Transportation-Train rather than breaking the train down into components like fuels, emissions, land use, etc. we can conveniently define the Substance Train.*)
3. Note that the units of the Substances for which the Environmental Loads are defined can vary. Just like we can define any Substance, we can express the Environmental Load based on any unit. The LCAPIX Module allows the user to define their own units as discussed in Section 8.5.6.
4. The Load Categories are used to classify information about the process. We are allowed to define Load Categories arbitrarily, but note that the major purpose it serves is to qualify the Substance by a Load Category- Substance relationship so that we can identify unique ELU values for the Load Category-Substance. (See item #1 discussed earlier in this list.)

The LCAPIX Module uses the above Load Categories but also allows the user to define their own Load Categories as discussed in Case 3: Adding New Load Categories. For example, we can define categories like toxic emissions, non-toxic emissions, or recyclable solid wastes.

The Elemental Component Processes in the LCAPIX Module are connected to the Environmental Load data contained in Table 2 as shown in Figure 15. It can be seen that Elemental Component Processes are essentially meaningful groupings of Load Category Substances that are stored in the library of the PIX Module. Thus if an Elemental Component Process is selected by the user, the program can easily retrieve the Load Category-Substance (and hence the Environmental Load data) associated with it.

But there is one more step before we can perform the calculations to find the Total Environmental Impact of a process that is specified by the user (See Figure 12). We need to calculate the amount of the Load Category-Substance, and it is done by the following equation:

Equation I

Amount of Load Category Substance = (Driver Factor) x (Driver 1) x (Driver 2) x ... (Driver n)

where drivers 1,2,3, ..., etc. are parameters like operation time of the process, length of weld during a welding process, or surface area to be painted during the painting process. Drivers are those parameters which characterize a process well. These drivers have units seconds, m, and square feet, for operation time, length of weld, and surface area, and the multiplicative product of all these drivers yields a unit that is (=seconds X m X square feet) that has to be adjusted so that it is the same as the unit of the amount of Load Category-Substance as available in the valuation method database shown in Table 2. This is achieved by the Driver Factor.

Thus, when the Elemental Component Process is entered into the database (see Case 3: Adding Elemental Component Processes to add your own Elemental Component Processes to the LCAPIX Library) the appropriate drivers for the process are selected. Then, the numerical values of the drivers and amount of each Load Category-Substance (see Figures 12 and 13) are measured experimentally, or culled from other records, as the Elemental Component Process is being conducted, and using Equation I, we can finally calculate the Driver Factor. (*Note: Special attention must be paid to the units in Equation I.*)

When the user uses the LCAPIX Module, the sequence of calculations is reversed. The user supplies the numerical values of the driver (e.g. 5 cm of the weld, or 30 sq. ft of area to be painted) then the program uses the driver factors present in its library to calculate the amount of Load Category Substance using Equation I again.

Once the user has provided all the required numerical values of the driver, the LCAPIX Module has sufficient information to calculate the amount of the Load Category Substances. This step of providing the driver values to specify the product is called **Determination**.

3.2.1.4 Calculating the Environmental Impact of a Product

The final step is to choose the Valuation Method and then execute the calculations for a Determination (a set of driver values that are provided). We can use the same Determination and evaluate its Environmental Impact according to different valuation methods. The effect of choosing different Valuation Methods is just that the (Environmental Load)/unit (see Table 2) values for all the Load Category-Substances are selected according to the Valuation Method selected.

The result of these calculations can be seen either as a report or chart as discussed in Case 1: Valuation - Calculating the Environmental Loads.

Part



4 Guided Tour

4.1 Guided Tour with Detailed Instructions

It is a good practice to decide what you need to do before starting to enter data or analyze processes with the LCAPIX Module. To keep the integrity of the database, once some entries are made (for example when an Elemental Component Process is added) they cannot be deleted. Thus, to prevent the database from filling up with the information that gets stored but is never used, develop a good idea of the tasks that you want to perform. These tasks are archived and you may view only Elemental Components that are relevant.

It is time-consuming to enter a Process Hierarchy for a new Product, but once it is entered it can easily be accessed by other users. Thus, only a few users will need to enter process hierarchies while most of the users will analyze the processes that are already present in the supplied database. Depending upon how you will be using the LCAPIX Module, choose one of the following cases:

Case 1: The process tree and data is already available in the program, only Environmental Load Impact analysis needs to be performed. Read "Process Hierarchy" and then go to "Process Data".

Case 2: The Process Hierarchy and Elemental Component Data are not in the LCAPIX Module and have to be entered. Read about "Process Hierarchy" and "Process Data" and then go to "Case 2: Adding Process Trees and Process Data to the Program".

Case 3: There is some data, but some parts of the process hierarchy, or some Elemental Component Processes, or more data, or options (like new units, new load categories, or new valuation methods) need to be added or changed. Go to "Case 3: Adding or Modifying Sub processes Data or Options in the Program".

4.1.1 Process Hierarchy

Let us consider, for example, the manufacture of a painted box. The box is first assembled from metal sheets. The assembly process involves two steps - first metal sheets are cut and, in the second step, the seams are welded to form the box. It is assumed that painting is only 1 step. The Process Hierarchy for the manufacture of the painted box is shown in Figure 9.

Figure 9: Process hierarchy for a painted box. The 1st and 2nd level process are indicated, and the lowest level processes in each branch (shown shaded) are called the baseline processes.

Tree View of Product Structure

Click Each Tree Item to Get Information:

Product Name: Painted Box - practice

Description: process tree for a painted box as recommended in the guided tour of the LCA PIX manual

Version: 1

Subprocess Name	Version	Type
Assembling the box	1	Decomposition
Powder Coating the box	1	Decomposition

Print Tree New ... Remove Close

There are two 1st level processes - "assembling the box" and "spray painting the welded box."

The "assembling the box" process further decomposes into two 2nd level processes - "cutting the metal sheets into rectangular pieces" and "welding the seams to form a box and its cover." There are no further decompositions.

The lowest level processes are the Baseline Processes. Hence there are 3 Baseline Processes - "cutting the metal sheets into rectangular pieces," "welding the seams to form a box and its cover," and "spray painting the welded box."

4.1.2 Process Data

The following information has been collected for the process to manufacture the painted box.

Table 3: Process data collected for the example in the Guided Tour of LCAPIX Module.

Baseline Processes	Possible Driver(s)	Inventory of Items to consider for Environmental Load.	Notes and data about the process
<ul style="list-style-type: none"> Cutting the metal sheets into rectangular pieces 	<ul style="list-style-type: none"> <i>operation time</i> of machine thickness of sheets cut length of the cut 	<ul style="list-style-type: none"> <i>energy</i> - electrical 	<ul style="list-style-type: none"> machine rating is 70 hp. the amount of electrical energy is not really dependent on the length of cut but depends on the time the machine is kept running. about 20 boxes can be made in an 8 hour shift.
<ul style="list-style-type: none"> Welding the seams to form a box and its cover 	<ul style="list-style-type: none"> <i>length</i> of weld <i>thickness</i> of sheets welded <i>time</i> of welding 	<ul style="list-style-type: none"> <i>process materials</i> - wire and solder <i>energy</i> - from gas <i>emission</i> - gaseous emissions from welding 	<ul style="list-style-type: none"> used an average of 50 g of solder per inch of weld used an average of 50 g of welding wire per inch of weld on an average it was found that it took about 600 cu.ft. of gas per 4 hrs. of welding not a very

4.1.3 Case 1: Analysis with Data Available in LCA PIX Module Library

This is the appropriate selection when the products (and the processes that are used in its manufacture) are already present in the LCAPIX database, and only analysis of their environmental load needs to be performed.

Recall that the analysis of a product to determine its environmental load consists of two steps (see Figure 3). The first step is when the dimensions of the product are specified and then in the next step the calculations are executed. The step in which the product dimensions are specified is called **Determination** and the next step in which the actual calculations are executed is called **Valuation**.

4.1.3.1 Determination

Determination is the step in which the user provides the values of the drivers for the product. Let us demonstrate how it is executed for a **Painted Box** that is already present in the LCAPIX database for demonstration purposes.

1. Start the LCAPIX Module by clicking on the LCAPIX icon in the **PROGRAM** menu in Windows 98 or higher.
2. Click on the **Determine** icon or choose Determination -> Run from the drop down menus. This will bring up the Product Selection as shown in Figure 10.

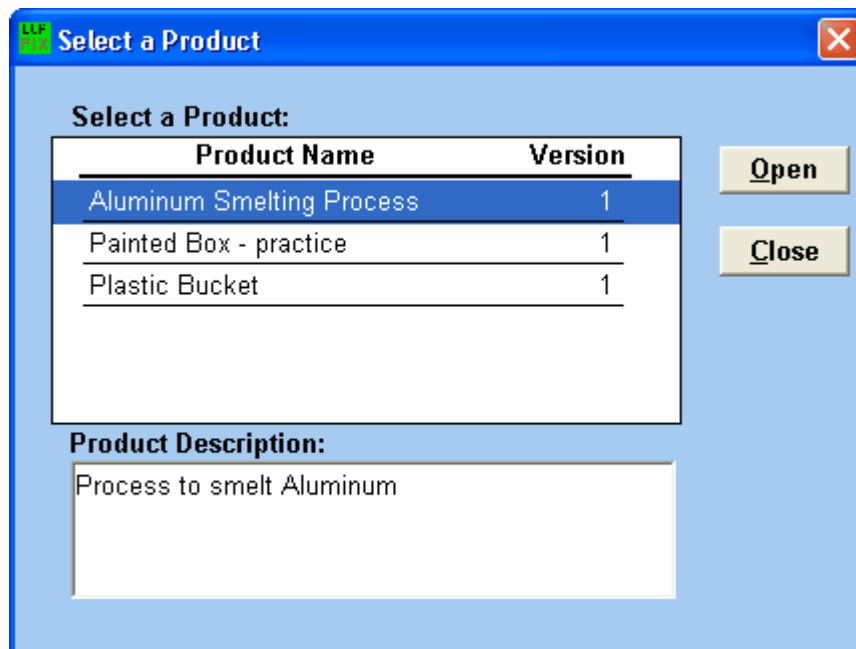


Figure 10: The Product Selection Window is to choose a product to analyze.

3. In this window all the products that are present in the database will be listed. Choose **OPEN** after selecting the product "Demonstration - Painted Box." It will bring up a Window as shown in Figure 11.



Figure 11: Screen for assigning an instance label to a set of product specifications.

4. Remember that in the **Determination** step all we are doing is providing a set product specification. As we can have more than one set of specifications for the same product (see Figure 8). Each set of product specifications is called an instance and there are 2 instances in Figure 11. Click the mouse on instance with the *Instance Label* "**Practice Example 1**" so the hand is pointing to it. In Figure 11 the hand is pointing to Instance Label "**Practice Example 1**." Then either choose **OPEN** or double click the mouse to open the instance.

Determination Driver Values

Component Title: Version:

Driver Title	Driver Unit	Driver Value
length of weld	inch	50.0000000000
time taken in welding	min	15.0000000000

Product Name: Date Created:

Version: Date Modified:

Instance Label:

Instance Owner:

Definition:

Information	Version
Product: Painted Box - practice	<input type="text" value="1"/>
Machine/Line: Assembling the box	<input type="text" value="1"/>
Subprocess: Welding the seams	<input type="text" value="1"/>
Operation:	<input type="text"/>
Task:	<input type="text"/>

Figure 12: The screen in which the values of the drivers are specified. This is the Determination step.

5. A window called *Determination Driver Values* as shown in Figure 12 opens up.

At the top of the screen the Component Title (which is an abbreviated name for Elemental Component Process) is listed. Remember that only driver values for Elemental Component Processes need to be specified.

The drivers are listed below the Component Title. In this demonstration example we need to only specify the operation time for the machines, on which cutting is done, to determine the contribution of the cutting operation to the Environmental Load of the product - i.e. the painted box. The operation time for cutting to "assemble the boxes" is specified as 15 minutes.

The product name is specified below the drivers as "**Painted Box - Practice Example**". The instance label which identifies the product size is specified below which in this case was "**Practice Example 1**."

At the bottom left of the screen the definition of the process - whether it decomposes or not - is specified. (If it does not decompose further, then it is a Baseline Process.) In this *Determination Driver Values* window, only Baseline Processes are displayed as they are the only ones that need to have the driver values specified but when we display the result in the Valuation Section we will need to see results for all the processes and sub-processes as discussed in the next section on Valuation.

6. The operation time shown as 15.00000000 minutes in front of the driver in Figure 12 and can be edited by either double clicking on the driver name box or by clicking on the relevant driver then choosing **EDIT**. Let us leave the editing for later though and meanwhile investigate the rest of the **Determination** section.

7. Click the mouse on the FORWARD button on the screen (Figure 12) to see the next Baseline Process which is called "**Practice - Welding**" as shown in Figure 13.

Determination Driver Values

Component Title: practice - cutting metal sheets Version: 1

Driver Title	Driver Unit	Driver Value
operation time	min	15.0000000000

Product Name: Painted Box - practice Date Created: 3/1/2004 12:08:07

Version: 1 Date Modified: 3/1/2004 12:12:08

Instance Label: Practice Example 1

Instance Owner: dba

Definition: Baseline

Information	Version
Product: Painted Box - practice	1
Machine/Line: Assembling the box	1
Subprocess: Forming and Bending the metal sheets	1
Operation:	
Task:	

Figure 13: Another Example of a screen where the driver values are specified in the Determination step of the analysis.

8. Pressing the **FORWARD** button will cycle the screen through all the Elemental Component Processes to provide you an opportunity to enter the driver values. The **BACK** button will take you to the previously displayed Elemental Component Process. The **TOP** button returns you to the Elemental Component Process that was displayed first when you entered the *Determination Driver Values* Window. Choose OK to return to the main **Determination** screen shown in Figure 11.

4.1.3.2 Valuation

For each **Determination Instance** that we create, (as was demonstrated in the previous section and shown in Figure 20) we can execute a valuation using every Valuation Method that is present in the LCAPIX database. The present version of the database contains data for the **Environmental Priority Strategy (EPS) Valuation Method**. (See Section 5.2 for more details.) There is some data in the **BU** system also for some substances, but that data is not officially recognized as is the EPS data. So, the

BU Valuation Method in the database should not be used without consultation with KM, Ltd. Personnel. As more Valuation Systems become available, updated database patches will be provided so that users of the LCAPIX Module can analyze their systems using various Valuation Methods. Let us now perform a valuation for one of the instances in the product "**Demonstration - Painted Box.**"

1. If the LCAPIX Program is not running, start the LCAPIX Module by clicking on the LCAPIX icon in the **START** menu.
2. Click on the icon **Valuate**.
3. A *Select Product* window will come up. Double click on the product "Painted Box - Practice Example," or click on it until it is highlighted and then choose **OPEN**.
4. If you worked through the practice example in the previous section, then a window similar to Figure 14 will appear.

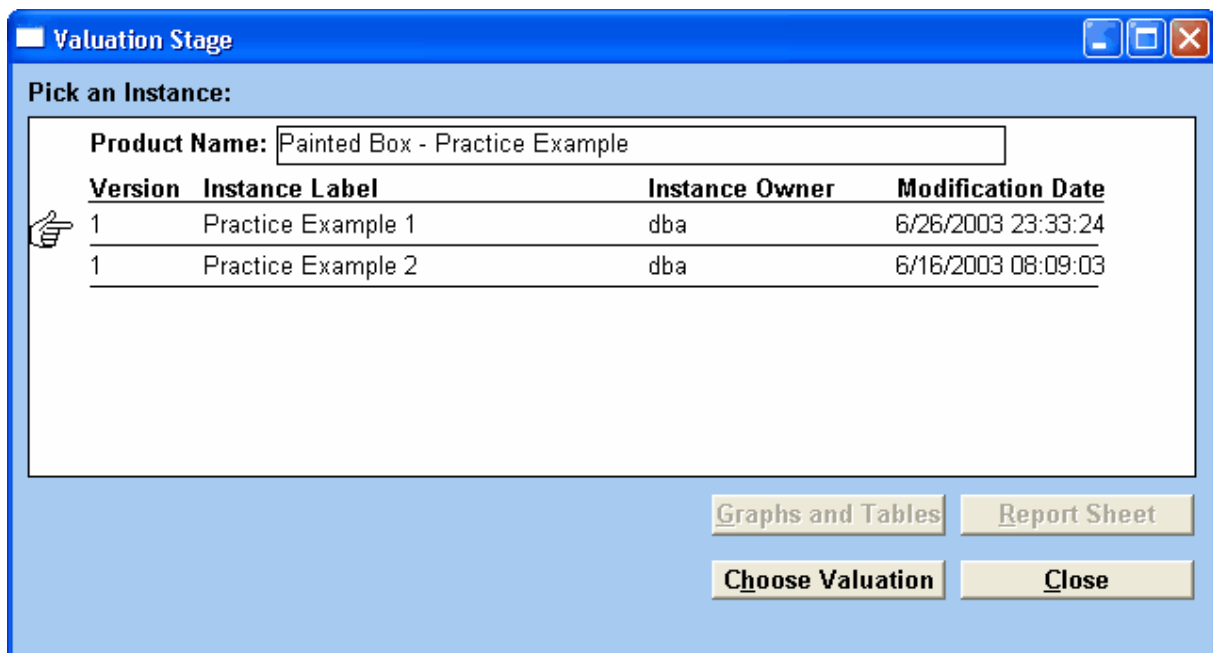
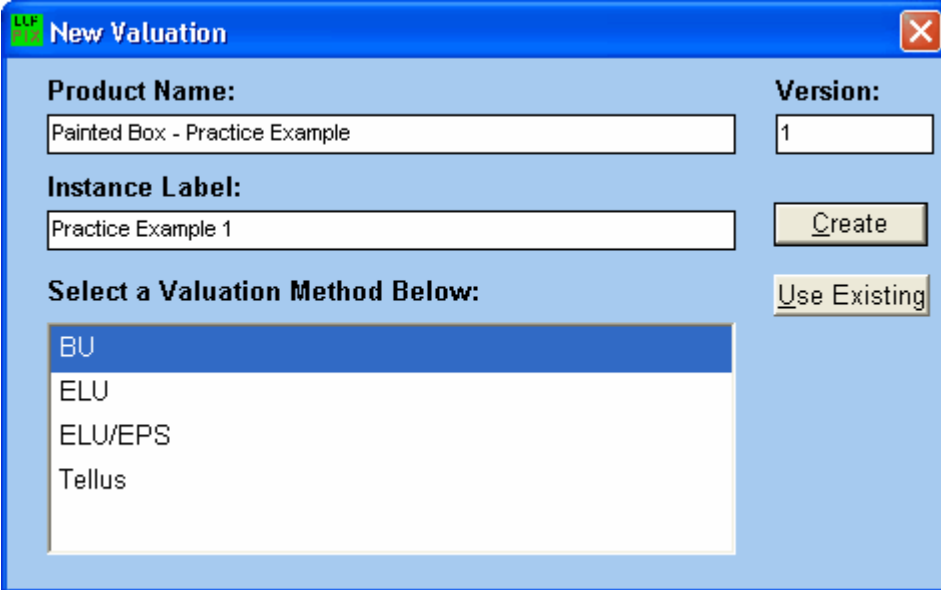


Figure 14: Opening Screen for the Valuation of the product "Painted Box - Practice Example."

5. The two buttons called **Graphs and Tables** and **Report Sheet** will be grayed out. These are to display the results after executing valuations on either the computer terminal (**Graphs and Tables**) or on a printer (**Report Sheet**).
6. The program does not store old valuations (or calculations) because there might be changes in the **Determination** of the instances (i.e. new instances may have been added, or the driver values in the old instances have been changed). So, to execute the calculations choose **CHOOSE VALUATION**.
7. Before the calculations can be executed, LCAPIX will ask you specify the valuation method in a window as shown in Figure 15.



The screenshot shows a software window titled "New Valuation". It features a blue header bar with a small "LCP" logo and a close button. The main area is light blue and contains the following elements:

- Product Name:** A text box containing "Painted Box - Practice Example".
- Version:** A text box containing "1".
- Instance Label:** A text box containing "Practice Example 1".
- Select a Valuation Method Below:** A list box with four options: "BU", "ELU", "ELU/EPS", and "Tellus". "BU" is currently selected and highlighted in blue.
- Buttons:** Two buttons are located on the right side: "Create" and "Use Existing".

Figure 15: Window in the Valuation Section to choose which Valuation Method to use to execute the calculations to determine the Environmental Load.

8. Click on ELU (the Environmental Load Unit using the Environmental Priority Strategy Method) until it is highlighted and click **OK**.
9. This will take you back to the screen in Figure 14, except now the buttons **Graphs and Tables** and **Report Sheet** will be live (and black) unlike earlier when they were inactive and grayed.
10. We can now choose any instance as the calculations for all of them have been performed. Let us, for example, look at the Valuation results of the *Instance "Practice Example 1."* Click on the box containing the Instance Label "**Practice Example 1**" until the hand icon is pointing to it. Let us view the results on the computer terminal, so choose and click on **Graphs and Tables**.
11. It will bring up a window as show in Figure 16 that contains the results.

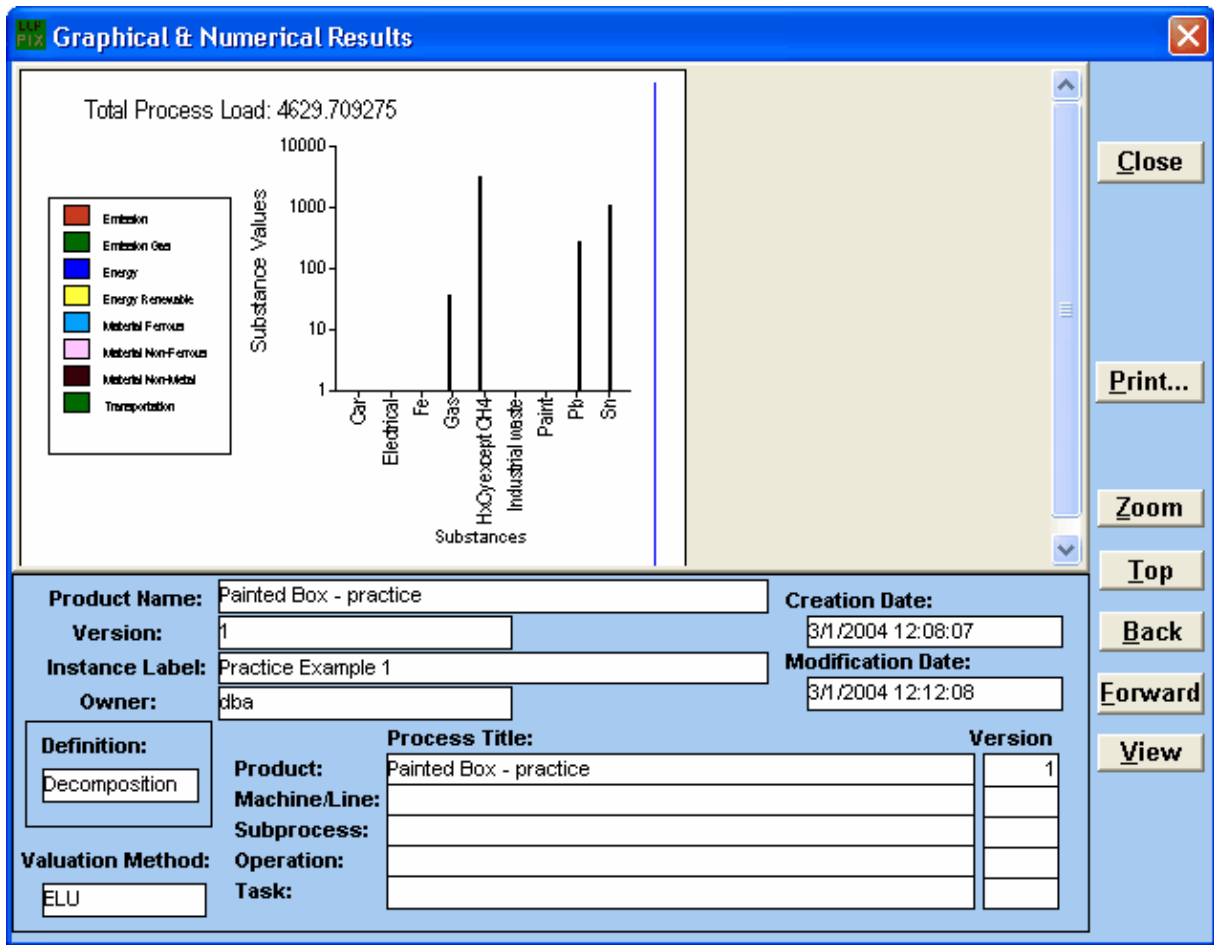


Figure 16: Top level screen showing the results of the valuation of the Product "Painted Box - Practice Example" and the Instance "Practice Example 1".

- In the box at the bottom half of the screen, details about the product and process are specified. The product name is "**Painted Box - Practice Example**," and the *Instance Label* (which is one set of driver values that define the product) is "**Practice Example 1**."

Now, unlike in the **Determination** section where we were interested in providing the driver values only for the Baseline Processes, in the **Valuation** section we are interested in seeing the results for both the Baseline Processes and all the higher level processes (i.e. 1st level, 2nd level, etc.). The process whose results we are seeing in the bar chart above is defined as Baseline or decomposition in the bottom left hand corner of the screen. In our case it is a Decomposition process indicating that the process decomposes into further constituent processes.

The Valuation method used to determine the Environmental Load is displayed right below the *Definition* of the process, and in our case it is ELU.

In the box, at the bottom of the screen, which has the title *Process Title*, the name and level of the process whose results are being displayed in the bar chart above is listed. In our case it is the Product, with no sub processes below it. This means that the results are for the complete product and hence the comprehensive environmental load of the product

The bar chart has the Substances on the x-axis and their corresponding Environmental loads in the ELU units on the y-axis. The total load for the "**Painted Box - Practice Example**" is 14966.21 ELU units.

13. To determine the Environmental Loads of the processes that are used to manufacture the product, click on **FORWARD** button on the right side of the screen. The **BACK** button will bring you back to the last process that you saw. The **TOP** button will bring you back to the highest level in the process hierarchy - i.e. the results about the product. The **ZOOM** button can be used to magnify the view of the bar chart (which may also be magnified by using a mouse to drag out its corners).
14. Once you have clicked on the **FORWARD**, as asked in step 13, the window as shown Figure 17 in will appear.

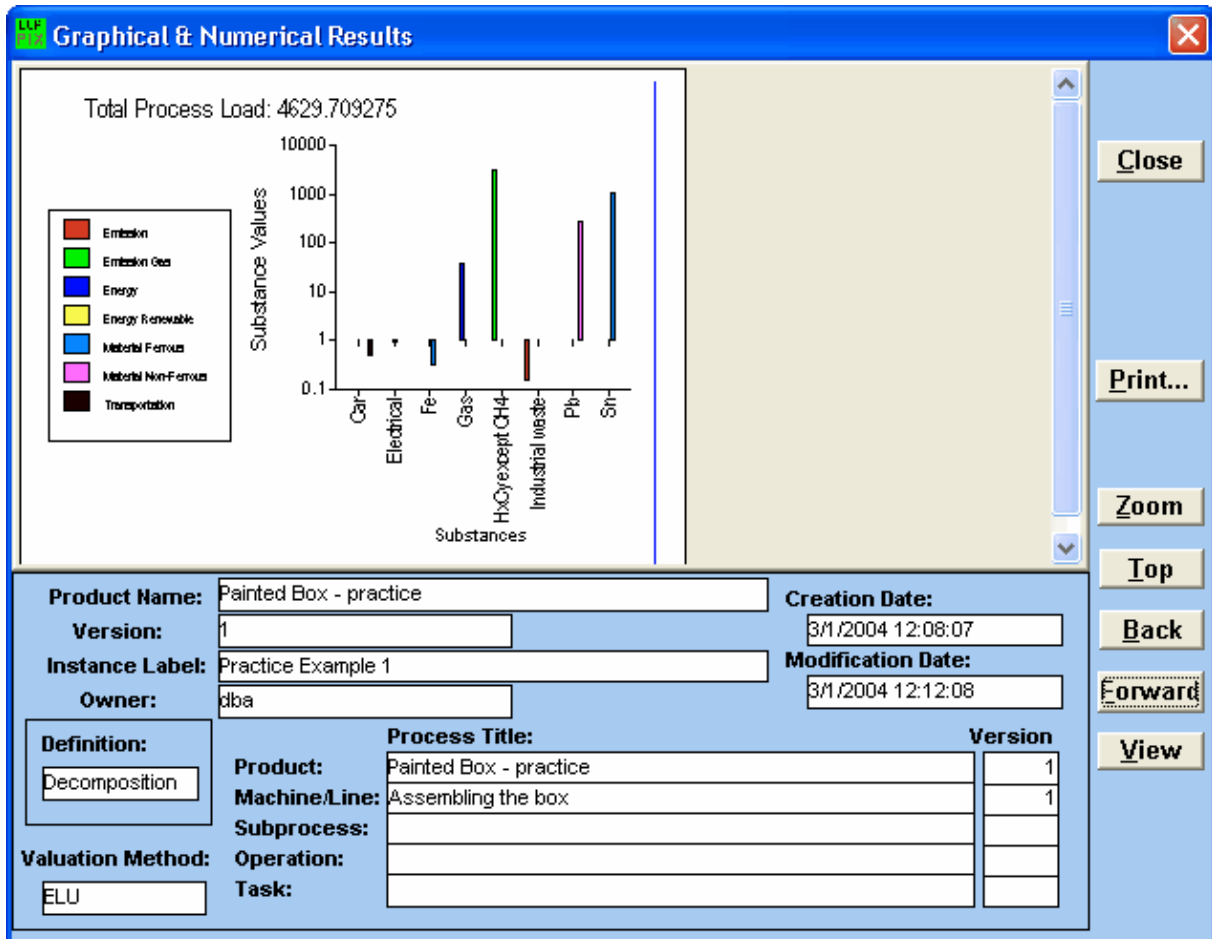


Figure 17: The second screen in the Valuation section illustrating the result due to "Assembling the box" towards making the product "Painted Box - Practice Example."

15. Notice that in Figure 26, at the bottom of the screen where the *Process Title* box is, a new process has appeared under the product "**Demonstration- Painted Box**," and it is "**Assembling the Box**." From the bottom left hand corner we still know that the *Definition* of the process is Decomposition (because as we know that it decomposes into "cutting the metal sheets into rectangular pieces," and "welding the seams to form box and its cover").

Thus, the bar chart on the top gives the Environmental Load of the "Assembling the Box," which itself is the sum of the Environmental Load of "Cutting the metal sheets to form rectangular pieces," and "welding the seams to form box and its cover". The total ELU of the process "assembling the box is 4629.025 as shown on top of the bar chart.

Click on **FORWARD** again to see the next result.

16. It will bring up a window as shown in Figure 18.

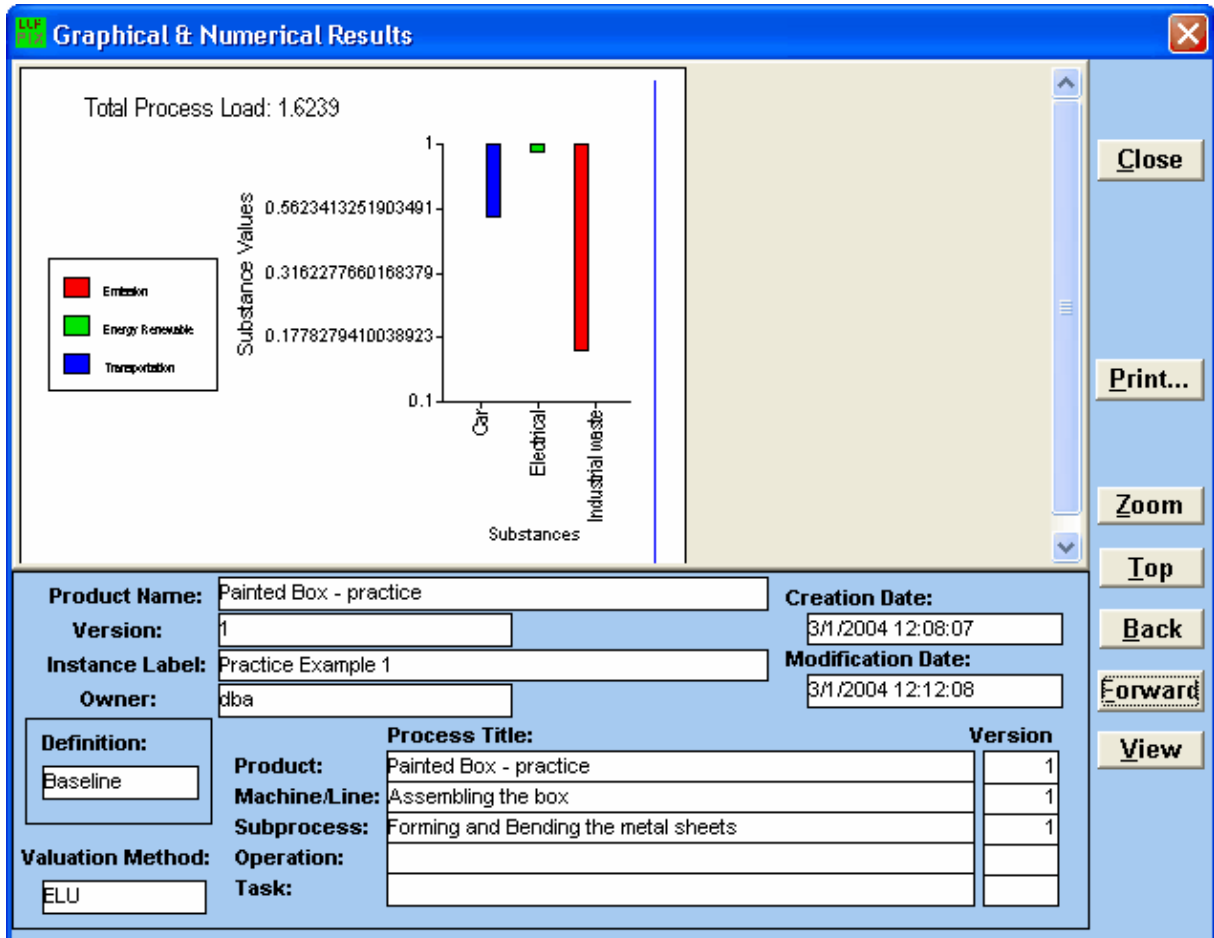


Figure 18: The valuation results for the baseline process "Forming and Bending the Metal Sheets"

17. Notice in Figure 18, the *Definition* of the sub process "Forming and Bending the Metal Sheets" is Baseline. This means that this is the lowest level process. Its load is 0.9399 ELU units. If we click **FORWARD** again, it will lead us into the next baseline process "welding the seams," and so on.

Instead let us click on **VIEW**. (If you did click **FORWARD**, you can come back to the screen in Figure 18 by clicking on **BACK**.) Clicking on **VIEW** shall bring up the screen shown in Figure 19.

18. The screen in Figure 19 shows the same results as in Figure 18, but in a numerical report form. This is especially useful if we want to look at the exact numerical values of the Environmental Loads.

19. We can also see the numerical report for the entire product (i.e. **the Demonstration - Product Box**) by now clicking on **TOP** which will bring up a screen shown in Figure 20.

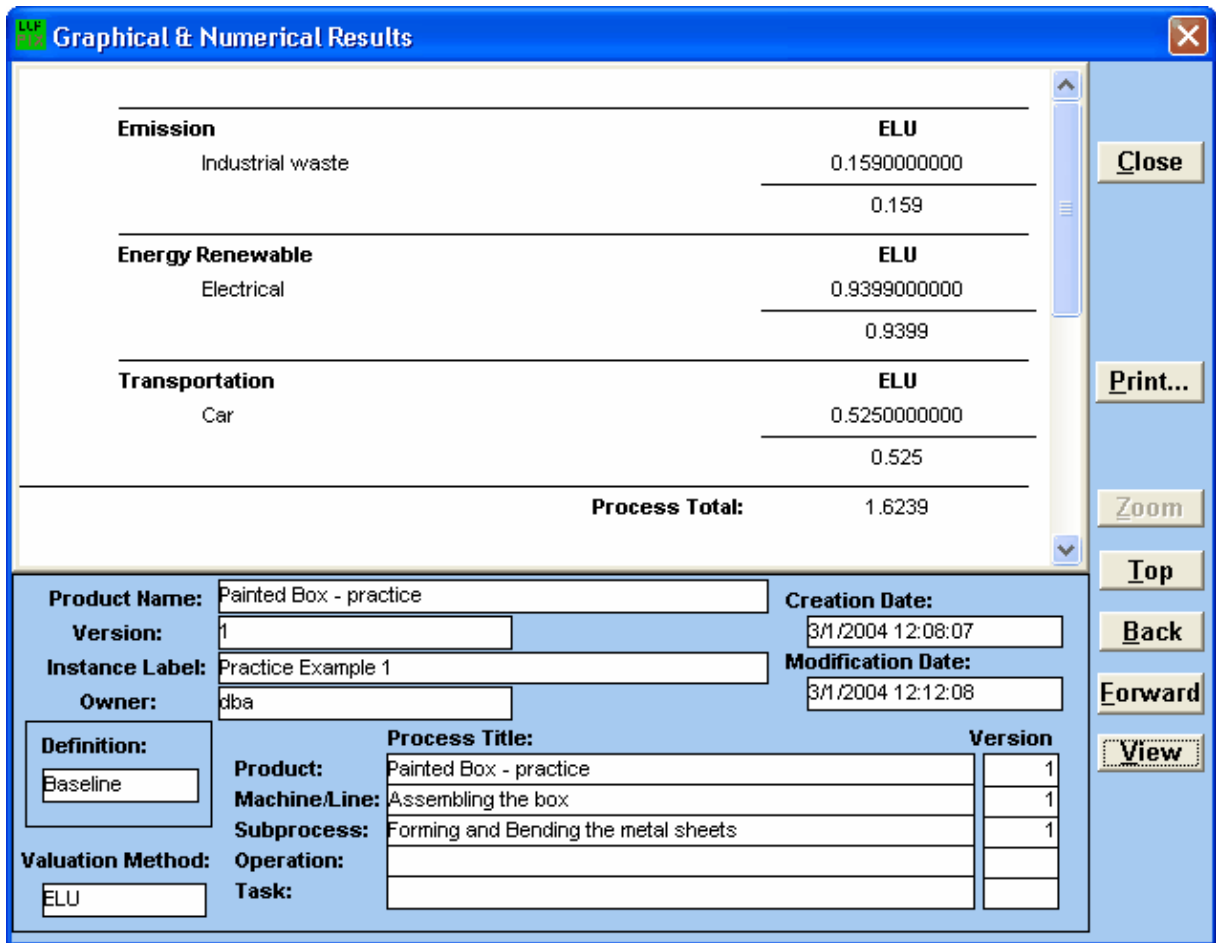


Figure 19: Toggling between the bar chart and the numerical report form by using the command VIEW in the Valuation section.

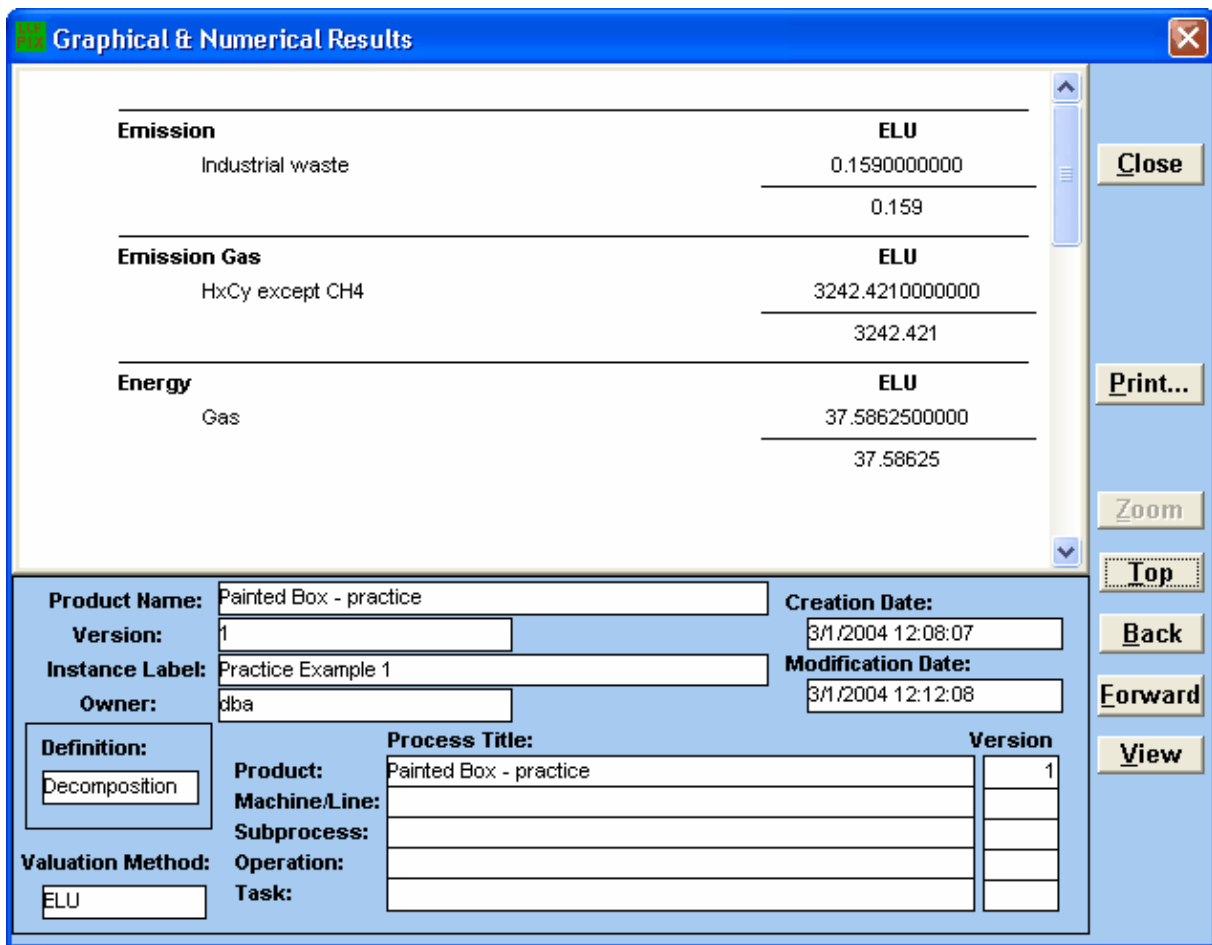


Figure 20: The environmental load for the "Painted Box - Practice Example" displayed in the numerical report form.

20. We can thus use the **VIEW** command to toggle between the bar chart view of the results and the results displayed in a numerical report form.
21. Choose **CLOSE** to exit from the section. We have now completed the tour of the Valuation Section.

4.1.4 Case 2: Adding Process Trees and Process Data

We will add process trees and process data in the following steps. First we will enter the Elemental Component Processes into the LCAPIX program library. Then the Process Tree (or hierarchy) will be entered into the LCAPIX program. As part of the entry of the process tree we will make associations between the Baseline Processes and the Elemental Component Processes.

4.1.4.1 Adding Process data to the LCA PIX database

We now have to add the Elemental Component Processes. The data in Table 3 has been restated in Table 4. Note that the Load Categories presently available in the LCAPIX module are Emissions, Emission Gas, Emission Liquid, Emission Particles, Energy, Energy Renewable, Material Ferrous, Material Non-Ferrous, Material Non-Metal, Natural Resource and Land Use, and Transportation. The user can add more Load categories as shown in Case 3: Adding New Load Categories.

The first column of the Table 3 indicates the Baseline Processes of the example depicted in

Processes's three Baseline Processes. These Baseline Processes are associated with the Elemental Component Processes shown in Column 2. We will store the data in the LCAPIX library for the Elemental Component Processes. Once we enter these Elemental Component Processes into the LCAPIX library, they will be available for association with any Baseline Process - i.e. we can build higher level processes (and even a product) from the Elemental Component Processes.

Each Elemental Component Processes is composed of Load Category-Substance as shown in the third column of the table. In this column we have listed all the information that we are interested in storing. For example in "Spray Painting" we can see that Paint is used as a raw material, energy in the form of electricity and gas is used, and there are emissions - water. Each of these Load-Category substances can now be stored on a unit basis depending upon the drivers that we choose. The drivers for each Load Category Substance are shown in Column 4. Then using **Equation I** we can calculate the Driver Factor using the data available in Table 3. The units of the driver factor are the units of the Load Category Substance in the Numerator, and the units of the associated drivers (all multiplied with each other) as the denominator. The units of the Load Category-Substance are the same in which the data is available in the Valuation Method which will be chosen for the calculations.

Baseline Process	Elemental Component Load Category - Process	Load Category - Substance (units)	Associated Driver(s) (units)	Derivation (elementary units) Load Category - Substance Derivation (elementary units) (7 hp 46 W p) (J / W 0 M) (s/ n. 3. 3 M m (5 g/ h 0. (1 Kg) : 0. 3 K ~
Cutting metal sheets into rectangular pieces	practice - cutting metal sheets	Energy Renewable - Electrical (MJ)	• operation time (min.)	
Welding seams to form a box and its cover	practice - welding	Material Non Ferrous - Pb (Kg)	• length of weld (inches)	

Table 4: The Process Data Restated for Entering into the LCAPIX Module.

Let us demonstrate how to enter the data for the Elemental Component Process "Practice - Spray Painting."

1. If you are not running the LCAPIX Module, start the LCAPIX Module by clicking on the LCAPIX icon from **START**.
2. Click on **Component** or choose **Inventory** and the **Component** from the menu.
3. This will launch a window called *Select an Elemental Component* as shown in Figure 21. This window lists all the Elemental Component Processes that are available in the LCAPIX Elemental Component Library. Products and higher level processes can only be built on these processes if calculations are to be done, because data is available to the LCAPIX Module only for these processes. Choose **NEW**.

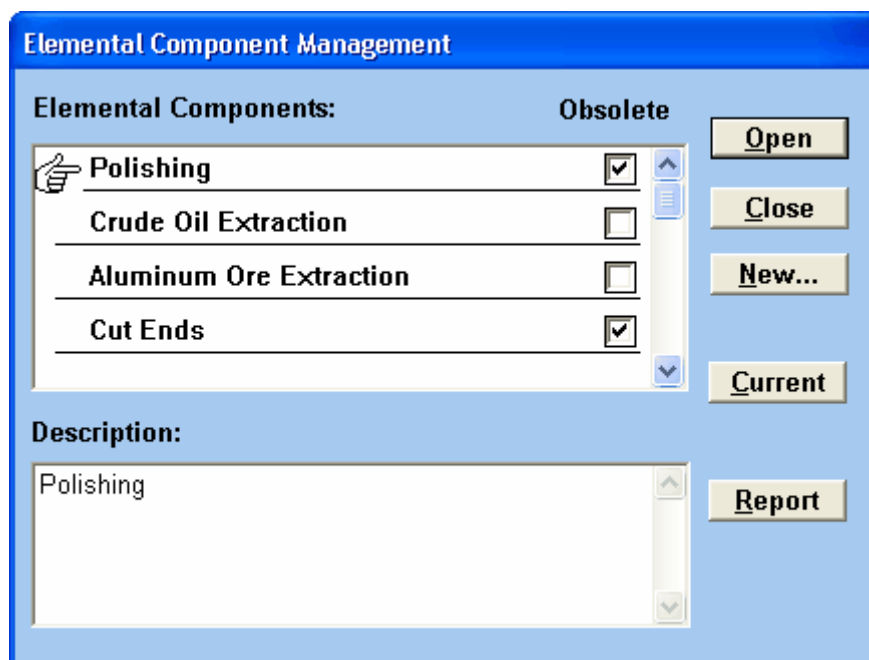


Figure 21: Window listing the Elemental Component Processes available in the LCAPIX library, and options to add more ECP's.

4. Choosing **NEW** will spawn a dialog box asking you for the name and the Description of the Elemental Component Process to be added. Type in the Title "Practice - Spray Painting" and a description as shown in Figure 22 and choose **OK**.



Figure 22: Dialog Box to enter the Elemental Component Process name and description.

5. You will return to the window shown in Figure 21, but with the newly added Elemental Component Process "Practice-Spray Painting" listed and highlighted. Choose **OPEN** to add information about this ECP.
6. A window as shown Figure 23 in will spawn. At the bottom of the window is a box titled "*Elemental Component Drivers*." Here all the drivers that are used for "Practice Sprays Painting" are to be entered. In our example, there are three drivers associated with spray painting - surface area, operation time, and thickness of paint. (See Table 5.)

Component Driver Name	Unit
-----------------------	------

Figure 23: Screen to add drivers to ECP. It also provides the choice to add the Load Category Substances and driver factors by the choice of ITEMS.

7. Click on **NEW** to add the drivers. It will spawn a dialog box asking for the name of the driver and its units as shown in Figure 24. Type in the name of the driver and then choose the units by clicking on the arrow beside the Unit box. Use the **UP ARROW** or **DOWN ARROW** on your keyboard to navigate through the various choices and select sq. ft. Choose **OK** after you are done.

Driver Title:	surface area
Unit:	sq.ft

Figure 24: Dialog Box to Enter the Name and Units of a Driver.

8. Choose **NEW** again to enter the 2nd driver of operation time (units: min) and the 3rd driver

thickness of paint coat (units: mm). After you have added each of the three drivers, the window in Figure 23 will look like Figure 25.

Inventory Elemental Component Layer - Practice-Spray Painting

Component Name: Practice-Spray Painting

Description: Example as described in Guided Tour for LCA PIX

Version: 1

Elemental Component Drivers

Component Driver Name	Unit
surface area	sq.ft
Operation time	min
Thickness of Paint Coat	mm

Buttons: **OK**, **Cancel**, **Items**, **New**

Figure 25: Screen showing the Elemental Component Process after all the possible drivers have been added. They will each be individually associated to the Load Category Substance, and driver factor information will also be added by clicking on the ITEMS button.

9. After the drivers have been listed, we need to add the Load Category Substance information and the driver factors for each of them. (See Table 5) To do this choose **ITEMS**.
10. Before you can go to the Items screen, a dialog box will pop up asking you "Do you want to save your changes to the drivers of this Elemental Component Process before editing its items?" Chose **YES**. It will lead into the window titled "Elemental Component Items & Drivers" as shown in Figure 26.

Elemental Component Items & Drivers

Name: Practice-Spray Painting Version: 1

Elemental Component Items

Load Category: Substance	Driver Factor

Add Item

Associated Drivers

Operation time (min)

surface area (sq.ft)

Thickness of Paint Coat (mm)

OK

Cancel

Figure 26: Opening screen to add the Load Category-Substances and the driver factors associated with each Elemental Component Process.

11. On the top of Figure 26 is listed the name of the Elemental Component Process "Practice Spray Painting." At the bottom is a list of all the drivers, of which we can selectively associate some with the Load Category-Substances which will be listed in the middle box titled "*Elemental Component Items*." Choose **ADD ITEM** to add the first LDAD Category *Substance* "Material Nonmetal - Paint" as shown in Table 4.
12. Choosing **ADD ITEM** will spawn a window listing all the Load Category substances that are present in the LCAPIX database as shown in Figure 27. First select the category from the drop down menu, **Material Non-Metal**. Then click the **SUBSTANCES** button for a list of all substances in that category. Highlight the choice **Paint** and choose **OK**.

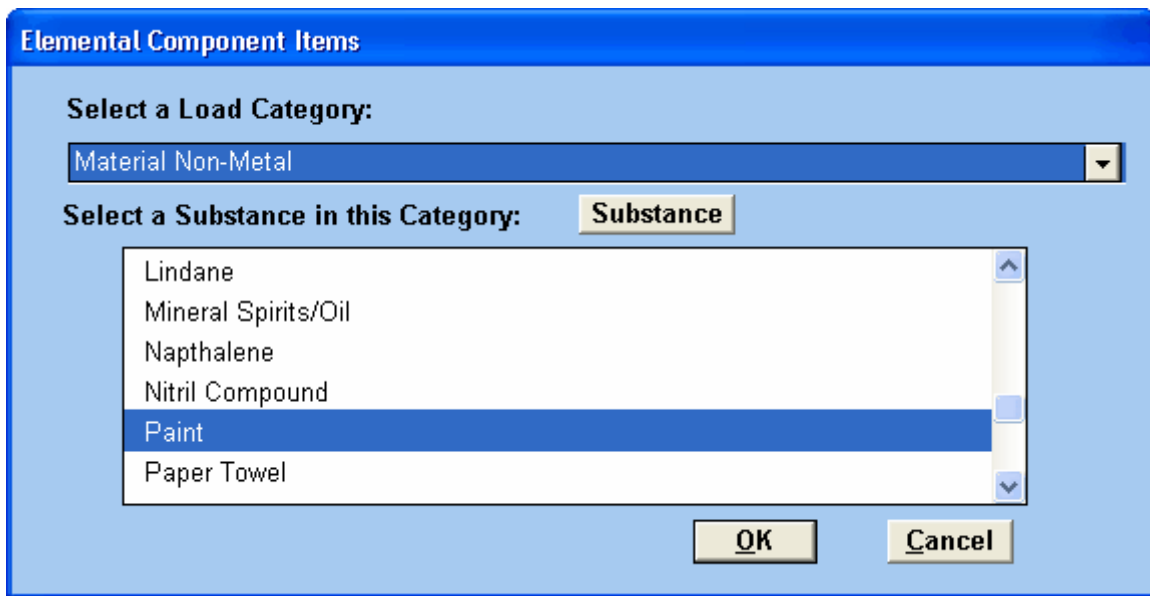


Figure 27: A listing of all the Load Category - Substance available in LCAPIX library.

13. Choosing **OK** for **Material Non-Metal: Paint** will enter it into Figure 26, which will now look like Figure 28. In the center box title "Elemental Component Items" the Material Non-Metal: Paint is listed. It has default driver factor of value 1. Highlight the value 1.00000 and press **DEL** to delete it and enter 0.00643. Then click on the drivers "surface area" and "thickness of paint coat" until a cross appears in the box associating the drivers with **Material Non-Metal: Paint**. See Table 4.)

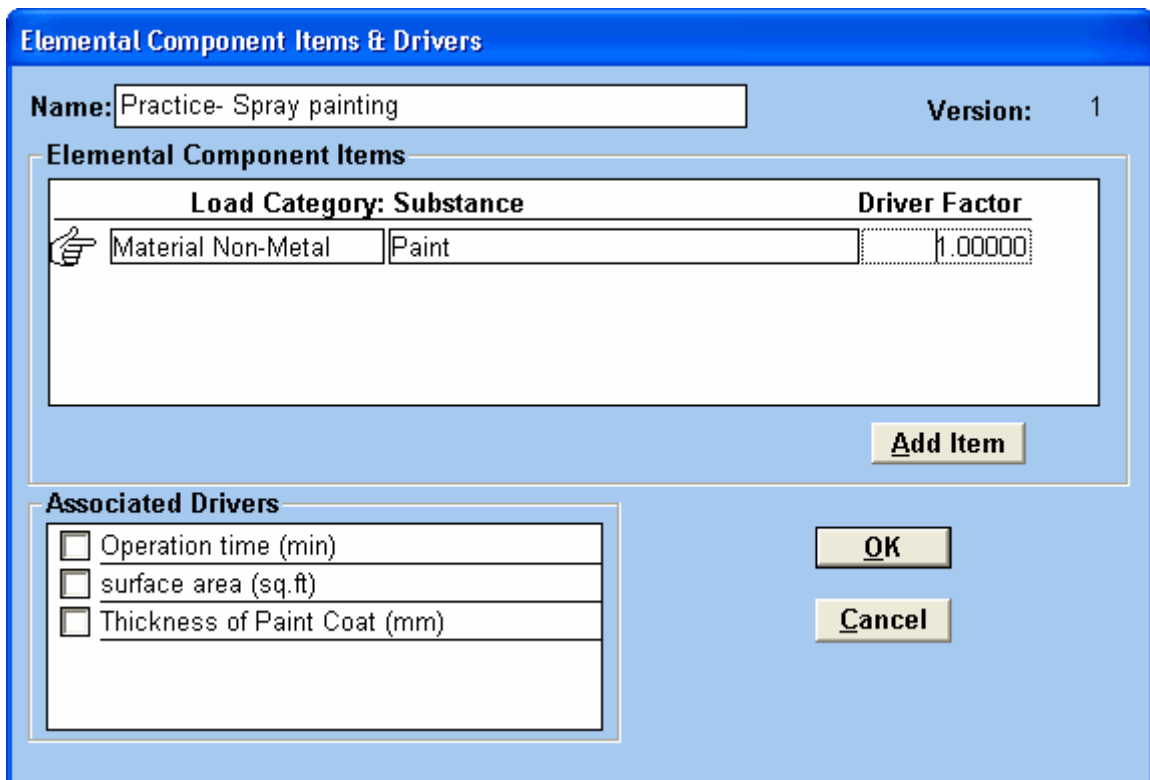



Figure 28: Adding Load Category-Substances, driver factors and associating drivers with an Elemental Component Process.

14. To add the next Load Category - *Substance* "**Energy Renewable - Electrical**" click on **NEW**. It will lead back to the list in Figure 27, from which use the **UP ARROW**, **DOWN ARROW**, **PAGE UP**, or **PAGE DOWN** on the keyboard to navigate and select "**Energy Renewable - Electrical**."
15. It will bring you back to the screen in Figure 28 with the second added listing of **Energy Renewable - Electrical**. Then **press DEL to delete** the default driver factor value of 1.00 and enter 2.4. Then associate the driver *operation time* (until a cross appears in the adjoining box) and choose **NEW**.
16. To add the next Load Category - *Substance* "Energy -Gas" click on **NEW**. It will lead back to the list in Figure 27, from which use the **UP ARROW**, **DOWN ARROW**, **PAGE UP**, or **PAGE DOWN** on the keyboard to navigate and select "**Energy -Gas**."
17. It will bring you back to the screen in Figure 28 with the second added listing of **Energy - Gas**. Then **press DEL to delete** the default driver factor value of 1.00 and enter 0.186. Then associate the drivers *surface area* and *thickness of paint coat* (till a cross appears in the adjoining box) and choose **NEW**.
18. To add the next Load Category - *Substance* "Emission - Industrial Waste" click on **NEW**. It will lead back to the list in Figure 27, from which use the **UP ARROW**, **DOWN ARROW**, **PAGE UP**, or **PAGE DOWN** on the keyboard to navigate and select "**Emission - Industrial Waste**."
19. It will bring you back to the screen in Figure 28 with the second added listing of **Emission - Industrial Waste**. Then **press DEL to delete** the default driver factor value of 1.00 and enter 250. Then associate the driver *operation time* (until a cross appears in the adjoining box). We have now entered all the Load Category Substances, their driver factors, and drivers. Choose **OK**.
20. After all the Load Category Substances have been associated with the drivers and the driver factors, the window in Figure 28 will look like Figure 29.

Elemental Component Items & Drivers

Name: Practice- Spray painting Version: 1

Elemental Component Items

	Load Category: Substance	Driver Factor
	Emission	Industrial waste 250.00000
	Energy	Gas .18600
	Energy Renewable	Electrical 2.40000
	Material Non-Metal	Paint .00643

Add Item

Associated Drivers

<input checked="" type="checkbox"/>	Operation time (min)
<input type="checkbox"/>	surface area (sq.ft)
<input type="checkbox"/>	Thickness of Paint Coat (mm)

OK

Cancel

Figure 29: Complete association of drivers, driver factors with the Load Category Substance for the "Practice - Spray Painting" Elemental Component Process.

21. Choose OK on the window in Figure 29. Choose OK again on the window in Figure 25.
22. We have successfully added the Elemental Component Process "Practice - Spray Painting." This process can now be used for any product that has spray painting involved in it.

4.1.4.2 Adding the Process Tree

1. Start the LCAPIX Module by clicking on the LCAPIX icon in the START menu.
2. Click on the **Process** Icon at the top of the Screen or Choose Inventory from the Tool bar and then choose **Process**. It will launch a window called *Product Selection* asking you to "Select a Product."

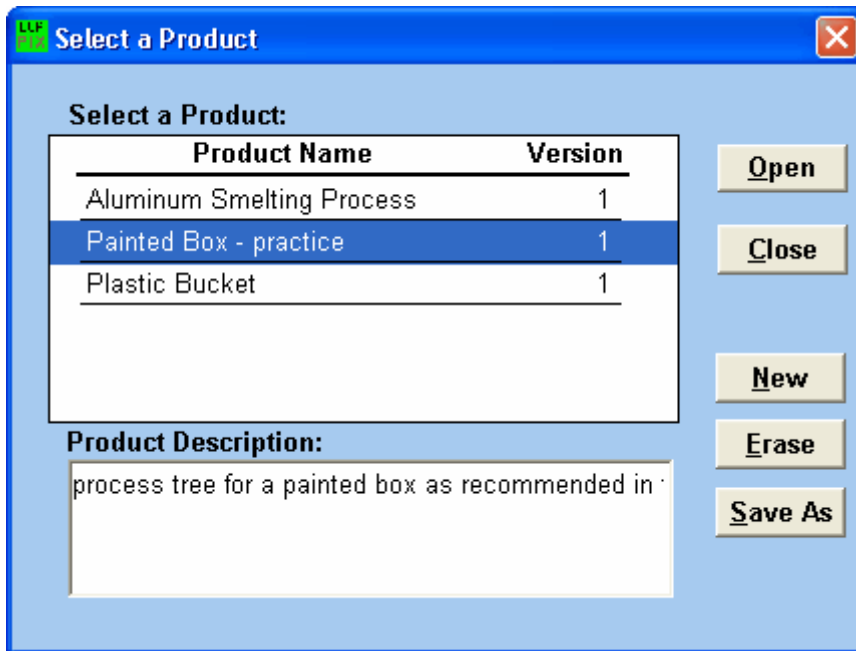


Figure 30: Ongoing screen to name a product whose Process Tree is to be entered into LCAPIX.

- Choose **New** to add a new product and in the Enter New Product Information enter the name of the Product as "Painted Box - Practice Example" and type in a description of this product and choose OK.

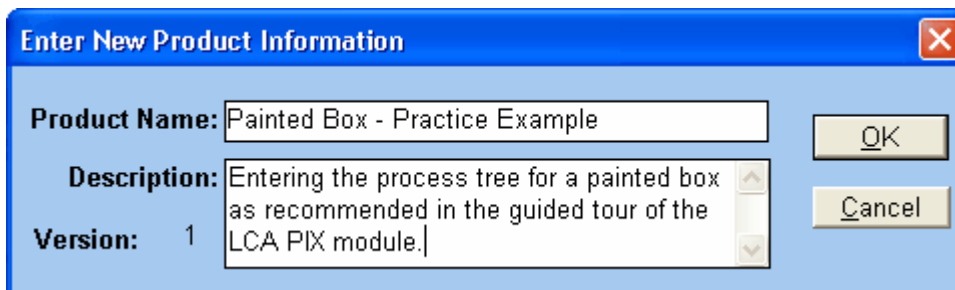


Figure 31: Dialog Box to enter the Product name and its brief description.

- We are now ready to enter the Process Hierarchy in the Window that will come up called *Process Inventory - Painted Box - Practice Example*. As we will be adding new processes chose **New**.

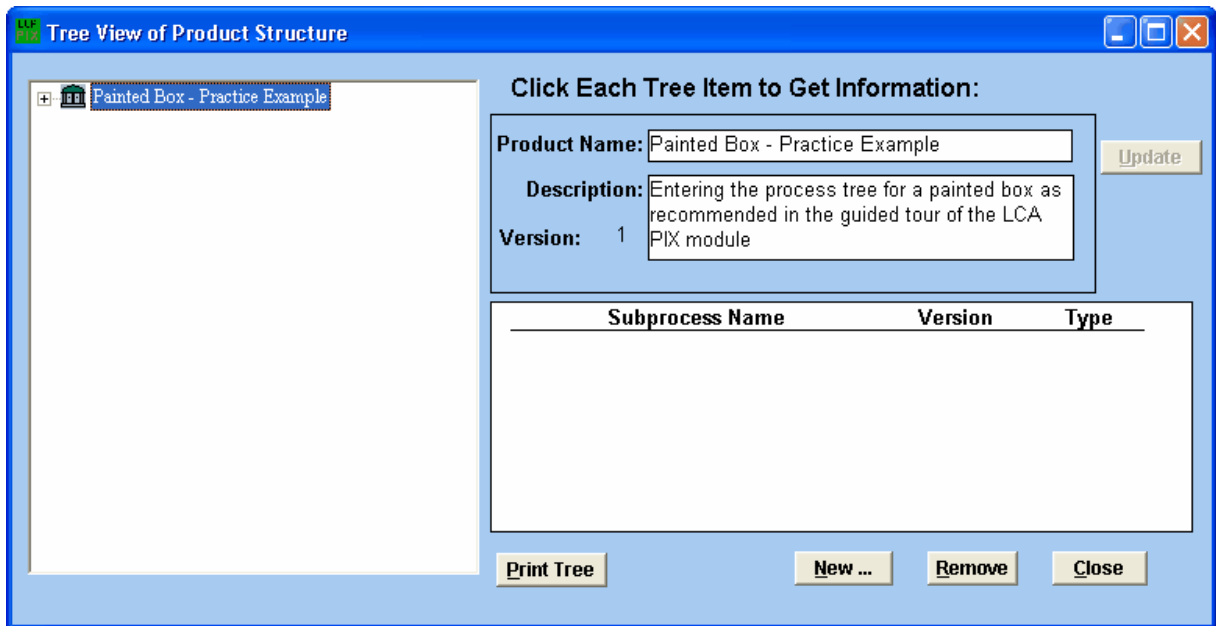


Figure 32: Screen for adding processes and the view of the overall Product Structure.

- Before a new process can be added, a dialog box will come up asking "Will this new process be decomposed into other processes?" As the process "Assembling the Box" decomposes into "cutting the metal sheets," and "welding the seams" (see Figure 37), choose **Yes** and it will launch a window called *Create Sub process* which is the name for the 1st level processes in LCAPIX Module.

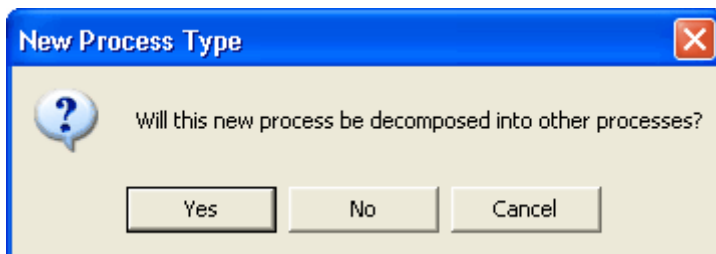
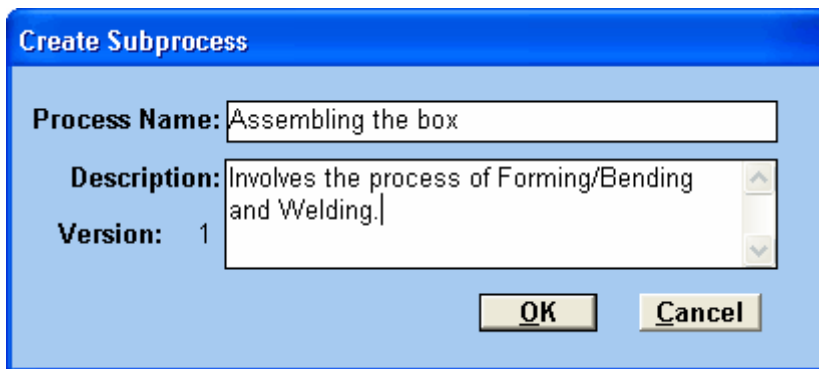


Figure 33: Dialog box to indicate whether the new processes being defined will decompose. The only time when it is answered **NO** is when we are entering Baseline Processes.

- In the Create Sub processes Window enter the name of the process as "Assembling the Box" and type in a description. Then choose **OK** (See Figure 34).



Create Subprocess

Process Name: Assembling the box

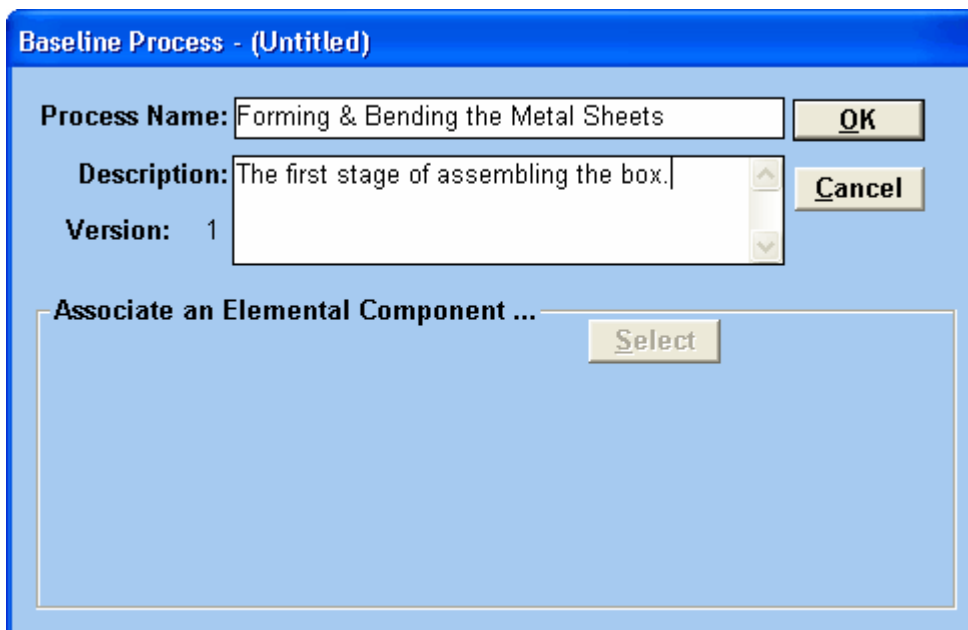
Description: Involves the process of Forming/Bending and Welding.]

Version: 1

OK **Cancel**

Figure 34: Screen for entering Process name and description.

- When you choose **OK**, the option **New** which was grayed out and not available becomes available now. This allows us to now define the processes under "Assembling the Box." There are two sub processes, and as they are the "lowest", and hence, Baseline Processes, they do not decompose. So Click on **New** and in the dialog box that comes up choose **No**. This launches a Window called *Baseline Process*.
- In the *Baseline Process* Window enter the name "Forming & Bending the Metal Sheets", and type in a description and choose **OK**. This will make the earlier grayed out option called **Select** available which allows us to associate Elemental Component Processes with this Baseline Process. We still have not entered the Elemental Component Processes so let us leave this for later. For now Choose OK again and return to the *Tree View of Product Structure* window (Figure 36, listed as a sub process) which will now have the Forming and Bending Metal Sheets.



Baseline Process - (Untitled)

Process Name: Forming & Bending the Metal Sheets **OK**

Description: The first stage of assembling the box.] **Cancel**

Version: 1

Associate an Elemental Component ... **Select**

Figure 35: Screen for entering the Baseline Process and description and associating and ECP.

- As we have the "Welding the Seams" process also at this level choose **New** and enter the name and a description of the "Welding the Seams Process" after choosing **No** to decomposition in the dialog box, and again choose **OK** without selecting the Elemental Component Process. After this the Tree View Window will contain both the processes and look like the following figure.

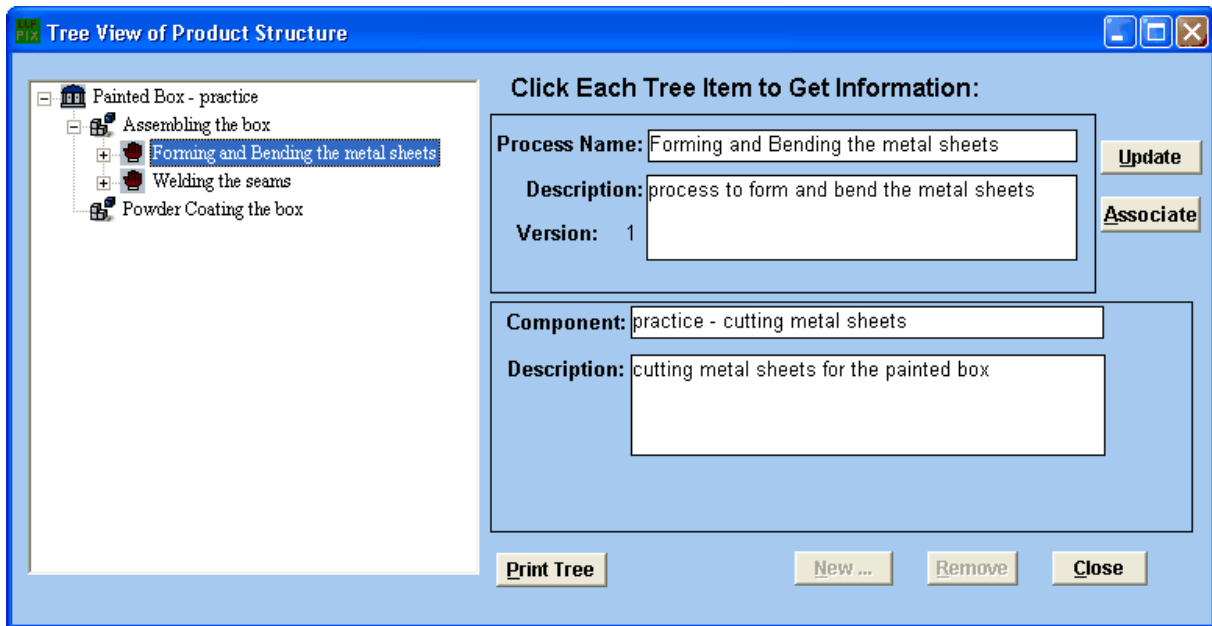


Figure 36: Tree View of the First and Second Level Processes.

10. We have finished defining the "Assembling the box" 1st level process. We now have to define "Powder Coating the box" which is at the same level as "assembling the box." So, choose **New**, but as this is the lowest level process (there is nothing below "Powder Coating the box,") so choose **NO** in the dialog box. Further in the window similar to Figure 35, do not select the Elemental Component Process yet but back out by choosing **OK**.
11. We have now finished entering the Process Hierarchy and hence choose **OK** in the window which should look similar to Figure 37.

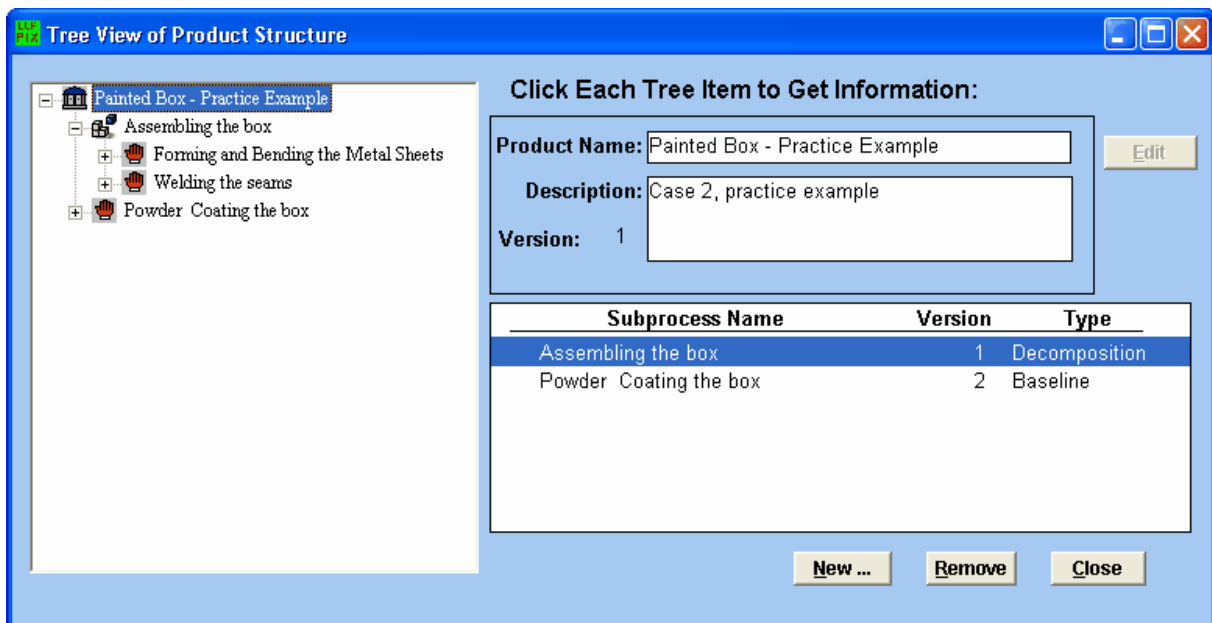


Figure 37: Tree View of the completed Process structure of the Painted Box - Practice

Example Product.

4.1.5 Case 3: Adding or Modifying subprocesses data

You may find that the LCAPIX database at times does not contain some of the units you work in, or some of the data regarding some substances that might be of interest to you. Despite absence of officially sanctioned data (by one of the organizations that provide the numbers for the valuation methods), you may at times still want to do the calculations by estimating the ELU/unit values. This section explains how to use the powerful features of the LCAPIX Module to address these and many other needs.

4.1.5.1 Adding new Processes

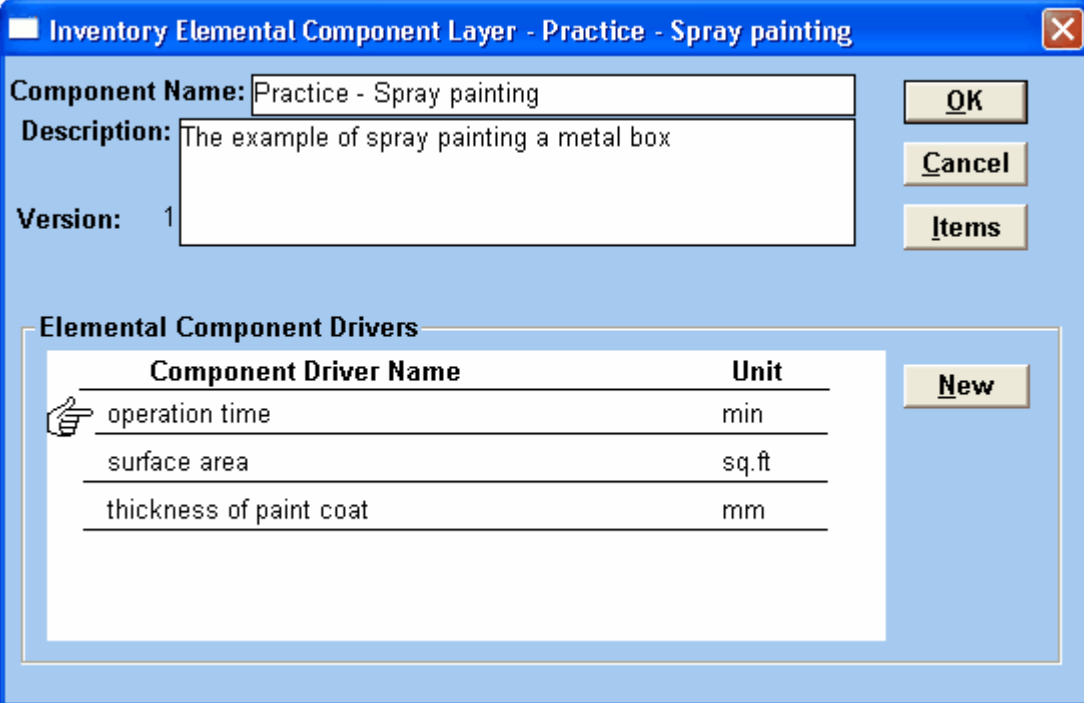
This has been described in Case 2: Adding the Process Tree (See Section 4.1.4.2, Adding the Process Tree for more details).

New processes may be added to existing products and Processes, names may be updated, by the **Update** button. Processes may be removed by the **Remove** button and Products may be deleted by the **Erase** button. Products may be copied and saved as a different Product name by the **Save As** button.

4.1.5.2 Adding Elemental Component Processes or Drivers

This has been described in Case 2: Adding Process data to the LCAPIX database, section 4.1.4. Specifically the steps for adding a new Elemental Component Process are as follows.

1. Start the LCAPIX Module from Windows.
2. Click on the Component icon .
3. In the "*Select an Elemental Component*" Window that pops up choose **New** as we want to create a new Elemental Component Process.
4. Choosing New will pop up a dialog box called "*Enter new Elemental Component Information.*" Type the name of the process, and a brief description of it. It is a good idea to give information about where the data was collected, and what drivers are used to capture information about the elemental component process. Choose **OK**.
5. Choosing OK will spawn a window called "*Inventory - Elemental Component Layer*" where we must associate the drivers that the elemental component process will use. In this step **all** the drivers that we intend to use must be associated. All the associated drivers are displayed in the box called *Elemental Component Drivers*.
6. To associate the first driver Choose **New**. Choosing **New** will bring up a dialog box in which you may enter the name of the driver like "Operation Time," or "Surface Area to paint." Then choose the units from a roll- down menu that can be activated by pressing on the downward pointing arrow. For example for "Operation time" we could choose the units of "min"(utes). Choose **OK**.
7. Repeat the above step for each driver that you want to associate with the elemental component process.
8. After all the drivers have been entered, and are displayed with their units in the "*Elemental Component Drivers*" box, the window "*Inventory - Elemental Component Layer*" will look similar to Figure 38.



Inventory Elemental Component Layer - Practice - Spray painting

Component Name: Practice - Spray painting

Description: The example of spray painting a metal box

Version: 1

Elemental Component Drivers

Component Driver Name	Unit
operation time	min
surface area	sq.ft
thickness of paint coat	mm

Buttons: **OK**, **Cancel**, **Items**, **New**

Figure 38: First step of entering elemental component processes - associating the drivers which are displayed in "Elemental Component Drivers."

9. The next step now is to enter the information about the Load Category Substances. This is achieved by clicking on the **ITEMS** button shown in Figure 38. Doing so will spawn a window as shown in Figure 39.

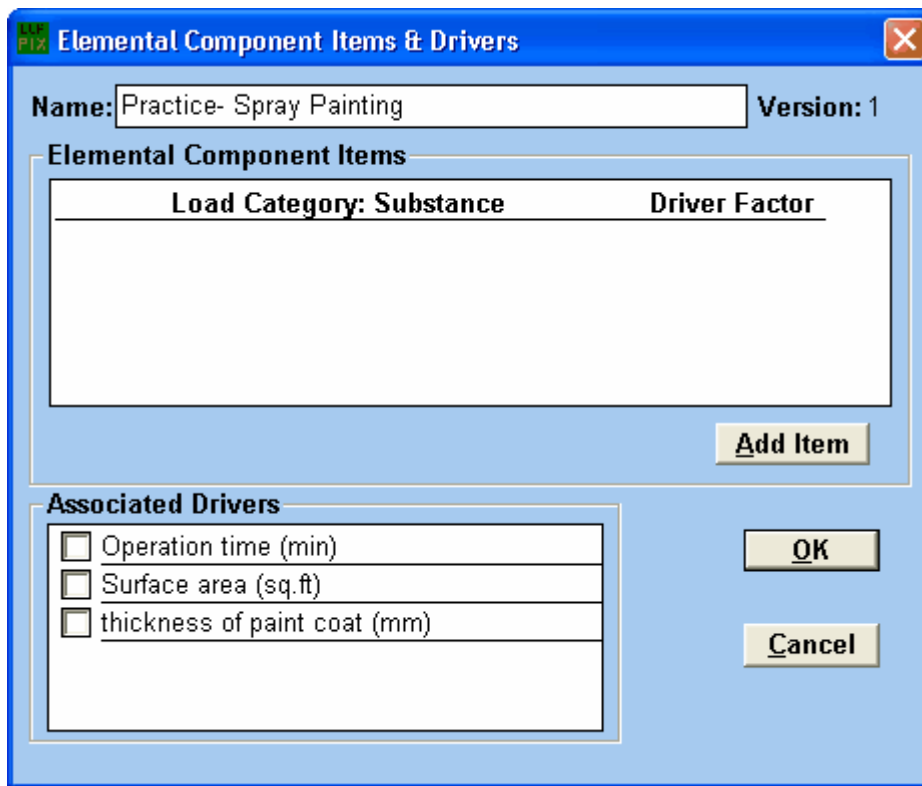


Figure 39: Associating the Load Category - Substances to the Elemental Component process.

10. We must now choose **Add Item** to add each load category substance with one or more drivers by clicking on the driver (a check will appear as a driver is selected.)
11. Choose Ok after all Load-Category substances have been selected.

4.1.5.3 Adding New Load Categories

1. Start the LCAPIX Module if it is not already running.
2. Choose the substance icon .
3. It will spawn a window listing the data available in the LCAPIX Module. The data is displayed as rows of information. First the load category, then the substance, followed by the units, and whether it is official or not. The official sign indicates that the data has been updated by a central source, while if it is not official, it indicates that it has been added by the user. This feature is useful when updates of the databases are to be conducted.
4. At the bottom right of the window, choose **Load Category**.
5. In the window spawned on choosing load category, choose **New**. Type in the name of the load category and a brief description and choose OK.
6. Add the name and choose OK

4.1.5.4 Adding New Substances

1. Start the LCAPIX Module if it is not already running.
2. Choose the substance icon .

3. It will spawn a window listing the data available in the LCAPIX Module. The data is displayed as rows of information. First the load category, then the substance, followed by the units, and whether it is official or not. The official sign indicates that the data has been updated by a central source, while if it is not official, it indicates that it has been added by the user. This feature is useful when updates of the databases are to be conducted.
4. At the bottom right of the window, choose **Substance**.
5. In the window that is spawned, choose **New**. As only a Load Category -Substance is unique and capable of having a unique environmental load value, the substance has to be specified in conjunction with the load Category. So, first select the load category from the available choices by clicking on the downward pointing arrow, then enter the name of the substance, choose the units again by clicking on the arrow and selecting from the choices available. Finally enter a description and choose **OK**.

4.1.5.5 Adding New Units

1. Start the LCAPIX Module if it is not already running.
2. Choose the substance icon .
3. It will spawn a window listing the data available in the LCAPIX Module. The data is displayed as rows of information. First the load category, then the substance, followed by the units, and whether it is official or not. The official sign indicates that the data has been updated by a central source, while if it is not official, it indicates that it has been added by the user. This feature is useful when updates of the databases are to be conducted.
4. At the bottom right of the window, choose **Units**.
5. In the window that is spawned, choose **New**. Enter the way you would like the units to appear (min. sq.ft. etc.) and then type in a description. Choose **OK**.

4.1.5.6 Adding New Valuation Methods

1. Start the LCAPIX Module if it is not already running.
2. Choose the substance icon.
3. It will spawn a window listing the data available in the LCAPIX Module. The data is displayed as rows of information. First the load category, then the substance, followed by the units, and whether it is official or not. The official sign indicates that the data has been updated by a central source, while if it is not official, it indicates that it has been added by the user. This feature is useful when updates of the databases are to be conducted.
4. At the bottom right of the window, choose Valuation Methods.
5. Choose **New** and enter the name and description of the Valuation method. Choose **OK**.

4.1.5.7 Assigning ELU/Units to load category substances

1. Start the LCAPIX Module if it is not already running.
2. Choose the substance icon.
3. It will spawn a window listing the data available in the LCAPIX Module. The data is displayed as rows of information. First the load category, then the substance, followed by the units, and whether it is official or not. The official sign indicates that the data has been updated by a central source, while if it is not official, it indicates that it has been added by the user. This feature is useful when updates of the databases are to be conducted.
4. At the bottom right of the window, choose **Load Per Unit**.

5. As the Environmental Load is only associated with a unique Load Category and Substance combination, and can only be expressed if the valuation method is specified, we need to specify all four. In the Window that spawns on choosing Load Per Unit, first choose **New**.
6. Then in the first row, select the load category by displaying the list after clicking on the downward pointing arrow. In the next row choose the Substance. Then enter the Load Per Unit numerical value, and then choose the units in the next box. Finally type in a brief description. Choose **OK**.

Part



5 New Features in Version 2.0

LCAPIX V2.0 Main New Features (various small changes are not included)

1. Installation

Run the install program. The user can choose or create the installed folder. The database engines and ODBC engines, if not already installed or too old, will be updated automatically. The ODBC configuration will be automatically performed, the connection name is "lcadb". The user can verify it via Control Panel, but it's not necessary. It points to the database file "demo.db" in the installed folder of lcapix. For the workstation install the database will be on the workstation. For the Network install the database will sit on a server. The user must specify the server directory. ODBC will be setup to point to the database.

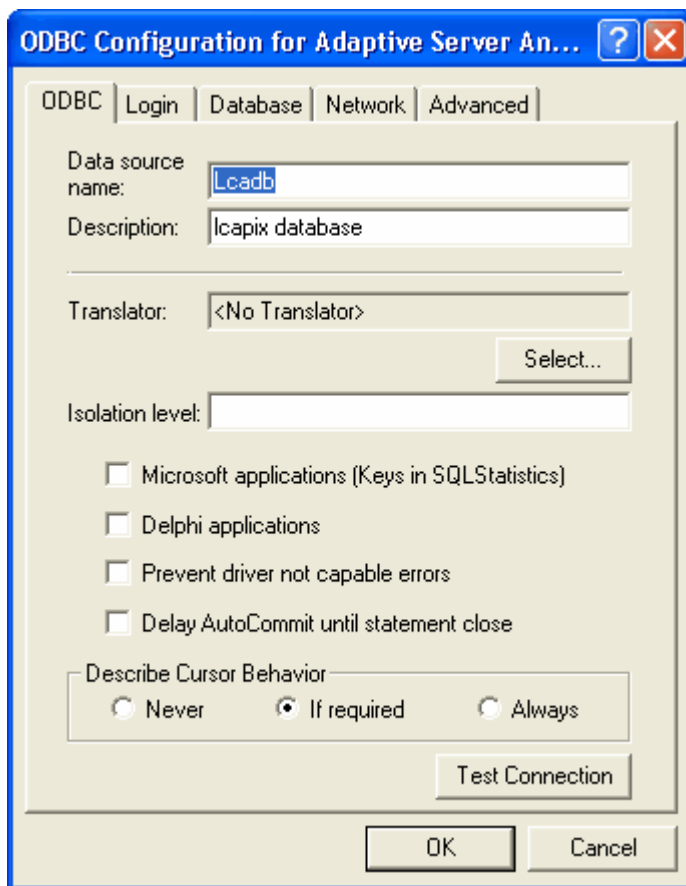


Figure 40: ODBC configuration window for setting up your database.

When the user starts the LCAPIX program, it will automatically connect to this ODBC connection. If the user changes the connection name, the program won't automatically work, so it's suggested that users leave the configuration as is.

2. Product Building and Editing

When a new product is created or an existing product is open, this window will be shown:

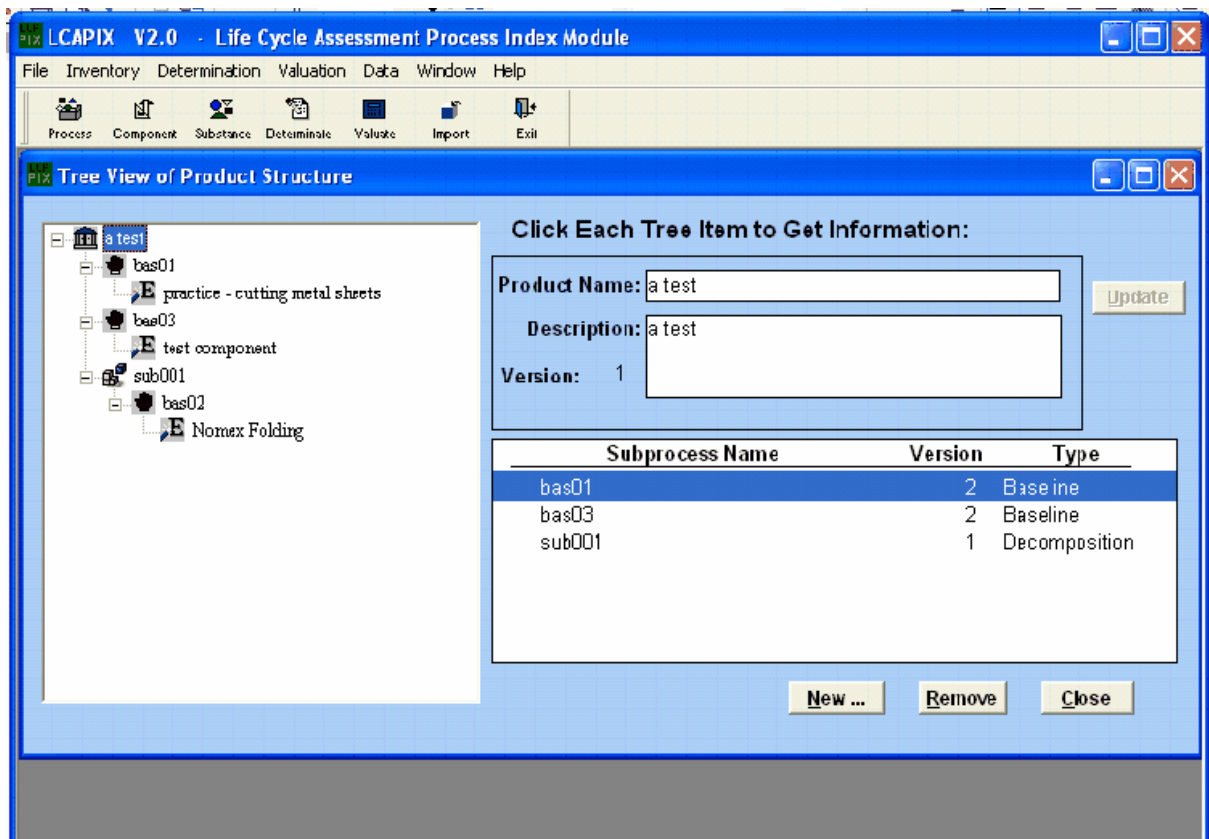


Figure 41: Tree structure of a new test product being created.

The tree structure can be expanded/compressed using the "+/-" controls. When an existing product is opened, everything is expanded initially.

To focus on a tree element click on the element name and its information will be shown on the right.

For processes except the root (product) and the elemental component (associated with a baseline process), the user can edit the "Process name" and "description", and click the "Update" button to update the names; the tree structure will change accordingly. If a user wants to change the product name (the root), the user can do it in the "select product" window, in which there are choices of "Save as" and "Erase". A baseline process name can be edited, but an elemental component name cannot be edited. The user must delete and re-add the corresponding baseline process, because we want to ensure that a component is attached to a baseline product. There are corresponding changes to the "add" process for a baseline process, too.

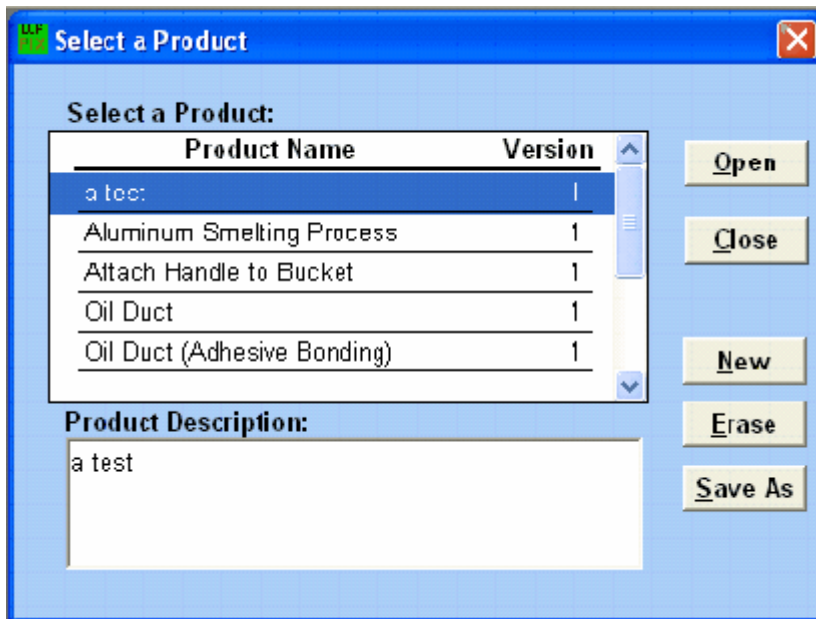


Figure 42: Updated window to select a product with which to edit.

The lower-right part of figure 41 is the list of sub processes for the current process selected. For baseline processes, the "new" and "remove" buttons are useless, because only one elemental component is allowed to be associated with it. For an intermediate sub process, the user can delete its sub processes by choosing from the list and click "delete". To add a new sub process, click "new" and follow the instructions. **If the new sub process is a "baseline process", choose "No".**

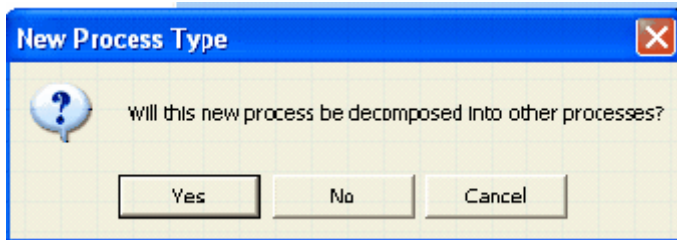


Figure 43: Ability to associate the newly created process or create a new baseline process.

"Yes" and "No" lead to different windows that perform differently. If the user chooses "No", then the user needs to enter a baseline process, and is forced to associate it with an existing elemental component, or create a new one.

If the user creates a new component, then the user needs to edit it in the "component" window later.

3. The Obsolete Function in "Component"

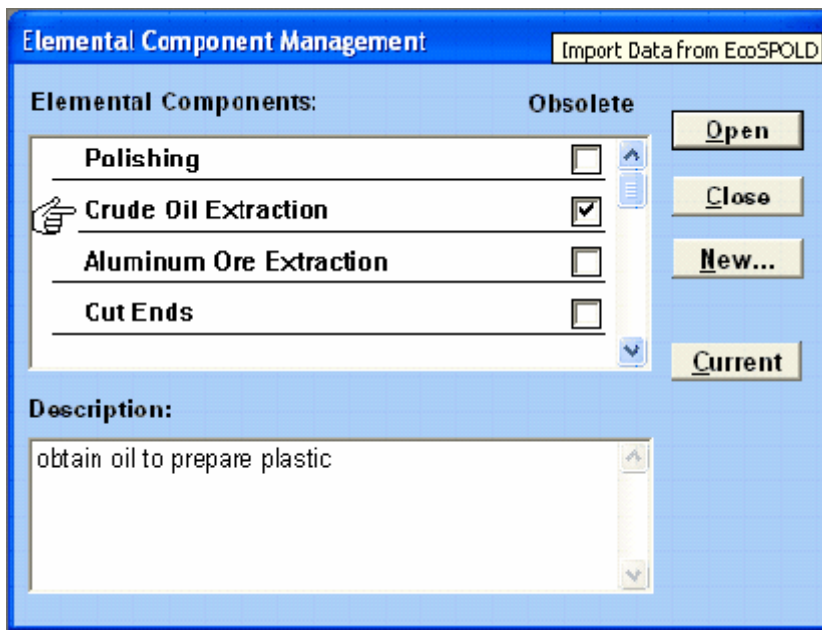


Figure 44: Component manager with the option to declare a certain element obsolete.

The user can click on the square box beside the elemental component name in order to make it obsolete ("checked" means "obsolete" here). Then the button "Current" will show only the components that are NOT obsolete. When clicked, the button name will change to "Show All", which if clicked, will show all components, with obsolete ones at the end of the list.

The function and name of the button will alternate between the two choices.

4. The new "Print" function

Now the print function is also added to the "Graphics and Tables" window, as well as the report window, so that user can print out the graphs, too.

When the "Print" button is clicked, the user has many choices for a print job, including printer selection, printer page setup, select pages to print, print to a file, etc.

The user may print the tree, the Elemental Components with drivers and drivers factors and driver values.

5. The "Import" function

There are two Excel files installed together with the installation of LCAPIX. They are located in the EcoSPOLDDTA sub folder of the installation folder. User can open them using Microsoft Excel. However, only the data part of Cost.xls is editable – other parts are protected by password "kml". The user can edit the cost values at will, but only valid numbers will be imported, others will be ignored.

Once the user executes import, the program will prompt the user to choose one of the data files.

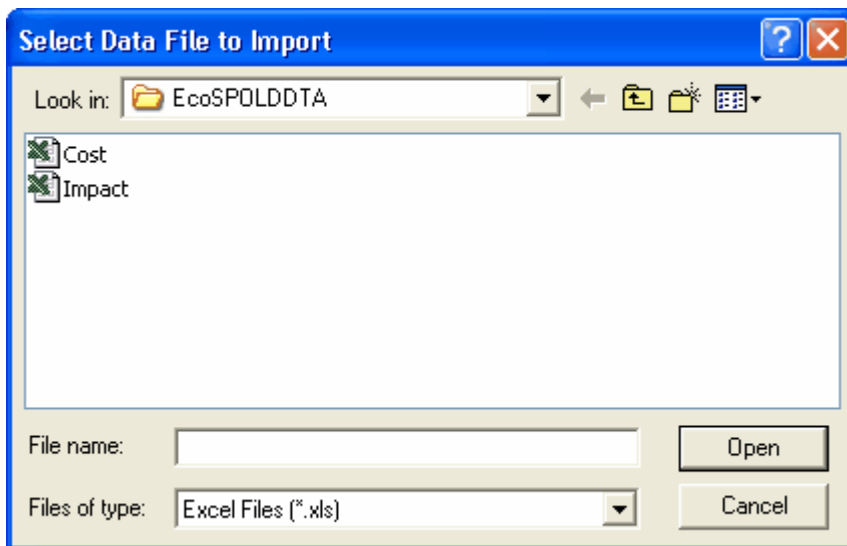


Figure 45: Select the excel file to import data from

Note: if the user has moved or changed the name of folder EcoSPOLDDTA after installation, the program will not automatically point to the two files. But in any case, the user can browse and find the files.

Then, the user can choose the data sets from the input file, and choose a valuation method from the system database as the destination. Right now there are three data sets to choose from Impact.xls, and one data set to choose from Cost.xls. In the system, there are four valuation methods accordingly: BU, ELU, Tellus, and Cost.

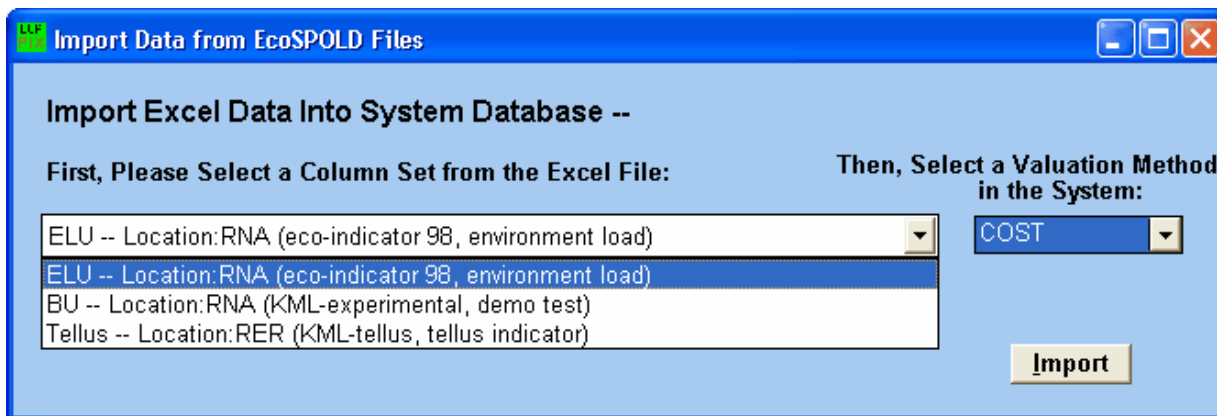


Figure 46: Select the data sets from the input file.

Clicking the "Import" button, a warning will be displayed. If user chooses to continue, the data being imported will be shown quickly beside the button, meanwhile the buttons will be disabled, in order not to interfere with the import process. Once the import is completed, a summary message box will show up.

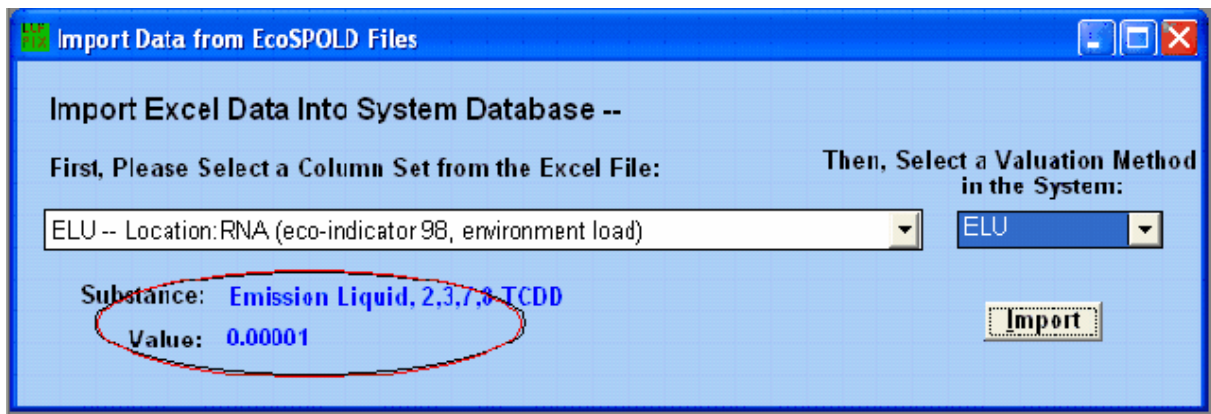


Figure 47: Warning screen before importing the Excel data.

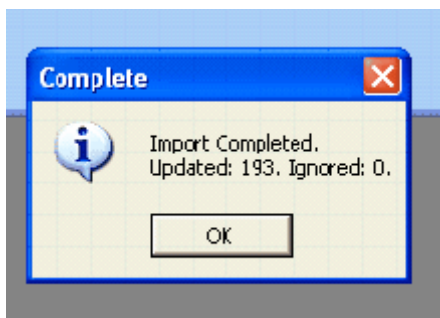


Figure 48: Summary message after data has been imported.

6. Substance and Valuation Method Changes

Users are now not allowed to add, delete or edit the following:

- Load Categories
- Substances
- Valuation Methods

This is to ensure database integrity. Once standard Category and Substance Names are given, users should be allowed to only edit the associated data, not the set of names.

Therefore, corresponding buttons were disabled (grayed out).

Part



6 Glossary of the Terms

Baseline Process: is the lowest level sub-process of a process-hierarchy. Once the baseline process parameters are quantified, all the upper level sub-processes can be computed by an appropriate combination of the constituent baseline processes. (Also see Process Level and Elemental component process.)

Component Menu: In the PIX module, this refers to the utilities provided in the software to add and update information about the elemental component processes.

Determination Stage (menu): In the PIX module, this refers to the step in which the driver values are specified so that Environmental Load (ELU) computations can be made in the valuation stage. For example, a driver like "surface area to be painted" will be specified as "200 sq. ft." in the Determination stage.

Driver Factor: Is the experimentally determined number which when multiplied by all the drivers yields the amount of Load Category-Substance. Attention must be paid to the units of the driver factor as it depends on the number and type of drivers used.

Driver: These are parameter(s) of the baseline process that can help us characterize the loads for each Load Category of that process. For example, if we know the "surface area to be painted" and the "thickness of the coating required" we can approximately determine the amount of "paint (i.e. materials)" that will be needed, the "emissions" during the process, "energy" requirements during painting. The "surface area to be painted" and "thickness of coating required" are the drivers, and the "paint (i.e. materials)," "emissions" and "energy" are the Load Categories, while the amounts of the paint, emissions, and energy are the loads.

Elemental Component Process: This is the library of processes for which experimental data has been collected and entered into the database. All baseline processes must be associated with one of the elemental component processes if the data in the database is to be used. This library is continuously expanding. In case an equivalent of a baseline process is not in the library, a new elemental component process can be created through the component menu.

Load: is the burden exerted on the environment. It is quantified depending on the Valuation Method that is being used. For example, the Environmental Priority Strategy (EPS) method assigns Environmental Load Units (ELU).

Load Categories: These are the attributes of the process like the process-materials used, the energy consumed, or the emissions, that need to be monitored. The name Load Categories is assigned because each of these process attributes exert a load on the environment, and the total load for the process is the sum of the load of all the load categories. (Also see Load Category-Substances)

Load Categories-Substances: The valuation method databases provide the loads for substances, but a substance can have different loads depending on what load category it is in. For example, when copper is used as a raw material, the load is 28.7 ELU/kg, but if copper particles are emitted the load is 500,000 ELU/kg. Thus, even though a substance should be referred to in this context even at the expense of using the load category qualification redundantly.

Process Level & Hierarchy: This is the system of processes and the sub-processes that compose the process. A Level I process is also called machine/line process, Level II is called sub process in this hierarchy and is also called the baseline process. (See Figure 4.)

Process Menu: In the PIX Module refers to the menu options that provide utilities related to adding and updating the Process Level & Hierarchy information.

Substance Menu: In the PIX Module refers to the menu option that provides utilities related to adding and updating the load category-substance database.

Substances: The databases of the valuation methods provide the loads for the substances. For example some values provided by EPS method are: oil = 0.4 ELU/kg; Forest Land Use = 0.00825 ELU/m²; N₂O emission = 5.55 ELU/g. Here, oil, forest land use, and N₂O are the substances. (Also see Load Category-Substance)

Valuation Method: is the method by which the amounts of load category-substances are assigned an environmental load. For example, in the EPS method (see load for EPS and ELU), Copper is assigned a load of 28.7 ELU/kg. The load in another method, like the Tellus Method, will be different from 28.7.

Valuation Stage: In the PIX Module refers to the step in which the loads are calculated based on the driver values provided by the user in the Determination Stage. The Valuation Stage combined with the Determination Stage corresponds to the Impact Analysis of the basic LCA methodology.

Part



7 Technical Assistance

LCA-Process Index Module is an evolving software and feedback from the users is welcomed. Please feel free to comment on any aspects of the software including (but not limited to):

- Application Interface
- Usability and Ease of Interaction with the Program
- Database Content
- Ease of Reuse and Exchange of Information
- Any custom modifications that you might make which can be shared with other users
- Any specific needs or desired enhancements which are not addressed in this version
- Any bugs in the program

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