Cost analysis and pricing of innovative postal products

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"Not everything that counts can be counted, and not everything that can be counted, counts".

-- Attributed to Albert Einstein

1. Introduction

Modernization of the postal sector raises a number of questions related to the nature and role of postal products (PPs) in the mail communication system. In addition to their traditional role PPs also serve as a main interface between users and postal operators (carriers) as well as a target for regulatory process. In a deregulated environment, pressure to quickly introduce new products with differentiated features is high. Having this in mind, and after reviewing the literature, we concluded that a clear definition of PP suitable for reliable cost analysis can be very useful. Meanwhile, significant progress was made in specifying data structures suitable for representing information in business applications.

In our previous paper we addressed implications of a formal approach to product definition for product innovation (Pintsov and Obrea, 2008, Postal Reform) that has many momentous advantages. The present paper exploits this approach for PP cost analysis exemplified by parcel products. While we believe that the approach advocated in this paper is broadly applicable to all classes of mail (letters, flats, and parcels) and mail products, we had to restrict our analysis to parcel products due to available experimental data[ii]. For our analysis we selected a single costing methodology due to limitation of space. We have chosen Activity Based Costing (ABC) since this is the methodology that is in use in Canada Post for parcel products. Finally, because we believe in a general trend of increasing complexity and variety of postal products, the ABC approach seems to be best fitting (Awerbuch and Preston, 2000).

Given this, the paper proceeds as follows. In Section 2 we give observations concerning PPs cost accounting as presently practiced and summarize its relevant characteristics in the context of product innovation. In Section 3 we outlined the concept of ePostal Commerce (Pintsov and Obrea, 2008) enabled by the Extensible Postal Product Model and Language (EPPML) that is focused on a PP description suitable for costing. Section 4 describes how EPPML-structured product definition can be applied to cost accounting and pricing. This is illustrated by a stylized example of Canada Post parcel product. Section 5 outlines a computer model we developed to analyze and understand complex interactions between products and their costs in a shared production environment when system resources are flexible. We conclude by summarizing major benefits and challenges of our approach to product costing in a rapidly changing postal market environment.

2. Cost accounting and postal product innovation.

There is extensive literature dealing with major theoretical and practical aspects of cost accounting (Crew and Kleindorfer, 2000), (Bradley, 1997), (Bradley,1993), (Bozzo, 2006) (Awerbuch and Preston, 2000), (Pintsov and Obrea, 2008), (M. Roberts, 2006).

Large postal operators (e.g. USPS, Canada Post and Royal Mail) have adapted postal product costing on a “disaggregated basis”. It first estimates mail volume-dependent (marginal) cost of each product by computing cost components of a given product independently for each activity in the value chain associated with the product delivery (for example mail collection, mail sorting, and mail delivery). Then all these activity-linked cost components are added up resulting in a product cost (Bradley, 1993), (LECG, 2006). Computation of incremental cost on the other hand requires knowledge of product specific fixed costs plus certain “intrinsic” (variable) costs in the cost pool. One of the main purposes of the incremental cost analysis is testing for cross-subsidies between different products.

Our main interest in this paper is the relationship between product innovation and cost accounting. It is not difficult to see why product innovation is expected to increase the volume of comparatively low-volume high-complexity products at the expense of high-volume low-complexity products. ABC methodology applied in a traditional manufacturing revealed that high-volume low-complexity products may subsidize low-volume, high-complexity products (Awerbuch and Preston, 2000). It has been also noted that the quality of the metrics or "cost drivers" is a key consideration if ABC is to be used reliably. Our objective is to provide more accurate and rich data input for the cost accounting algorithm while avoiding debates about the best conceptual model. Typically ABC costing requires that the process of product delivery ("production") is divided into a set of activities whose cost is evaluated under appropriate assumptions about product quantities and measurable parameters of its associated mail items (e.g. cubage). The latter aspect is of particular importance. In the traditional volume-variable cost accounting the description of PP is *implicitly assumed* as opposed to being *explicitly defined.* For many decades the product portfolios of postal operators were stable mainly consisting of a few letter/flat mail products [first class (or premium) mail and second class or economy mail, distinguished mainly by transit times] and a few parcel products (differentiated basically along the same lines). In addition a few "value-added" products were offered (e.g. certified, registered and confirmed delivery mail) that were viewed as add-ons to the standard products such as first or second class mail. Most products were sufficiently high volume and fluctuations in volume from year to year did not have material impact on the cost evaluation methodology or its input data. This is already changing and will definitely change in the future. Electronic substitution and increasing competition in postal and delivery sector are forcing postal operators to differentiate their products. Recent data from Royal Mail and TNT indicates that the pace of introduction of new products increased significantly in the last few years (for example Royal Mail introduced 11 new products between 2003 and 2005 and 21 new product between 2006 and 2007). Changes in the cost of PPs in the traditional environment (characterized by the stable product portfolio) came mostly from changes in the general ledger data (e.g. labor cost), improved productivity and network parameters (e.g. new equipment, new facilities and carrier routes). Accordingly costing methodology and costing input data collection were adapted to deal with these changes. We argue that the increasing customer demand for new products with comparatively smaller volumes and higher complexity may require a different approach with much more precise identification, definition and measurement of PPs cost-causative attributes. This is the main subject of the paper.

The complexity of postal cost accounting and allocation is attributable to several factors, namely philosophical differences concerning a framework of basic reference (true economic costs versus conventional accounting (reporting) costs (Awerbuch, 2000), multiplicity of postal products (services) and a complexity of the postal processes that are organised into several distinctly different functions (collection, processing, transportation and delivery), each of which has different ratio of fixed to variable costs. More specifically, cost of processing and delivering a mail item is a function of many interconnected attributes and parameters. First, there is the mail item itself that can be described by its intrinsic characteristic (e.g. size, weight, and material parameters) and by its information carrying and group aspects (e.g. addresses, identifiers, digital postage mark, information readability, level of presort). Then there is a product that can be defined as a collection of physical and informational attributes, as well as rules and access requirements (we give a detailed explanation and definition of the product attributes below). The postal process (viewed as "manufacturing" of postal products) is a sequence of operational activities required for delivery of a given product to a given mail item. And, finally, there is a postal network with its processing plants and equipment, retail facilities, collection boxes, carrier routes, transportation fleet, IT infrastructure and personnel, all with their own cost parameters and characteristics. In view of this computing cost of a PP is complex. This complexity is aggravated by the fact that many PPs share common resources and processes. Some of the difficulties of the product costing merely reflect the natural complexity of the costing task and can not be alleviated. We believe however that some other difficulties are due to the lack of definition of what constitutes a PP optimized for the cost accounting purposes. We are in need of a definition of a PP that can serve as a suitable input to the costing algorithm. If such a definition exists it then can be used to computer-assist (or even completely eliminate) manual activities related to decomposition (for costing purposes) of the postal process required for a given product delivery. If this is accomplished, one aspect of complex and lengthy postal product innovation, (namely determination of economic and regulatory feasibility of new candidate products) can be improved. We believe however that besides constructively defining PPs it is equally important to have clearly defined and stable activities (business processes), and accurate (reliable) metrics (e.g. general ledger, volumes and activity metrics). In this sense our approach would help to crystallize potential defects in the definition and description of activities and metrics but would be of limited use in solving other costing issues.

3. Product Innovation and ePostal Commerce

Previously in (Pintsov and Obrea, 2008, Postal Reform) we have described a new approach to postal product definition and distribution. In this section we briefly summarize this approach with the emphasis on its features important for the data collection suitable for cost accounting.

A postal product can be viewed as an informational object. It can be defined by a formal structure consisting of elements organized as an extensible collection of measurable attributes and their relations. It is convenient to group these attributes and their relations into four categories, namely *physical attributes*, *informational attributes, rules* and *access requirements*. Physical attributes define physical parameters of the mail item(s) and the postal network subject to a given product. Information attributes define data to be supplied to the product users (e.g. mail items senders and recipients). These attributes are described in terms of the information that is or could be made available to the postal operator (PO) as a result of its operational or other information gathering activities related to delivery of the product and its associated mail item. The rules define a broad variety of physical, informational and financial activities that the PO would undertake vis-à-vis the mail item being served. These activities depend on the processing conditions that are requested by users and allowed by the delivering post(s) as features or options of the product. The access requirements are also specified in terms of conditions imposed on a) the mail item itself, b) the information that is required to be collected by the user and electronically communicated to the post, c) accounting evidencing and payment instructions including volume or other discounting conditions, d) packaging and containerization instructions, e) the product validity period. The best known example of conditions imposed on the mail item is “make up” rules defining data elements that should be present (visible) on the mail item. These data elements are, for example, the destination address block, the product indicator and the postage evidencing data. A typical example of the electronic information requirement is the statement of mailing submission (also known as the manifest especially when dealing with parcels) that describes information pertaining to the entire collection of mail items (Pintsov and Obrea, 2008, CEN/TS, 2006).

The four categories of product attributes and their relations are presented and exemplified in Tables 1, 2, 3 and 4. Table 1 describes attributes that are related to the *physicality* of the mail item and its induction, processing, transportation and delivery operations and exemplifies acceptable ranges for the values of these attributes.

Attribute	***Description***	***Value (example)***
Mail Item Dimensions	Length x Width x Height	(10-20)" x (5-9)" x (0-8)"
Mail Item Volume	volumetric measure of allowed mail items	(0 – 1,000) cubic inches
Characteristics of mail item’ cover material	Allowed type and parameters of cover material	Any except metal foil

Mail Item Content	Restrictions on the content of the mail item	No explosives or liquids
Geography of induction	Geographical area where mail item can be inducted (described in terms of a set of postal codes, geocodes or conventional addresses)	Postal code K1A0B1
Geography of delivery	Geographical area where mail item can be delivered (described in terms of a set of postal codes, geocodes or conventional addresses)	Postal codes T0J 0A0 - V5T 1Y9
Timing and frequency of collection	Description of when and how frequent mail items can be collected from senders	Every Monday from 9:00 am till 17:00 pm
Timing and frequency of delivery	Description of when and how frequent mail items can be delivered to recipients	Daily except Sundays once a day in the afternoon
Delivery Instructions	Description of conditions defining mail items delivery to recipients	Leave at Door (no card) or Pick-up on demand

Table 1 – Physical attributes

The attributes in Table 1 define characteristics of the physical movement of mail items through the postal distribution network and are mostly are self-explanatory. The last set of attributes (delivery instructions) is particularly important for parcel and express mail products. These attributes include any requirements from simple (leave at the door with no other conditions) to complex, involving obtaining positive proof of identity from the recipient, signature, COD and return service labels.

Table 2 exemplifies *information* attributes that describe data relevant to the use of mail by the mail senders and recipients.

Attribute	***Description***	***Value (example)***
Event information for the mail item that is being served by the product	Information about events that occurred during mail item processing described in terms of date and location of its occurrence and the nature of the event (significant changes in the values of selected measurable attributes)	Tracking information, delivery confirmation, the mail item defects detected as a result of a scanning event
Event information for mail item(s) linked to the mail item being served	Information about events occurred to other mail item(s) linked to the mail item that is being served	Business reply mail tracking information

Table 2 – Information attributes

The attributes in Table 2 describe “data services” associated with physical movement and processing of mail items, for example tracking information defined as a special case of event information (CEN/TR 15524, 2005). More detailed description of information attributes are given in (Pintsov and Obrea, 2008).

Table 3 exemplifies a *rule* that redirects the mail item whenever it is damaged.

Rule	***Description***	***Example***
If the mail item is damaged during postal processing, transportation or delivery, redirect the mail item to another pre-specified address	The rule is a description of actions to be taken by the post when the physical and the information attributes associated with the mail item that is being served satisfy pre-determined conditions. This also includes remedies for exceptional situations when the product could not be delivered as specified.	**If** the weight of the mail item is less that the its original weight by 10% or more (as it has been measured at induction) **then** deliver the mail item to the address different than the original delivery address

Table 3 – Example of a rule

Rules are flexible constructs that are expressed as relations between physical and informational attributes. The most important examples of rules involve exceptional situations (which are not that infrequent in practice).

Table 4 describes the product *access requirements* that are defined as conditions for product use that must be satisfied by mail producers, mail recipients or both and the product validity period.

Elements	***Description***	***Value (example)***

Mail Item Make Up	Data elements that must be present on the mail item in terms of the data content, data format and data placement	Address Block must be at least 3" from the edge of mail item; Identifier Barcode must be in the first line of the address block and must have 13 digits encoded in code 39
Statement of the Mailing Submission	Electronic data that must accompany mail item(s) including data format and communication protocol	Statement of Mailing Submission must satisfy requirements of the XML schema defined in CEN Standard 15523
Payment	Payment requirements in terms of its timing, method and discount qualifications	Payment for the mail item must be made prior to its induction via electronic transfer into the account ABI 577546899. For mailing of more than 1,000 items there is 10% discount
Product Validity Period	Beginning and ending dates when the product is available	From May 14, 2008 till August 5, 2008

Table 4 – Access requirements

The list of attributes, elements and relations in Tables 1 through 4 is not exhaustive and is merely meant to signify the method of identifying useful attributes rather than the attributes per se. The characteristics of a product description language exemplified in Tables 1 through 4 are relatively straightforward to incorporate into a formal, computer-oriented language. Indeed, the formal representation of attributes and elements in Tables 1 through 4 that is suitable for computer processing can be made using an XML schema, which is a widely used mechanism to define the syntax for XML documents (files) and which in turn can readily express constraints on their structure and content. Thus, postal products can be represented formally as XML documents processable by computers. In this context the product representation language is known under the name “Extensible Postal Product Model and Language” (EPPML) emphasizing its openness for extensions and interpretation by computers (UPU P28 EPPML draft standard 2008). It also possesses important interoperability features that are useful for interlining which is discussed in more detail below.

The EPPML-formatted product definition files can be automatically downloaded into mailer’s operations (e.g. mail assembly and finishing) (Fig.1).

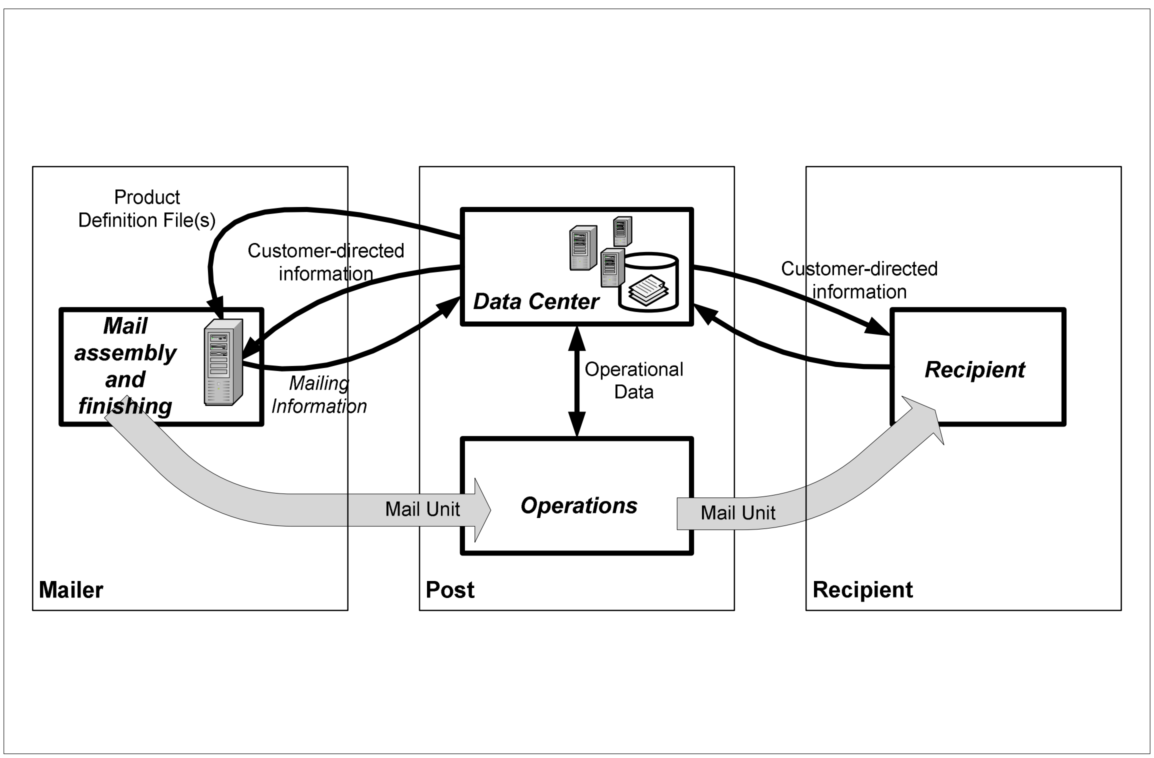

Fig.1 – ePostal Commerce environment

Products for downloading are selected using criteria defined by the sender. Upon choosing the best available product an automated mail assembly and finishing system verifies that the product access requirements can be successfully met using the product definition file and generates (automatically or with an operator's assistance) the mail item(s) and all the associated mailing and payment information. Then the mail item is inducted and the mailing information is transferred into the postal operations for processing and delivery. Requests for data captured during sorting, transportation and delivery and the resulting information (operational data) are exchanged between operations and the data center. If the selected product requires delivery of the information to mail users (e.g. tracking or confirmation of delivery) the data center transfers this information upon completion of the corresponding operation. This information is known under the name "customer-directed information" and it is described in detail in the European Standard CEN/TR 15524, 2006.

There are many benefits resulting form the definition of PPs using EPPML (Pintsov and Obrea, 2008, Postal reform). Most significantly, it allows for quick introduction of new products tailored to customer needs using web and streamlined, automated Internet-based access to these products by customers, creating a far more efficient distribution channel for postal operators and carriers. It also contributes to cost reduction by decreasing the number of postal process-unfriendly mail items.

From management and governance perspective the EPPML-based system allows to expedite postal product cost accounting and approvals. Specifically, attributes, rules and access requirements of Tables 1-4 when represented as an XML (EPPML) document serve as an input to a cost accounting algorithm.

4. Cost accounting in the EPPML-enabled environment

In this section we shall give a stylized example of cost accounting in the EPPML-enabled environment. We show how new features can be added to existing products and how the cost of resulting new products can be computed.

First, the EPPML file containing complete description of a PP is converted into cost drivers (cost parameters of all activities involved in the delivery of the product) (Fig. 2).

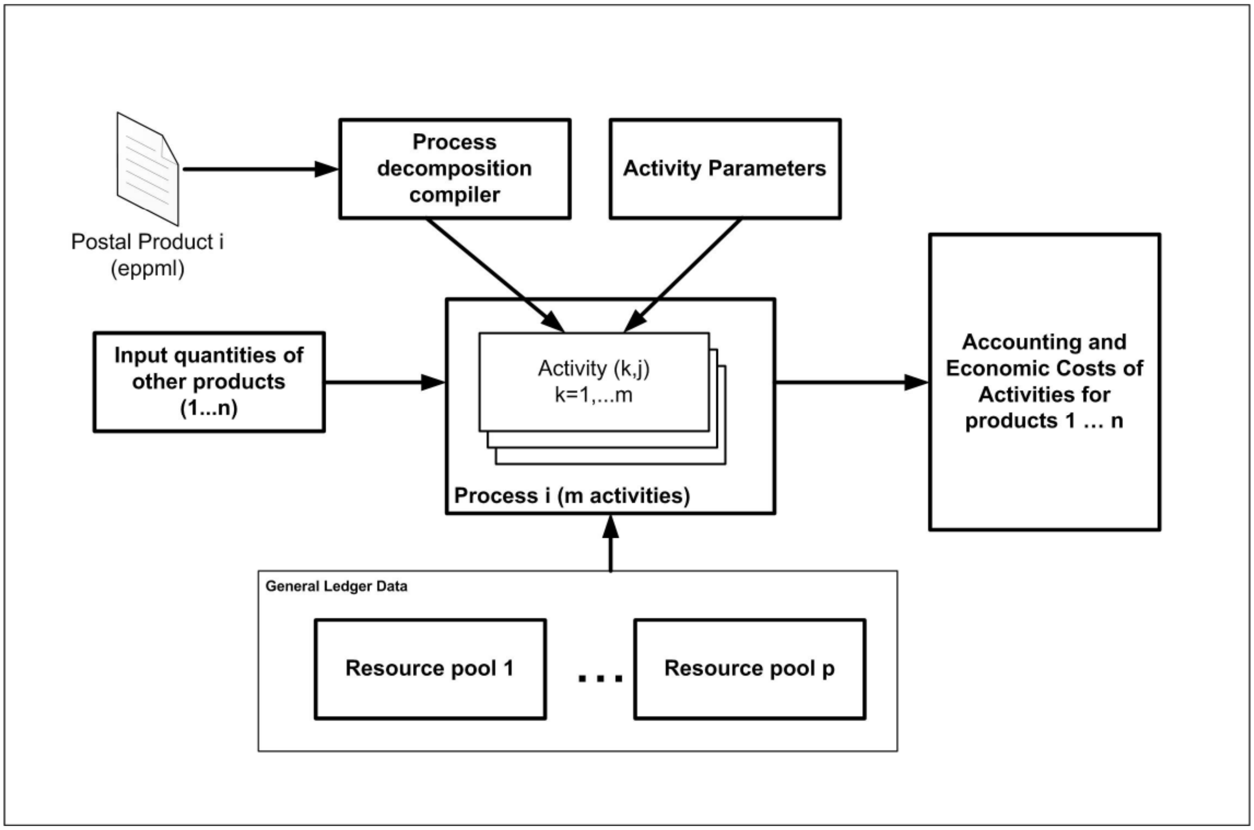

Fig. 2 – Cost Accounting Process in EPPML-enabled environment

Each cost driver reflects a cost contribution of specific activity (e.g. induction, sort, transportation and delivery). The conversion is performed by a software application (product decomposition compiler) when mapping between product attributes and process activities (and their corresponding drivers) is possible. We claim that the conversion is always possible providing that the product structure is adequately expressed in the EPPML product file and a detailed and properly structured catalog of process activities and steps is also available. After the conversion the total operating cost is computed by summation of the (average) costs of individual activities. Each of these costs in turn is computed by combining cost drivers, volumes and general ledger data (stored in resource pools). Our approach allows for two modes of operation. Before actual product introduction the product cost can be estimated as a function of an anticipated demand (volume) for the product. After product introduction the cost can be computed based on the actual demand with the demand data collected on a real time basis (on-line). This in principle enables dynamic costing and pricing of new products and it is highly desirable when the demand for various postal products changes rapidly as a result of changing economic, seasonal and technological conditions in the communication market in general.

The postal product decomposition compiler (Fig.3) maps individual attributes of the product and their values from the EPPML file onto specific activities. For example the feature of the product described as “obtaining delivery confirmation with signature of the recipient” is captured in the “sender-directed information” tag of the EPPML file and maps directly into delivery activity. It should be noted that each composite activity of the process (e.g. sorting or delivery) is in practice decomposed into a number of elementary steps each of which has a unique cost driver. The steps are stored in a data base that can be updated whenever a new activity or a step is identified as necessary. It is this data base we meant when we mentioned availability of the detailed and properly structured catalog of the process activities and steps.

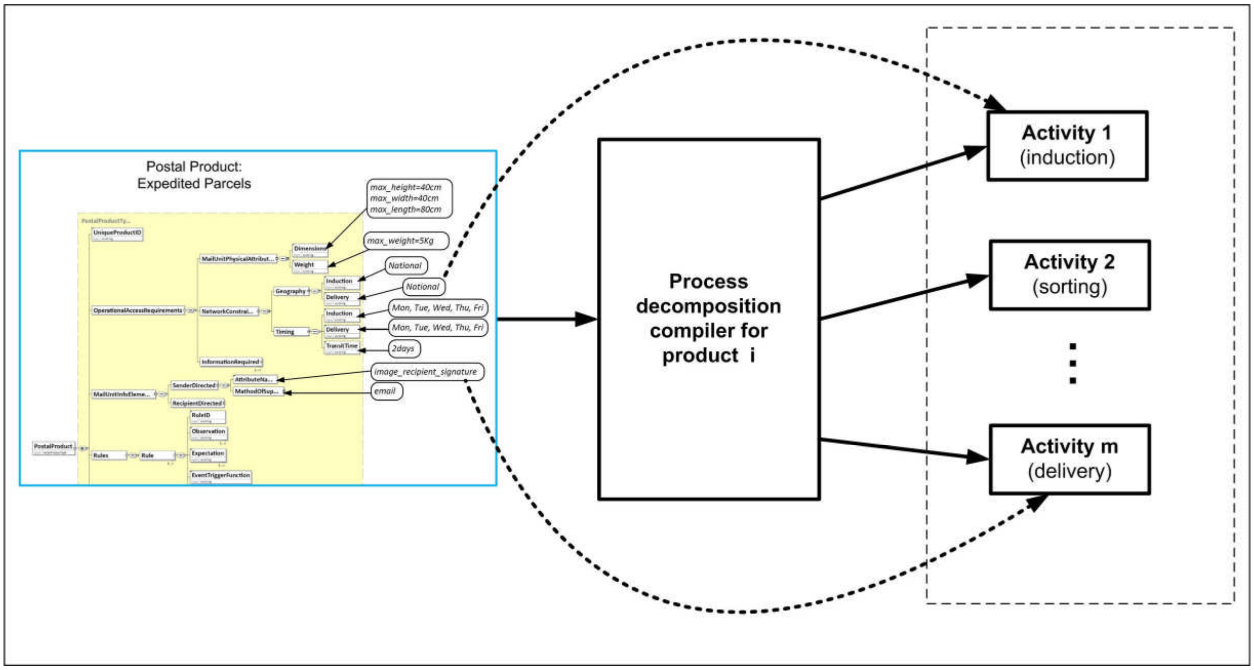

Fig. 3 – Postal Process Decomposition

All attributes in the EPPML description of a given PP can be divided into cost-causative and others. Cost-causative attributes can be mapped into product cost driver profile (Fig. 4). In this figure each cost driver (weight, transport and delivery modes and options) is matched with one or several product attributes from the product EPPML schema. Actual values in the cost driver profile are computable from the EPPML document (i.e. EPPML schema populated with the real values of attributes of mail items in the mailing) in a straightforward manner.

Average Weight	Actual	0.650	**cost-causative** Computable from PhysicalConstraint/Weight and/or dimensions/girth
	Dimensional	0.417	
Transport Mode	Single Hub	0.0%	**cost-causative** This information is computable from InductionMechanism/Location/Address, DeliveryMechanism/Location/Address.
	National Surface	100.0%	
	National Air	0.0%	
	Premium Air	0.0%	
	Northern Air Stage	0.0%	
Delivery mode	MSC	0.0%	**cost-causative** This information is computable from InductionMechanism/Location/Address.
	CUS	0.0%	
	LC	59.2%	
	MLC	28.8%	
	RSMC	9.8%	
	Retail	2.2%	
Options	Signature	Yes	**cost-causative** Covered in CarrierOriginatedInfo and Rules and Actions.
	Signature Copy	No	
	Loss or Damage	No	
	Delivery Updates	No	
	Collect On Delivery	No	
	Scheduled Pick-up	Yes	
	On-Demand Pick-up	No	
	Return Service Labels	No	
	Leave at Door	No	
	Do Not Safe Drop	No	
	Card for Pick-up	No	
	Proof of Age	No	

Fig.4 – Cost driver profile and EPPML cost-causative attributes

We now illustrate with an example. Canada Post product “Expedited Parcel” contains a number of standard and optional features. Standard features include on-time delivery guarantee, tracking and delivery confirmation, nominal coverage for loss or damage, forwarding and return to the sender (if not deliverable). Optional features include signature of the recipient and scheduled pick-up. A condensed portion of the EPPML file containing a full description of the expedited parcel with the signature option is depicted in Fig.5. The shaded area on the left represents names of attributes and rules structured in accordance with the EPPML syntax. The oval frames on the right hand side contain values of the attributes, for example maximum dimensions and weight as well as allowed geography of induction, delivery and timing constraints. Note that the attribute “SenderDirected” contains value “image-recipient-signature” that indicates that the sender will receive recipient signature information in the form of a digital image. When a new product (or product feature) is introduced, the EPPML file is updated to include additional attributes and their values as well as new rules. For example when “redirection in transit” to a new address is requested by the sender, a redirection rule is introduced and its trigger function is defined. This is depicted in Fig. 5 in a grey shaded area as a logical predicate stating that redirection is commenced when the parcel is not yet delivered and the sender has requested redirection. Similarly the introduction of a new product that allows senders to obtain a positive proof of the identity of the recipient results in the entry of a new value for the “SenderDirected” attribute, namely “recipient-personal-identifier”. This could be a serial number for a driver’s license, passport or birth certificate and it is shown also in grey shaded area in the right hand side of the Fig.5. Introduction of new rules, attributes or values will result in a different mapping from product features onto activities and process steps as described above.

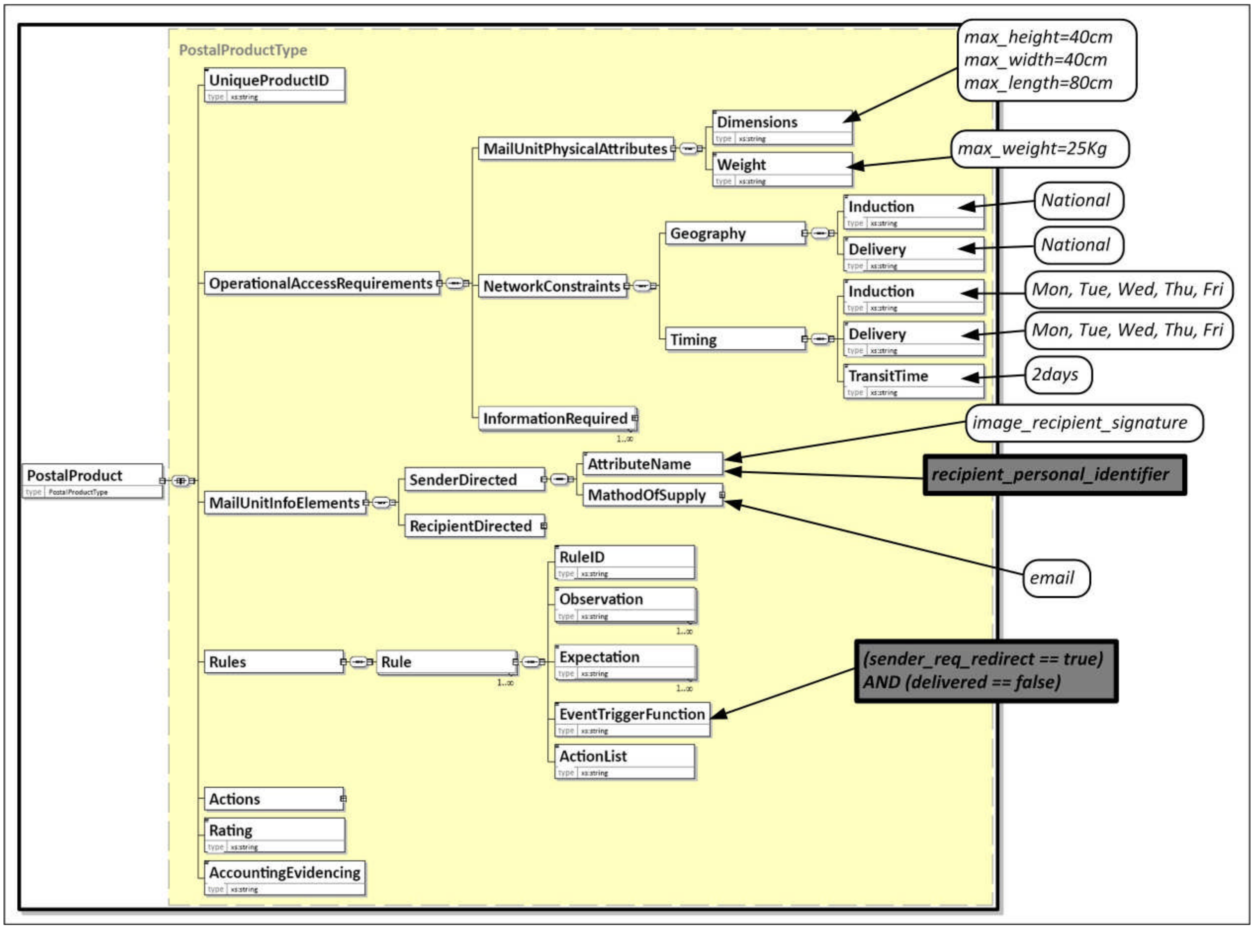

Fig.5 – Redirection and positive proof of identity product as an EPPML document

The total product operating cost is computed as a sum of average cost contributions from all steps and activities involved in the product delivery (Table 5).

Activity			Avg. Cost per Piece
Collect		$	0.722
Sort		$	0.795
Transport		$	0.325
Deliver	*Normal*	$	2.613
	Positive Proof of ID	$	1.500
	Redirect	$	1.060
Total Operating Cost		**$**	**7.014**

Table 5 – Operating Cost for "redirection and positive proof of identity" product

Delivery of a new product that involves redirection in transit and positive proof of identity requires several additional steps that must be taken during delivery activity. Average operating costs for these steps are added to the cost of regular expedited parcel product resulting in the total operating cost. Typically the total operating cost would also include indirect and support product costs such as cost of selling, cost of customer service, cost of billing and collection expenses etc. These costs as well as general overhead costs are not directly related to the product definition (i.e. its features and options) and thus are not affected by any automation or enhancements resulting from the introduction of the EPPML-based approach. It is clear however that EPPML enables reduction in customer service cost. Recall that the EPPML-based system provides for automated definition and meeting of access requirements (Table 4, Section 3) resulting in far fewer errors in mail item make up. In addition the EPPML allows for web-based download of PP definitions. In more simple cases, a configuration wizard containing a list of the basic cost of several commonly requested PP attributes (associated with process activities) can be encrypted and stored on the sender's computer, allowing for rapid and dynamic costing of customized products. Pricing can be organized based on pre-set margins. Then, the agreed upon price can be passed to the carrier for billing and the customized EPPML attributes of the selected PP can be set for the mail item or items. In more complex cases, the desired set of attributes can be passed to the carrier's system, where a more complex pricing algorithm can handle a majority of the complex requests, with the possibility of human interference when needed, whereby for example the customized services requested are unavailable, or where conflicting attributes are submitted by the mailer.

While in general we expect some (hopefully significant) reduction in indirect and support cost we can not quantify it at this point.

Our approach to postal product definition and distribution can be also beneficial for dynamic, customized pricing driven by demand and capacity considerations. Indeed as products are requested and downloaded by senders, a virtual private communication channel is established between mailer' operations and carrier data center (Fig.1). Upon selection of the optimal product (the product that best matches senders' needs) the sender sends his/her product selection together with a price request to the carrier data center. Then, the price for the product can be customized by the carrier based on the actual product cost (best estimation known to the carrier), a perceived value of the product, available capacity, information about competitor products/prices, sender-requested product quantities and the like. The customized price then can be communicated to the sender using already established virtual private channel, thus protecting secrecy of the pricing information between the sender and the carrier. The EPPML also can be structured to streamline contractual aspects of mailer-post interface. When product attributes and price is accepted by the sender and the carrier, formal contractual obligations of both parties can be sealed on line using now widely available mechanism of digital signatures (Menezes et al, 1997). This simplifies payment and reduces billing and collection costs mentioned above.

The other significant benefit of the EPPML approach, when it is broadly adopted by the postal community, is facilitation of inter-carrier transfers of mail items between geographic areas, known as interlining. The standardized EPPML attribute set would function as a standard interface between interliners, much like the automotive industries AIAG standards, allowing for the downstream carrier to be accurately compensated, while passing on the requirements of the original sender for specific services such as redirection and proof of identity. Again, some human intervention most likely will be required (such as choosing a second interliner) if the first interliner in question could not provide options selected by the sender or would not accept the proffered price.

Yet another intriguing benefit of the EPPML-based system is regulatory. For regulatory purposes (analysis or audit), a formal filter could be set up, based on a particular set of attributes, to distinguish between competitive and market-dominant products. This would facilitate verification by the postal operator that regulatory constraints on pricing are being met, and that competitive products are being sold at a positive margin, reducing accusations of predatory pricing and investigations. For financial management purposes, the richness of data available in the EPPML-enabled environment allows the assessment of margins on offering certain attributes, for example by customer, industry or marketing segment.

5. Modeling

A traditional postal network represents a classic case of a shared production environment whereby many different products share common resources. The network and production process in the traditional postal environment are designed to accommodate peak loads and are not flexible in the sense that production resources (e.g. labor, equipment, and transportation) can not be easily added to or removed from the system (see for Crew et al, 1997 for discussion of peak loads). The production process for each individual product is also not isolated but shared with other products. Introduction of a new product that could simultaneously require a share of existing resources and processes and addition of new or removal of existing resources and activities may have hard-to-predict effects on the costs of all products involved. There are also difficult-to-predict changes in demand (volumes) for different products. In Section 4 we have outlined an ABC-based costing methodology suitable for traditional postal environment where service standards (operating time windows) for most products are fixed and system resources are set at peak load levels. We believe that such arrangement is going to be difficult to maintain in the future and postal operators and carriers will need to develop a far more flexible environment whereby operating windows and system resources will be changeable on a short time notice. In the more flexible and complex interactive environment costing of new products will require a different approach. One way to develop a feel for the behavior of such complex interactive environment is to create a computer model that would allow to run different “computational” experiments to simulate various ”what if” scenarios. This differs from more traditional econometric models in the sense that the product delivery (production) process is not treated as a black box, but rather decomposed into detailed activities each of which is supplied with its own variable resources, parameters and constraints. We have developed such a model to better understand various effects of a new product introduction into the environment with a multitude of existing and well established products and processes, specifically for the purpose of understanding the dynamics of cost behavior for all affected products. Our model is also designed to run specific optimization scenarios where values of some variables (e.g. cost) can be minimized by finding corresponding optimal values of controllable resource variables.

Figure 6 shows the logical structure of the model. The terminal entities of the model are the *sender* who creates mail items which are subject to several *activities* (i.e. Collect, Sort, Induct) and the *recipient*. Mail items travel through the model of the production process from the sender to the recipient stopping while they are subjected to activities. Depending on the PPs associated with mail items, they are exposed to a different set of activities. Pools of resources of various types (labeled A, B, C and D) are available as required by each activity. Mail items may have to wait before entering an activity until all necessary resources become available.

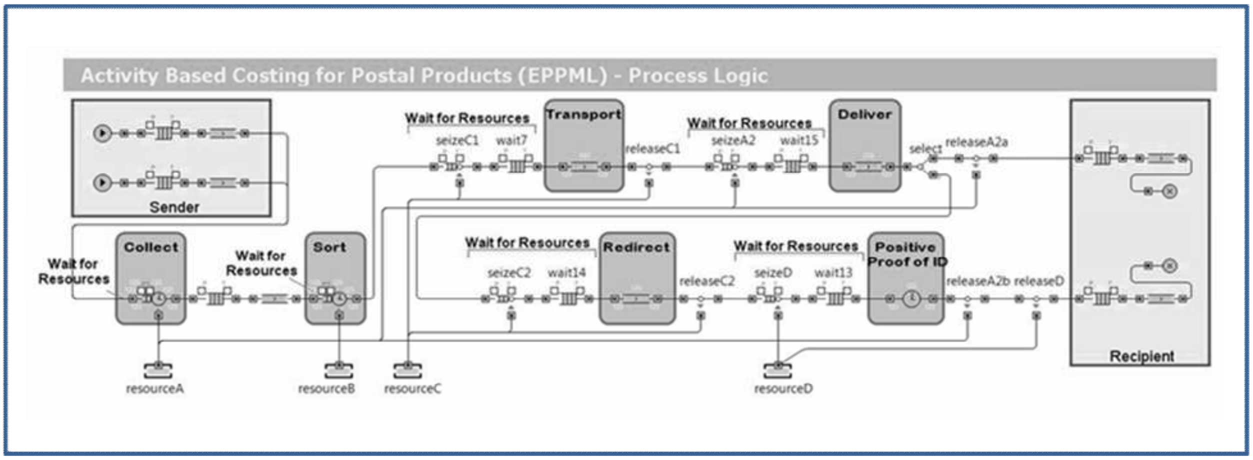

Figure 6 – Model's structure

We modeled interaction between two products P1 and P2 using the notion of a new product (P2) introduced in the Section 4. In one scenario, P1 requires four activities *Collect*, *Sort*, *Transport*, and *Deliver*, while P2 requires two additional activities, namely *Redirect* and obtain *Positive proof of ID*. Each activity uses a specific set of resources, for examples trucks, palettes, labor, sorting equipment, and storage. Pools of resources are allocated to activities. The size of each resource pool is a selectable parameter of the model. As shown in Figure 7, some activities use resources of more than one type and the same resource types may be used for more than one activity. For example, resource A (e.g. labor) is used for activities *Collect*, *Deliver*, *Redirect* and *positive proof of ID*. Activity *Redirect* requires resources of types A and C (e.g. equipment). Mail items created by the sender are associated with either product P1 or P2. Mail items acquire resources (for example, a palette, a driver, or a truck) before they are subject to an activity (for example transportation or sortation). If a resources is not available, mail items have to wait. After they acquired necessary resources, mail items may have to wait again for an activity to be performed as the processing throughput of the activity is limited (which is also selectable parameter).

Our model allows for each activity to be completed in a specified time period. We introduced some randomness to reflect a situation where the time to complete an activity is variable fluctuating around its average value. Another parameter which is randomized is the number of mail items submitted by senders for each time interval.

Each resource in the model has an "idle" cost and a "busy" cost. As shown in figure 7, mail items accumulate cost as they travel through the system. There is a cost associated with resources acquired (for example a truck waiting for a loading dock to become available) and an allocated cost for each activity (for example maintenance, supplies, etc.). The cost of idle resources is distributed between all mail items. When mail item arrives at the recipient, all costs it incurred since its induction are tallied and the unit cost for each postal product is calculated as the sum of all costs accumulated by mail items divided by the number of mail items (average cost).

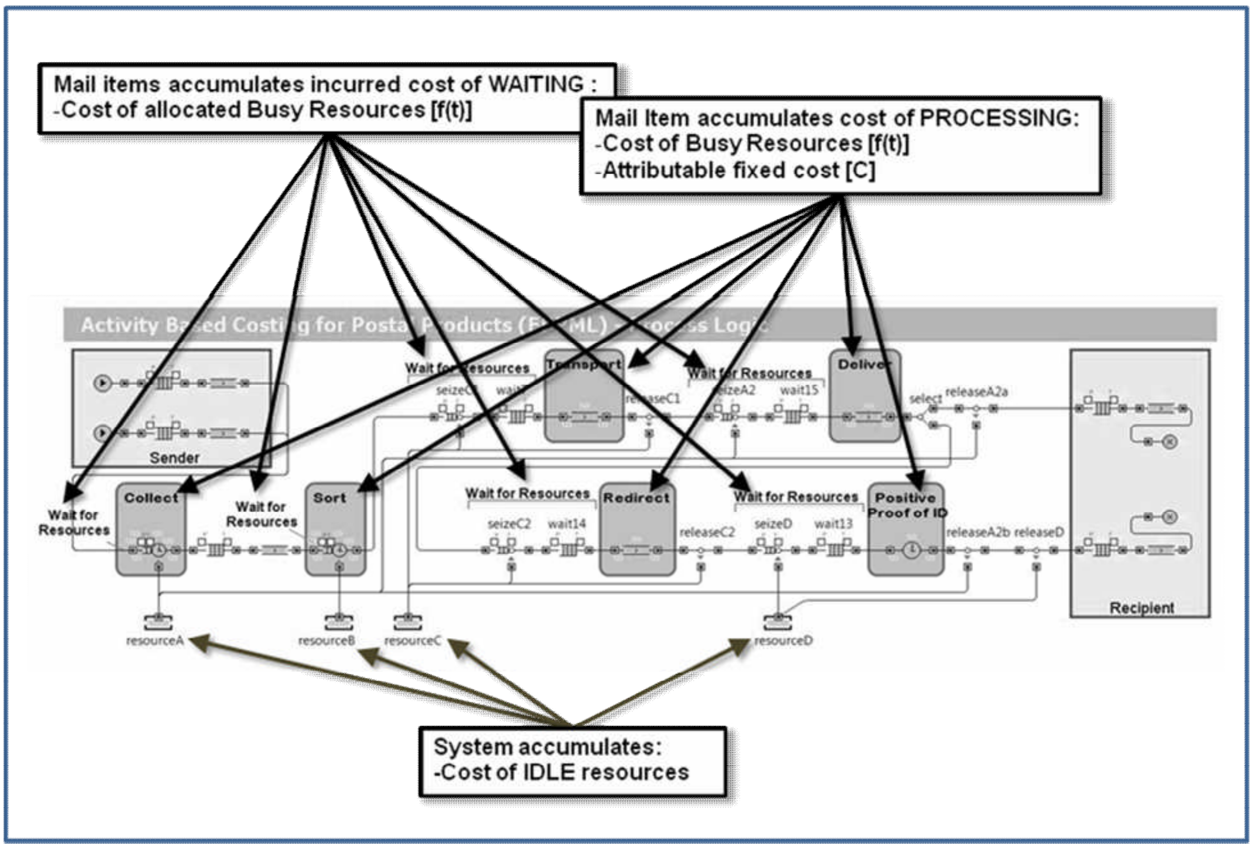

Figure 7 – Elements of postal product cost

We first run the model with only one product P1 and observed its unit cost. We then optimized the size of resource pools for the system that has given mail volumes for two products P1 and P2 and we modeled the effect of introduction of a second product P2 on the unit cost for P1. We found that depending on the size of resource pools, processing delays and throughput, the cost of P1 can decrease or increase. The intuitive explanation of the former phenomenon is that idle resources initially allocated to P1 are used to deliver P2 and as such, their cost is now partially attributed to P2. The increase in the unit cost of P1 is explained by throughput limitations that create long processing delays.

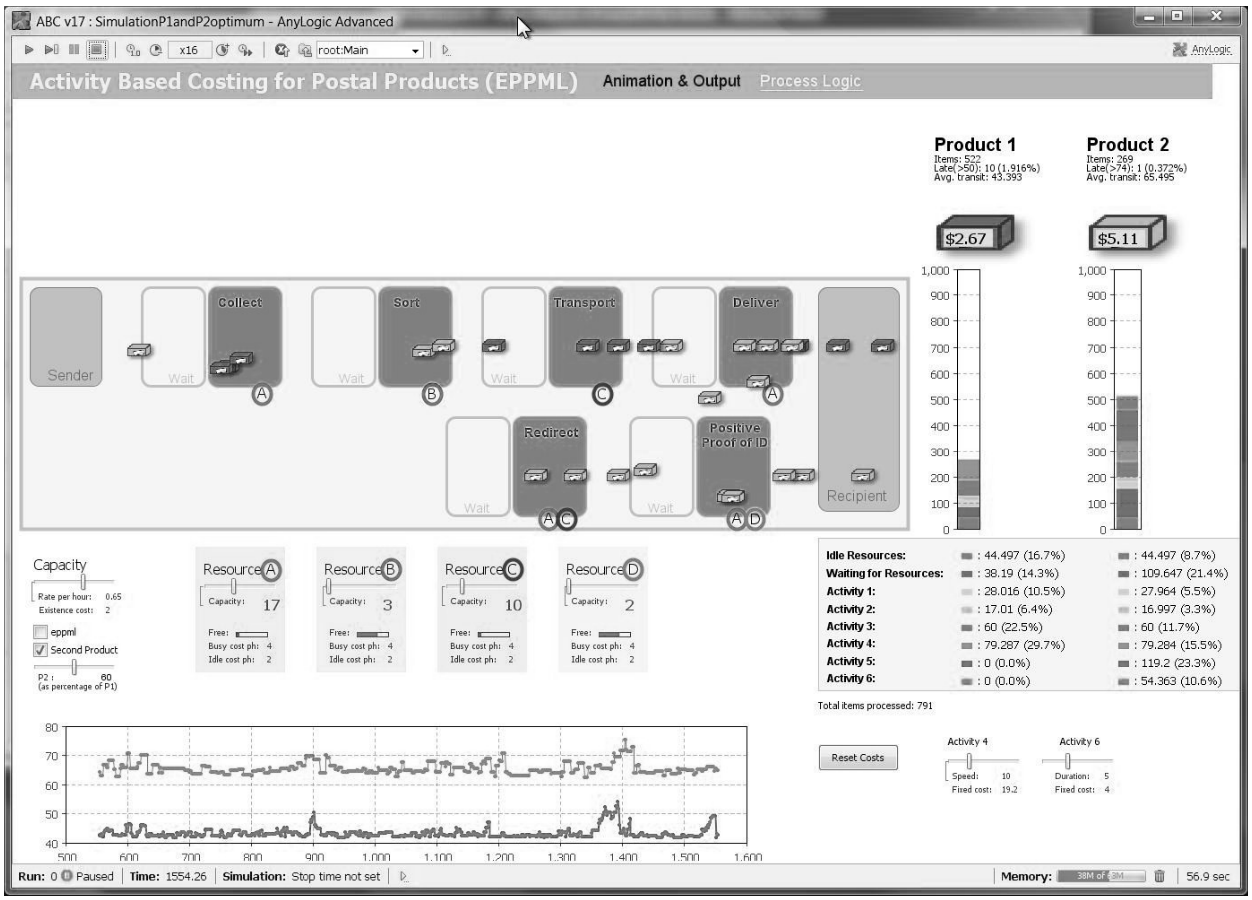

Figure 8 Model's user interface

The model computes fluctuations in the transit time for mail items (shown in the lower left corner of Figure 8). Transit time for products P1 and P2 is one of the parameters which control the optimization of the size of resource pools. The model also computes the contribution to the unit cost due to idle resources, due to the cost of mail items waiting for resources and the cost due to each of the six activities.

When a PP is formally represented as an EPPML file, it is possible to automatically determine activities necessary for its delivery (Figure 3). The parameters used in the model (processing times, resource allocations, etc.) can be automatically derived from the formal PP representation and from operational parameters of a specific postal process. The model can be extended to reflect postal processes with any desired level of detail, including for example very basic operations such as scanning a label, printing a barcode, processing image data, etc. The usefulness of the model depends greatly on the availability and accuracy of data regarding costs or resources, processing time, resource allocation, structure of postal processes, equipment capabilities, etc. We believe that our model can be made into a useful and practical tool for postal management but predictive properties of our model deserve further studies.

6. Conclusion

Postal cost accounting was designed and refined to its present state as a result of treating postal products as inflexible notions and was driven by a mix of economic, regulatory and financial reporting considerations. This works adequately when the product portfolio is stable. In a rapidly changing postal environment where new products and services are constantly being created or changed, such approach will create multiple challenges. The approach outlined and discussed in the paper makes use of computerized product description as a flexible input to the cost accounting algorithm (while keeping other components of the costing process, namely cost functions and general ledger data unchanged since they are invariant to the description of the product). Thus, the approach we have taken is based on the notion of the postal product that serves as an independent input to the cost accounting algorithm. This algorithm combined with the EPPML definition of products can be optimized to achieve a number of very desirable properties. Specifically, we believe that it will go a long way toward customized, dynamically manageable pricing of new products and streamlined cost-reduced billing, collection and customer service. Our approach can also reduce time and cost associated with complex regulatory functions concerning new product approvals. Due to its interoperability properties the EPPML-enabled systems allow for much simplified and effective collaboration between carriers. We have built a computer model of a postal product delivery process with flexible resources shared between multiple products that allows for evaluation of many “what-if” scenarios and for cost optimization. This may be particularly important for a rapid management decisions when products could be offered or removed depending on the overall profit potential of a postal enterprise, specifically when such enterprise is operating in a competitive environment. Preliminary results of running the model indicate that it has desirable properties and is flexible to simulate many interesting practical scenarios.

One of the major challenges for our approach is integration with existing ERP solutions. This means that the EPPML-based description of postal products must be made configurable to fit existing ERP applications where many data elements required for costing are stored and maintained. We believe that this challenge is manageable since EPPML by its very nature is a specialized version of widely adopted and highly flexible XML data description language and as such is well suited for integration with ERP applications.

The EPPML-based approach to product costing is a step toward more effective management and governance of mail communications that adheres to our long standing belief that what can be done by computers should be done by them. Anything less is not consistent with the spirit and achievements of 21 Century technology.

7. References

S. Awerbuch and A. Preston, ‘Postal ABC’, in Current Directions in Postal Reform, M. Crew and P. Kleindorfer (eds), Kluwer Academic Publishers, Boston/Dodrecht/ London, 2000, pp. 195-215.

T. Bozzo, PRC Docket 2006-1, USPS-T-12

M. Bradley, J. Colvin and M. Smith, 'Measuring Product Costs for Ratemaking: The United States Postal Service', in Regulation and the Nature of Postal and Delivery Services, M. Crew and P. Kleindorfer (eds), Kluwer Academic Publishers, Boston/Dodrecht/ London, 1993, pp. 133-157.

M. Bradley, J. Colvin and J. Panzar, 'Issues in Measuring Incremental Cost in a Multi-functional Enterprise', in Managing Change in Postal and Delivery Industries, M. Crew and P. Kleindorfer (eds), Kluwer Academic Publishers, Boston/Dodrecht/ London, 1997, pp. 3-21.

CEN/TR 15524, (2005) Postal Service - Customer-directed information.

CEN/UPU Draft Standard P28: Extensible XML-Based Postal Product Markup Language 2008.

M. Crew, P. Kleindorfer and M. Smith, 'Peak Loads and Postal Services: Some Implications of Multi-Stage Production', in Managing Change in Postal and Delivery Industries, M. Crew and P. Kleindorfer (eds), Kluwer Academic Publishers, Boston/Dodrecht/ London, 1997, pp. 42-64.

M. Crew and P. Kleindorfer, 'Cost Estimation and Economically Efficient Prices', in Current Directions in Postal Reform, M. Crew and P. Kleindorfer (eds), Kluwer Academic Publishers, Boston/Dodrecht/ London, 2000, pp. 149-170.

LECG report, 'Future Efficient Costs of Royal Mail's Regulated Mail Activities', 2006, http://www.psc.gov.uk/postcomm/live/policy-and-consultations/consultations/price-control/LECG_Efficiency_Report_Top_Down_Final_Conclusions.pdf

A. Menezes, P. Van Oorschot and S. Vanstone, 'Handbook of Applied Cryptography', CRC Press, Boca Raton/New York/London/Tokyo, 1997

L. Pintsov and A. Obrea (2008), 'Data requirements for cost accounting in the mail communication system', in Competition and Regulation in the Postal and Delivery Sector, ADVANCES IN REGULATORY ECONOMICS, Michael A. Crew and Paul R. Kleindorfer, Editors, Edward Elgar Publishing, London, 2008

L. Pintsov and A. Obrea (2008), 'Postal Reform and Product Innovation', Postal Reform Book, 2008

M. Roberts, 'An Economic Framework for Modeling Mail Processing Costs', 2006, http://econ.la.psu.edu/~mroberts/

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[i] The paper expresses views and ideas of the authors that are not necessarily those of their employers CPC and Pitney Bowes Inc. The authors are grateful to Ted Kwiatkowski (CPC) for many useful comments and suggestions .

[ii] In fact the distinction between mail item and mail product is frequently so convoluted that it is hard to say what is what. We believe that we have provided a conceptually clear distinction (Pintsov and Obrea, 2008) where we have stated that a mail item had specific values of its intrinsic measurable attributes (dimension, weight etc.) while postal product description contained acceptable ranges for all explicitly specified attributes of mail items.