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Understanding the dynamic complexity of the editorial process for an employee portal - Lessons learned at Lufthansa German Airlines

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Abstract

Corporate intranets and portals have attracted increased attention among information managers (Detlor 2000). Although intranet and portal developments aim to diminish the costs for internal information publishing and to increase corporate information dispersal (Rice 1996, Thyfault and Marx 1996), real-world implementation projects show that for a successful content management, there are still a lot of open questions. Particularly the management of a standardized editorial process suffers from clear concepts. To address this issue, this paper explores the structure of an intranet editorial process, the dynamic behavior resulting from this underlying structure and presents a first conceptualization for a successful process management.

1. Introduction

Corporate intranets and portals have attracted increased attention among information managers (Detlor 2000). Although intranet and portal developments aim to diminish the costs for internal information publishing and to increase corporate information dispersal (Rice 1996, Thyfault and Marx 1996), real-world implementation projects show that for a successful implementation of an editorial process management environment accompanying a portal or intranet project no clear concepts have been established in the literature. This means that there are no decision rules and information or key process indicators for managerial decisions available that could for example help a manager to decide how many people are needed to manage a given number of intranet pages that are maintained through a defined editorial process and are subject to clearly defined quality standards (e.g. design, layout, style and age).

The term process management comprises in this context two major components shown in figure 1, namely the physical and the information network. The physical component depicts the process structure as illustrated by step 1 to 4 (links between steps are indicated by arrows between the different graphical elements). The information network highlights the accompanying decision rules or policies applied to a process. In figure 1, for reasons of simplicity, only one policy is shown, which influences step 2 and 3 on the base of information derived directly from the process (Information I_1 and Information I_2) or the process environment. (Information I_3 and Information I_4). Based on this model, the graph indicates that a policy can be thought of as an information processing procedure (Sterman, 2000). Thus, it can be written as:

$$\text{Policy} = f\,(\text{Information } I_1, \text{Information } I_2, \text{Information } I_3, \text{Information } I_4).$$

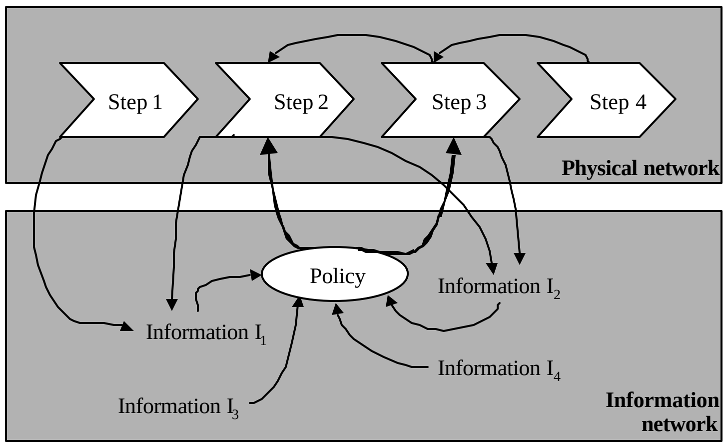

Figure 1: Physical and information structure of a process management (including single linear and also feedback relations).

To enable such a process management for a portal or intranet editorial process environment especially the inherent dynamical complexity of the considered physical process needs to be understood in a more thorough way to support a sustainable success of an intranet project. This fact is reflected in the observation that most intranet process environments are managed now a days quantitatively in a deficient way if one compares the expected process results with the used resources and management concepts. The main reason for this situation is believed to be rooted in a missing quantitative understanding of the dynamical complexity of a typical intranet editorial environment. This finding is not surprising as it is in agreement with observations made in other process dynamics related studies (e.g. Sterman 2000, Warren 2002). It is a remarkable finding in these studies that even for structurally extremely simple process environment most organizations lack a clear quantitative and/or qualitative understanding of the related process dynamics (e.g. Warren 2002). This situation can mainly be attributed to the insight that even simple process structures, especially if they include delays, can produce nonlinear relationships between process input and output parameters (e.g. Sterman 2000, Warren 2002).

To overcome this limitation, this paper will explore the dynamics produced by a simplified physical structure of the intranet editorial process as it is implemented at Deutsche Lufthansa (DLH). The main goal of the study is to understand the dynamical complexity created by the process structure in quantitative terms in the frame of the given process parameters.

To address this issue the presented study starts with a detailed description of the editorial intranet environment established at DLH. Based on this information a simplified process model for the further analysis is proposed. This model contains only the physical network of the editorial process system. The information network including the policy design for the editorial process environment are intentionally not considered here, but will be analyzed in detail in a separate paper. Such a two-step process was chosen to reduce the structural and dynamical complexity of the considered process model to a minimum. It is hoped that by this restriction a clearer understanding of the physical process characteristics can be achieved, which is required before a successful policy design for a process management approach can be set up. The simplified process model is then analyzed in two ways: (a) a System Dynamics (SD) based simulation approach to investigate the system behavior over time (far away from an equilibrium state) and (b) an equilibrium analysis approach to investigate the equilibrium state of the system in terms of the given system parameters. The authors believe that such a combined approach is of high interest as both methods provide complementary insights. SD based simulation runs enable the exploration of an unknown dynamics hidden in the given structure of a physical process model far from equilibrium conditions. In contrast to that an analytical equilibrium analysis puts more emphasis on analytical relationships between system parameters and the system equilibrium state, thus enabling a clearer understanding of the influence of the control parameters for the system dynamics.

At the end of the paper different editorial process scenarios based on different parameter sets are discussed and evaluated for their practical relevance. The outlook gives a summary of the main results and stresses the need for a policy design (information network) for the editorial process. In that respect the presented work should only be understood as a first step towards a complete editorial process management, as the extension of the presented work by the process information network remains an open issue for further work.

The results presented in this paper are first results of an ongoing research project conducted at Deutsche Lufthansa in the frame of ongoing efforts at DLH to redesign its internal eBusiness activities. Due to the close link between this study and the internal eBusiness framework at DLH the authors are convinced that the results of this study can be of practical interest for other companies too that are in the process of actively redesigning their intranet editorial environments.

2. The promise of corporate portals and the situation at Deutsche Lufthansa

The motivation behind corporate intranets is the idea that the internal use of Internet technology can act as a business process transformer (Lindström and Frank 2000). It is hoped that through a catalytic effect of the used technology a whole company and its respective value chains will potentially be optimized. Furthermore, direct effects of the use of portals like diminishing costs for internal information publishing and an increased corporate information dispersal (Rice 1996, Thyfault and Marx 1996, Lindström and Frank 2000) add to this optimization. The development of corporate intranets can be divided into three different evolutionary stages: (a) In the beginning, the main goal is only to "be online" by having an information on the Intranet without paying too much attention to content and functionality. (b) In the next stage, (internal) customer-oriented services are offered on portals, which triggers first process redesigning efforts. (c) The last stage represents the fundamental change of the company with respect to its internal structure by becoming an etransformed company (Lindström and Frank 2000).

Although corporate portals are described to "become the new metaphor for desktop computing in business" (Konicki 2000) and the Meta Group predicts that nearly 85 percent of businesses will have portals by 2003 (Cruz 2000), most companies are nowadays between stage one and two. Only few companies have fully reached the last stage of this three-step business transformation (Lindström and Frank 2000). The three stages of business transformation described above reflect the typical path big corporations have to go nowadays. Despite the clarity of this statement especially for big companies there is no detailed description of how they have to change their way of doing business if they are considering implementing a corporate portal.

Generally speaking, the use of an enterprise portal is diverse and depends on the fields of activity: there exist Business-to-Business (B2B), Business-to-Consumer (B2C) and Business-to-Employee (B2E) portals (Trowbridge 2000) dependent on the main target group of the portal. From a functional point of view common elements of corporate portals function as integration platforms and contain knowledge management, collaboration and communication modules (Detlor 2000). Furthermore, they typically provide a search engine, an index for structured and unstructured data, links for both internal and external Web Sites and information sources (Borck 2000, Quellette 1999). But to evolve their full capability, corporate portals must also comprise concepts for security, personalization, and application integration. The latter ranges from simple web applications to ERP (enterprise resource planning) or legacy mainframe systems (Borck 2000). Last but not least every corporate portal also requires a standardized, role based editorial process environment, to supply the portal with fresh content and an information structure that is able to organize and host all integrated systems in a user-friendly and meaningful way. Without the latter every portal is in danger of providing only information fog to its users. With all these features, Detlor sees the opportunity for portals to offer "a rich and complex shared information work space" for employees (Detlor 2000, p. 93).

Deutsche Lufthansa already uses Business-to-Business (B2B) and Business-to-Customer Portals (B2C) ("Infoflyway" and "Corporate Flyway"). In the field of Business-to-Employees (B2E), Lufthansa was in 2001 in the transitional phase from stage one to two. To advance further to stage two and three in a structured fashion, DLH launched an employee portal project called "eBase"[1] in January 2001. The main goals of this project are: (a) to provide a new infrastructure for DLHs internal eBusiness platform (e.g. Public Key Infrastructure, employee Metadirectory, portal and enterprise content management platform), (b) to design and implement a new corporate wide information structure, (c) to

[1] The title "eBase" is a combination of the two words „**e**Business" and „home **base**".

increase the connectivity of the employees and (d) to ensure "skill and will" on the employees side. Through these activities it was hoped to trigger the internal eTransformation at DLH, so that cost reduction, productivity and innovation potentials could be realized for DLHs internal processes.

For a company with a decentralized organization as DLH especially the aspect of information structure and quality is of crucial importance, as it must ensure the employees ability to locate all information he/she needs. As mentioned above the so-called business transformation of an enterprise through a corporate portal or intranet is driven by a diverse set of portal functions. From a process point of view, a portal or intranet environment is supported by two main processes: the editorial process and the process of application integration. Both processes have been considered and analyzed at DLH in the frame of eBase. Nevertheless, in the following we will focus on the editorial process environment, as it establishes the natural framework for the process of application integration[2].

3. The editorial process at Deutsche Lufthansa

The editorial process developed by Deutsche Lufthansa aims to show a standardized way to produce content. The meaning of the word content in this context is very diverse as the definition varies from the simple correction of spelling faults of already existing content to the production of new and complex content with pictures etc.. Hence the different content types should be differentiated according to the following aspects: complexity, priority, scope, cycle time for updating and confidentiality. From this diversity logically result different quality standards for each type of content. But although there are different types of content at DLH, the editorial process stays the same for all types of content. Before we will present these steps, the different roles involved in the editorial process will be described.

In the editorial process at DLH, four different roles are defined, which are shown with their list of activities in table 1. The roles are author, subject specialist, editor and chief editor. The author is an expert, who produces the specific or technical content after having discussed a request for publication with the executive of a department. The subject specialist is responsible for stylistic corrections and helps with the definition of criteria for meta data. The editor is responsible for the look and feel, the correctness of meta data and the strategic fit of the content. Furthermore, he is usually responsible for the structure of a home page of a department. Chief editors exist in every DLH business unit and for each global topic in the DLH portal information structure[3]. The chief editor manages the complete editorial process environment of a business unit or a global topic. Furthermore, he is responsible for the final release of content (delegation is permitted). The chief editor also advises the editors and solves editorial conflicts. With respect to the above described role model for the editorial process at DLH, it should be mentioned that in general one person can fill out several roles.

[2] Information about the standardized process for application integration into the DLH employee portal eBase called „eTrack" can be obtained from the authors on request.
[3] The 1st level navigation of the DLH employee portal comprises besides links to the business units of DLH also links to so called global topics (e.g. News, Work and Life, Knowledge or Marketplace).

Role	*Activities*
Author	• Coordinates request for publication with executive from competent department • Defines target group and maintenance of content (together with editor) • Produces and updates content • Proposes a link and navigation structure • Creates a teaser and headline (together with editor) • Determines date for publishing and period of validity (together with editor)
Subject specialist	• Checks the content for spelling, style, expression, logical order, consistency and validness • Communicates all necessary changes to author • Checks the link proposition and puts it in practice afterwards • Defines meta data and provides content with meta data • Verifies meta data and content on the basis of a check list (together with editor) • Evaluates look and feel of content (together with editor) • Checks navigation structure (together with editor)
Editor	• Identifies a request for publication and an author • Defines target group and maintenance of content (together with author) • Evaluates request for publication and assigns content to a business unit or global topic area • Checks the link proposition and puts it in practice afterwards • Verifies meta data and content on the basis of a check list (together with subject specialist) • Evaluates look and feel of content (together with subject specialist) • Checks navigation structure (together with subject specialist) • Creates a teaser and headline (together with author) • Determines date for publishing and period of validity (together with author) • Takes care for archiving of content

Chief editor	• Verifies the completeness of content on the basis of a check list • Releases content and informs author and all persons involved of released content

Table 1: Roles in the editorial process

The editorial process itself consists of five different steps: concept phase, production, completion, publishing and archiving. These steps will be described in more detail in the following and are shown as a graph in figure 2.

In the concept phase, an editor identifies a request for publication and an author, who coordinates the request for publication with an executive from the respective department. Author and editor define a target group and the maintenance procedure for the content. In the next step the editor evaluates the request for publication and assigns the content to a business unit or a global topic. Finally, the editor informs the author of the assignment, so that at the end of the concept phase, there is an evaluated request for publication with an assignment for a business unit or a global topic.

The production phase starts with the production of new and the updating of old content by the author. Separately, the author proposes a link and a navigation structure. Next, the subject specialist checks the content for spelling, style, expression, logical order, consistency and validness. After having checked the content, the subject specialist communicates all necessary changes to the author. The result of this phase is produced content, which has been quality checked for editorial aspects.

After having checked the proposition for a link structure, the editor or subject specialist starts the completion phase by putting the link structure into place. Furthermore, the subject specialist defines meta data and provides the content with meta data. In cooperation with the editor, the subject specialist verifies meta data and content on the basis of a check list, evaluates the look and feel of the content and checks the navigation structure. Finally, the editor in cooperation with the author creates a teaser and a headline and determines a date for publication and a period of validity for the content. Fully quality controlled content, which is provided with meta data is the goal of the completion phase. At this stage, the content is ready to be released with all components.

In the publishing phase, the chief editor verifies the completeness of the content on the basis of a checklist. Afterwards, the chief editor releases the content and informs the author and all persons involved about this fact. The final result of the editorial process is content published on the eBase live site.

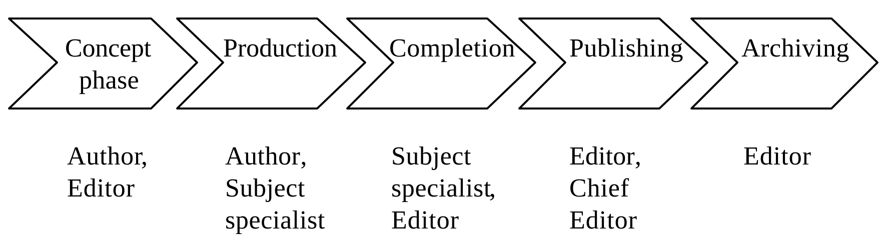

Figure 2: The standardized editorial process at Deutsche Lufthansa

After the period of validity of the content has passed, the decision has to be taken if the content has to be updated or archived. In case of archiving the editor takes care that the content will be removed from the live site without causing link errors. Finally he stores the content in a structured way in the eBase archive.

For the development of a standardized editorial process at DLH different motivations can be stated:

- the need to define clear responsibilities and rights in the organizational units working with the editorial process,
- the wish to establish clear organizational guidelines for content publishing,
- the goal to achieve a standardization of the existing historically emerged process models by using a newly developed standard editorial process, so that for example the use of a centralized Content Management System (CMS) is eased (number of process models that need to be implemented),
- more transparency about interfaces and
- an increase in efficiency and effectiveness in content production.

Besides these structural aspects of the standardized editorial process, for a successful process management, as stated above, a clear understanding of the hidden dynamics in this process structure is important. Therefore, in a next step the structure of the editorial process at DLH is modeled and analyzed using a system dynamics model that will be presented in the next section. Such a model is of high interest as it enables an analysis of both, the qualitative and the quantitative dynamics of the process.

4. The editorial process in System Dynamics notation

The physical structure of the DLH editorial process can be mapped by a stock and flow diagram consisting of four different levels: *concept pages*, *HTML pages*, (published) *content* and *old content*. The first phase of the editorial process - the concept phase - is illustrated by the rate *production of concept pages*, which leads to the level *concept pages*. The production phase is represented by the rate *production of HTML pages* going from the level concept pages to the level *HTML pages*. The completion and publishing phase are combined to one rate called *quality management* to underline the importance of the quality management process in these two steps of the editorial process. As a result of these two phases, the content exists on a live site in eBase. After a certain period of time, the content gets old, which is illustrated by the rate *content aging*, which leads to the level *old content*. *Content aging* is modeled in this framework as a first order delay, which means that on average all content that is older than a threshold age T_A is transferred to the stock old content. This threshold is in general content type dependent. In this study the assumption is made that T_s is constant for all content types. T_s must be interpreted as an average threshold age.
Old content can either be updated or flowing out of the system and by that gets archived. Hence, the archiving phase is portrayed by the rate *content flowing out*. For reasons of simplicity this rate is also modeled as a first order delay[4]. The rates *quality management*, *content aging and content flowing* out are assumed to be time-dependent. The variable

[4] The archiving rate could be modeled as a work related rate (e.g. production of concept pages) too. This approach is not used here, as it is assumed that archiving will mainly be achieved through an automatic process only requiring small working efforts.

quality management is influenced by the auxiliary *time for quality management*, which reflects the time needed to go through the quality management procedures in the editorial process. The rate *content aging* depends on the lifetime of the content, which is represented by the auxiliary *time to age*. Finally, the auxiliary *time to flow out* influences the rate *content flowing out* and therefore the amount of old content flowing out of the system.

The decision to produce concept pages and HTML pages are dependent on the following variables: *productivity*, *workforce* and *hours worked*. As the production of concept pages needs a different amount of time, people and productivity as the production of HTML pages, figure 3 shows such a differentiation.

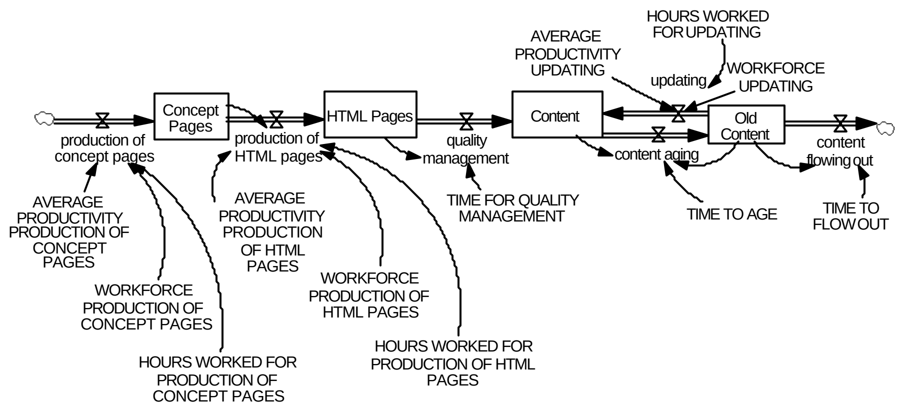

Figure 3: The system dynamics model mapping the editorial process at DLH.

For a more detailed dynamical analysis of the existing process structure, it was decided to reduce the given process model to the generic structure of an aging chain, as we are convinced that this simplified model can capture the main dynamics of the more complex one. With this attitude we follow Sterman who states: "a broad model boundary that captures important feedbacks is more important than a lot of detail in the specifications of individual components" (Sterman, 2000). However the discussion about the model size still takes place in the system dynamics community. Hence, Keating names the assessment of model scope, including time horizon and system boundary, one key aspect in the model design phase (Keating, 1998).

By aiming for a relatively simple structure, the different steps to produce content were condensed to one rate, which is simply called *production*. The latter depends on the variables *average productivity production*, *hours worked production* and *workforce production*. Despite this condensed view on the process, figure 4 shows that the basic structure stays the same with respect to the aging process from content to old content. The decision on how many pages are updated is influenced by three constants: *average productivity updating*, *hours worked updating* and *workforce updating*. In order to represent a very simplistic ("policy-free") decision-making process, *updating* only depends on these exogenous factors, not on old content (non-negativity of old content is assured).

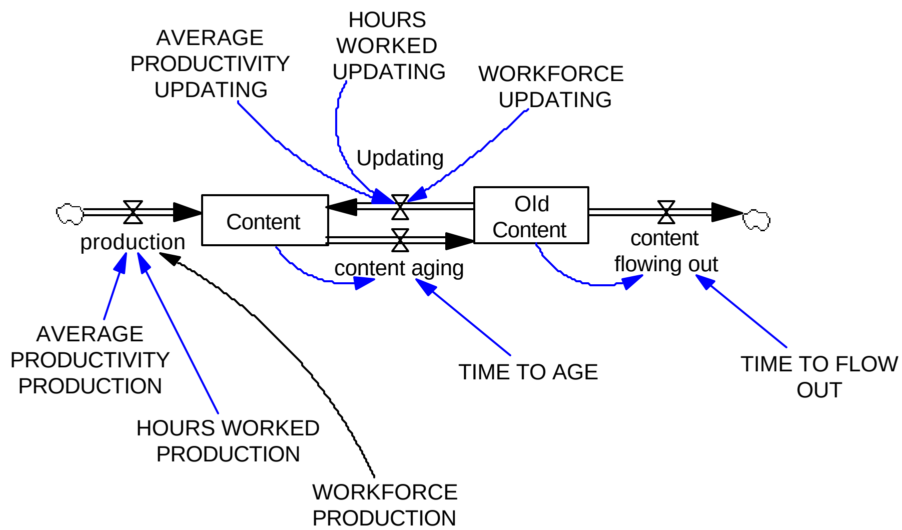

Figure 4: Basic model for the simplified editorial process.

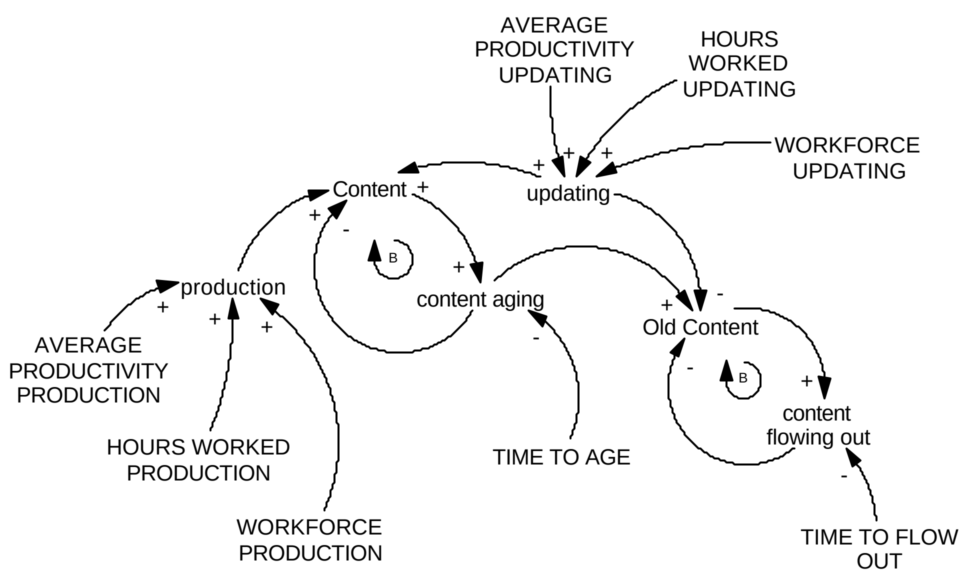

Figure 5: Causal loop diagram of the simplified editorial process.

The resulting condensed structure of the simplified editorial process is the structure of a second order material delay.

Considering the dynamic structure of the process, figure 5 illustrates that the simple structure of the editorial process consists of two negative feedback loops. The first one comprises the following dynamics: an increase of content leads to a higher rate of *content aging*, which reduces thereupon the level of *content* again. The same feedback structure exists for *old content*, which is flowing out of the system. The more *old content* exists in the system, the higher the rate of *content flowing out*, which decreases the level of *old content*.

A base run of the simple editorial process model shows the typical goal-seeking behavior of negative feedback loops. Put into other words, the amount for *content* and *old content* reaches an equilibrium state. Hence, an analytical analysis of the equilibrium state of the system appears to be of high interest and will be presented in the following section.

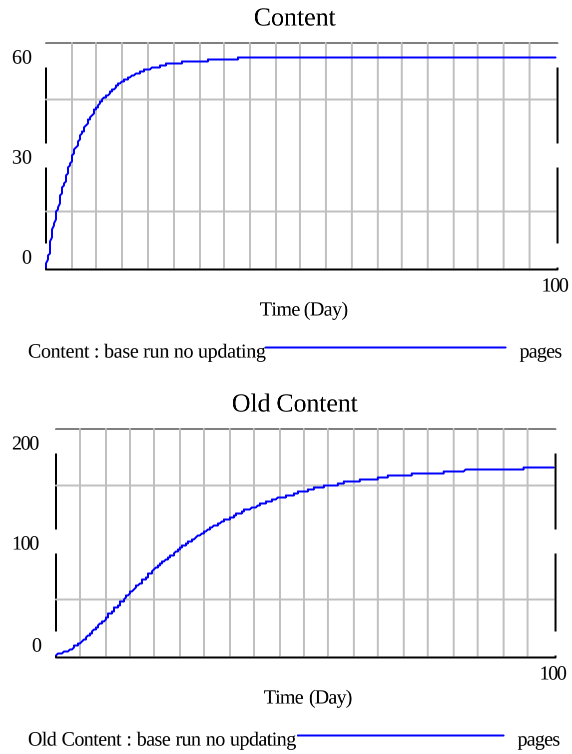

Figure 6: Dynamic behavior of content and old content in the basic model.

5. Analytical analysis of the system equilibrium state

Before we can start with an equilibrium analysis of the editorial system, the equations for the system variables need to be identified and presented. First the equations for the five different rates and second the equations for the two levels will be shown.

The five system rates can be expressed as follows:

- The *production rate* (P), which measures how many pages, can be produced per day. It is assumed to be the product of the *average productivity for production, hours worked for production* per day and *workforce for production.* The equation can be written as follows:

$$P \quad = AP_p \times h_p \times N_p \text{ [pages/ day]} \qquad (1)$$

with

AP_p = average productivity production [pages/ (h x person)]

h_p = hours worked for production per day [h/day]
N_p = workforce for production [person]

- *Content aging rate* (CA*)*, which equals the amount of pages that age per day. The rate equals the ratio between content and the time to age and can be described as a first-order material delay:

$$CA = C/TA \text{ [pages/ day]} \quad (2)$$

with

C = Content or number of fresh pages [pages]
TA = time to age [day]

For a short explanation on how the variable content aging can be modified for practical needs see the appendix.

- The *updating rate* (U), which describes how many pages are updated each day: U is the product of the *average productivity for updating*, *hours worked for updating* per day and *workforce for updating*. This gives:

$$U = AP_u \times h_u \times N_u \text{ [pages/ day]} \quad (3)$$

with

AP_u = average productivity updating [pages/ (h x person)]
h_u = hours worked for updating per day [h/day]
N_u = workforce for updating [persons]

- *Content flowing out rate* (CO) indicates the amount of old content, which is flowing out of the system per day. As stated above, the rate reflects simultaneously the degree of archiving and can be consequently thought of an archiving rate. The activity of archiving would claim workforce too. For reasons of simplification, the rate content flowing out is defined in the same way as content aging. Hence the equation is similar:

$$CO = OC/TO \text{ [pages/ day]} \quad (4)$$

with

OC = Old content or number of outdated pages [pages]
TO = time to flow out [days

For a short explanation how the variable content flowing out can be modified for practical needs see the appendix.

As displayed in figure 4 the structure of the editorial process contains two levels that can be described by the following equations:

Fresh content: the amount of *content* increases through the inflows of *production* and *updating rate* and decreases through the outflow of *content aging*, which gives:

$$dC/dt = P + U - CA \qquad (5)$$

Using equations (1), (2) and (3), the differential equation for C looks as follows:

$$dC/dt = AP_p \times h_p \times N_p + AP_u \times h_u \times N_u - C/TA \qquad (6)$$

Old content: the amount of *old content* increases through the inflow of *content aging* and decreases through the outflow of *updating* and *content flowing out*:

$$dOC/dt = CA - U - CO \qquad (7)$$

Inserting equations (2), (3) and (4), the differential equation for OC can be written as:

$$dOC/dt = C/TA - AP_u \times h_u \times N_u - OC/TO \qquad (8)$$

Based on these equations for the levels and rates of the system, an equilibrium analysis can be performed. The aim of such an analysis is to deduce analytical expressions for the relationship of the stocks and flows under equilibrium conditions. The equilibrium analysis can be performed by using equations (6) and (8). In dynamical equilibrium conditions the system state is characterized by dC/ dt = 0 and dOC/ dt =0. Under this assumption the following relationship for C results:

$$AP_p \times h_p \times N_p + AP_u \times h_u \times N_u - C/TA = 0$$
$$C = TA\,(AP_p \times h_p \times N_p + AP_u \times h_u \times N_u) \qquad (9)$$
$$C = TA \times (P + U) \qquad (10)$$

In equilibrium, the amount of fresh pages depends on the sum of the *production* and *updating rate* multiplied with the average aging time for content, which is *time to age.*

The equation for *old content* can be derived in the similar way resulting in:

$$C/TA - AP_u \times h_u \times N_u - OC/TO = 0$$
$$OC = TO\,(AP_p \times h_p \times N_p) \qquad (11)$$
$$OC = TO \times P \qquad (12)$$

The last equation shows the interesting insight that the old content in equilibrium only depends on the production rate multiplied with the average delay time for old content, which is *time to flow out*. This is remarkable, because the production rate does not represent a direct inflow to the level variable old content. Furthermore, the direct in- and outflows to the variable – *content aging*, *updating* and *content flowing out* - have no influence at all.

For a further analysis in a next step, three ratios relating the two system levels in different ways were developed:

Ratio$_1$: Ratio of content to old content, which relates the amount of fresh pages to already outdated pages. This ratio is called Ratio$_1$ in the following. By using equations (9) to (12), Ratio$_1$ can be written as follows:

$$\text{Ratio}_1 = C/OC$$
$$= \frac{TA\ (AP_p \times h_p \times N_p + AP_u \times h_u \times N_u)}{TO\ (AP_p \times h_p \times N_p)}$$

$$= \frac{TA \times (P + U)}{TO \times P}$$

$$\text{Ratio}_1 = TA/TO \times (1 + U/P) \qquad (13)$$

Ratio$_2$: Ratio of old content to content, which equals the reciprocal of Ratio1:

$$\text{Ratio}_2 = OC/C$$
$$= \frac{TO\ (AP_p \times h_p \times N_p)}{TA\ (AP_p \times h_p \times N_p + AP_u \times h_u \times N_u)}$$

$$= \frac{TO \times P}{TA \times (P + U)}$$

$$\text{Ratio}_2 = TO/TA \times \frac{1}{(1+ U/P)} \qquad (14)$$

Ratio3: Ratio of old content to total content, which equals the amount of old content in the system and is called Ratio$_3$ in the following. By using equations (9) to (12), Ratio$_3$ can be written as follows:

$$\text{Ratio}_3 = OC/(C+OC)$$

$$= \frac{TO\ (AP_p \times h_p \times N_p)}{TA\ (AP_p \times h_p \times N_p + AP_u \times h_u \times N_u) + TO\ (AP_p \times h_p \times N_p)}$$

$$= \frac{TO \times P}{TA \times (P + U) + TO \times P}$$

$$\text{Ratio}_3 = \frac{1}{TA/TO \times (1 + U/P) + 1} \qquad (15)$$

Interpretation of these results of the equilibrium analysis leads to three main insights that can be formulated as follows:

- In case of no updating, which means U =0, the equation for total content is the following:

  $$C + OC = TA\ (AP_p \times h_p \times N_p) + TO\ (AP_p \times h_p \times N_p)$$
  $$= TA \times P + TO \times P$$
  $$C + OC = P \times (TA+TO)$$

This means that the stock of content in transit is the product of the inflows (*production rate P* and *Updating Rate U*=0) and the two different average delay times (*time to age* and *time to flow out*). This relationship is know as Little's Law which states that in equilibrium the stock in transit is equal to the product of the total delay time in the aging chain and the inflow rate into the chain (Sterman, 2000).

- In case of no updating, the three ratios are only dependent on the two time variables *time to age* (TA) and *time to flow out* (TO).

$$\text{Ratio}_1 = \text{TO/TA},\ \text{Ratio}_2 = \text{TA/TO},\ \text{Ratio}_3 = 1/(\text{TA/TO} + 1)$$

These time variables characterize the different types of content or the different quality criteria for aging of content e.g. content pages indicating news typically have a lower time to age than content with a long-term character. Hence, it can be concluded that without updating a change in the ratios can only be caused by a change in the time variables, which means a change in the quality standard or the type of content.

- In case of updating, the different ratios change their values dependent on U. For example ratio$_2$, which indicates the ratio of *old content* to *content*, changes its value in terms of TO/TA from 1 to 0, dependent on the degree of updating. This can be illustrated in figure 7.

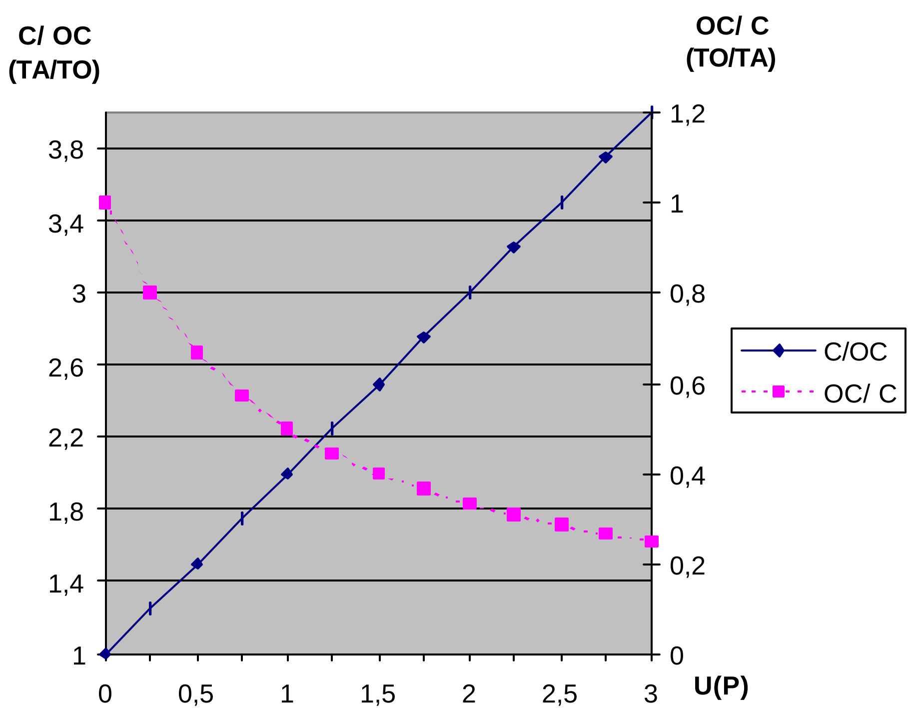

Figure 7: Ratio$_1$ and Ratio$_2$ in dependence of the updating effort.

On the x-axis, the updating effort is shown in terms of the production effort. On the first y-axis on the left side, one can see $ratio_1$ scaled by TA/TO. The curve shows that in equilibrium an identical updating and production effort (U(P)=1) leads to a number of fresh pages scaled by TA/TO which is twice as high as the number of outdated pages.

The y-axis on the right side shows $ratio_2$ scaled by TO/ TA. This means that for an updating effort of 2 (updating effort is twice as high as the production effort) the ratio of old content to content scaled by TO/TA is 1/3. Consequently, the graph shows two critical lines showing $ratio_1$ and $ratio_2$ in terms of TO and TA in equilibrium. These curves may be helpful as an indicator for managers, who have to decide about their distribution of resources between content production and content updating. Figure 7 may give them for the equilibrium state of the system a first idea about the effects of a certain workforce distribution on the number of outdated pages compared to the number of fresh pages and vice versa.

To further elaborate the presented results the next paragraph will illustrate different scenarios for the editorial process environment. Furthermore, at the end the practical relevance of the lessons learned from the introduced framework will be presented.

6. Different Scenarios for the editorial process

(1) Content production without updating

In this scenario, it is assumed that no updating is done which means that the *updating rate U*=0. For the variables influencing the *production rate P*, *workforce for production* was assumed to be 10 persons with 8 hours working per day and a productivity of 0.25. This means that each person needs four hours to produce one page of new content, a value, which has been determined after an internal discussion with experts from Lufthansa German Airlines. One should keep in mind that in these four hours not only the production of the page but also the conceptualization takes place. The variable *time to age* was set to 7 days and the auxiliary *time to flow out* to 30 days respectively. The latter means that old content will be archived once a month.

In equilibrium this parameter setting leads to the following results for content and old content:

$AP_p = 0.25 \qquad TA = 7$
$h_p = 8 \qquad TO = 30$
$N_p = 10$

$$C = TA\,(AP_p \times h_p \times N_p + AP_u \times h_u \times N_u) = 140 \text{ pages}$$
$$OC = AP_p \times h_p \times N_p \times TO = 600 \text{ pages}$$

For the three different ratios one obtains the following results:

$$Ratio_1 = C/OC = 0{,}23$$
$$Ratio_2 = OC/C = 4{,}29$$
$$Ratio_3 = OC/(C+OC) = 0{,}81$$

With a team of 10 people, working 8 hours a day with a productivity of 0.25, in the equilibrium 140 fresh pages can be produced. On the other hand, 600 pages will be already outdated, which leads to a percentage of old content of 81% in the system.

To lower the percentage of old content, the parameter of *hours worked production* was enhanced to 12 hours. This leads to a *content* value in equilibrium of 210 pages, which means that with a working day of 12 hours for 10 people working with a productivity of 0.25, a rise of 70 pages could be achieved. On the other hand, *old content* in equilibrium increased as well to a value of 900 pages. The interesting consequence of this behavior is the fact that the values of the three ratios remain constant.

Another strategy comprised the enlargement of the workforce: it was increased to 20 people, which represents an increase of 100% of the workforce. Although *content* in equilibrium climbed up to 280 pages, the amount of old content rises in parallel to a value of 1200 pages. Looking at the three ratios in this situation shows again the same results, which means the ratio values remain constant. Figure 8 illustrates the ascent of content and old content in the basic model for the above considered parameter changes.

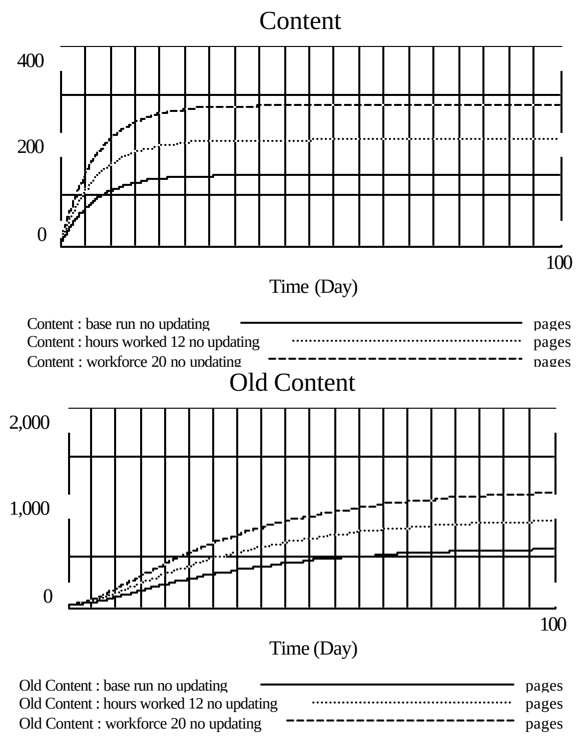

Figure 8: Parameter change for hours worked and workforce compared to base run

The main insights for Deutsche Lufthansa were fourfold:

- Although a change of single parameters like *hours worked* or *workforce* lead to a higher level of content, the growth is always limited. Therefore, any increase in parameters cannot avoid that there are limits of growth considering the production of content.
- An increase of single parameters did not only lead to an increase of *content*, but automatically also to an increase in *old content*. As a consequence, the three ratios relating *old content* and *content* keep constant values.

- To change the value of the ratios and thereby the ratio between content and old content in the system, a single parameter adjustment for P or U is not sufficient.
- Changes in the ratios can be only achieved by changes in TA and TO which represent structural changes in the system e.g. changes of content types or different definition for the aging threshold (which might equal a change in the quality policy).

The above results are very interesting as missing resources (i. e. workforce) are often considered to be key success factors for content production, which is obviously not the case when one is looking for a system with a low $ratio_3$. People are obviously convinced that an increase of resources would lead to a continuously growing amount of fresh content. The focus on content production represents a mental model centered on the input of fresh pages into the system. This does not imply that updating is not an issue at all, but it shows clearly the biased nature of the existing mental models when it comes to production and updating efforts. Hence, it can be stated that in the mental models of the editorial personnel at DLH the two following aspects were not too dominant yet: the possible growth of content production is limited and always counterbalanced by content aging, so that content needs to be updated regularly. In this context, it is very probable that the editorial personnel at DLH is not able to see clearly the underlying dynamics of the editorial process producing the observed goal-seeking behavior for the content. Hence, the simple system dynamics model may already help to change the awareness for the editorial process dynamics. Furthermore, the importance of TA and TO and the accompanied system parameters appear to really new insights, which means that an important extension of the mental models of the involved personnel seems desirable.
Therefore, DLH decided to enter into the process of discussing the implications of the simple model and its structural and dynamical insights with its editorial personnel.
Finally, it is interesting to note that this scenario maps very nicely the history of the first intranets, which often ended in a situation of “senescence” and as a consequence of that of limited usage.

(2) Content production with updating
For this scenario apart from content production, updating of content was considered. It was assumed that the workforce is strictly divided to one of the two operations. This means that one person is unable to fulfill both activities at the same time. Hence, as the workforce stays at 10 persons, it was assumed that 5 persons are responsible for content production and 5 persons are doing the updating. Furthermore, the working hours for production and updating are 8 hours per day in the base run. Besides, it was assumed that the *average productivity for updating* is twice as high as the *average productivity for production*. Consequently, the value for AP_u is 0.5 whereas the value for AP_p stays at 0.25. The variable *time to age* was set to 7 days and *time to flow* out to 30 days respectively.
In equilibrium this parameter setting created the following results for *content*, *old content* and the three ratios:

AP_p	= 0.25	AP_u	= 0.5	TA	= 7
h_p	= 8	h_u	= 8	TO	= 30
N_p	= 5	N_u	= 5		

C = 210 pages
OC = 300 pages

$$
\begin{aligned}
Ratio_1 &= C/OC \\
&= 0,7 \\
Ratio_2 &= OC/C \\
&= 1,43 \\
Ratio_3 &= OC/(C+OC) \\
&= 0,59
\end{aligned}
$$

Hence, with a team consisting of 10 people working 8 hours a day, half of them on content production and the other half on content updating, 210 fresh pages can be produced in the equilibrium by assuming an AP_p of 0.25 and an AP_u of 0.5. As the number of outdated pages lies at 300 pages, the amount of old content in the system can be reduced to 59%.

Figure 9 illustrates a change by showing the dynamic behavior of *content* and *old content* in a comparison to the no updating scenario. It can easily be seen that because of the updating activities, more new content can be produced while the amount of outdated pages decreases compared to the no updating scenario.

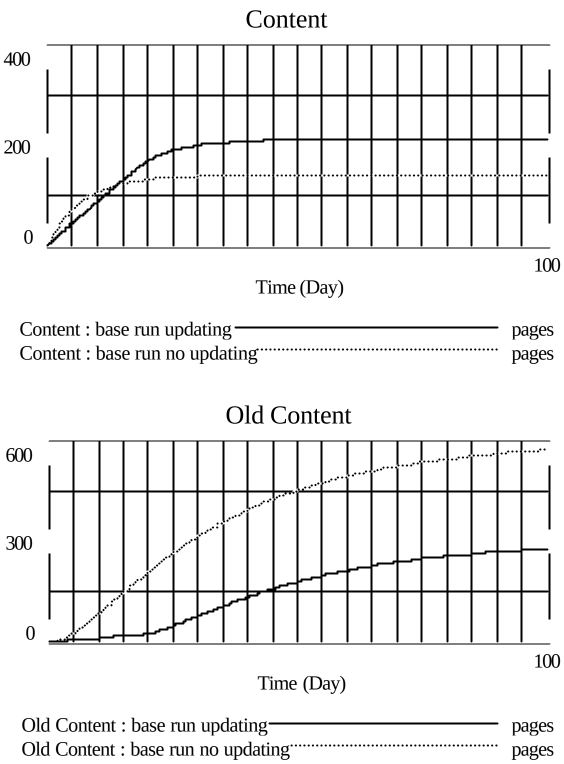

Figure 9: Dynamic behavior of content and old content in scenario no updating and updating

In this context it is also interesting to note that the shape of the graph of content in the updating scenario is different from the scenario without updating. This is due to the modeling of the updating rate, which is done by the use of a MIN-Function in this scenario. Thereby the minimum of the values for *old content* and the linear updating rate - depending on *workforce for updating*, *hours worked for updating* and *average productivity for updating* - are considered. Consequently, in the first period with a very low level of *old content* (much smaller than the linear updating rate), all *old content* gets updated and the available updating force might not be used 100%. Hence the updating rate is equivalent to the amount of outdated pages. As soon as the amount of old content surmounts the value of the defined linear rate of updating, the linear rate of updating characterizes the intensity of updating.

Interpretation of this scenario leads in addition to the before mentioned results to the following additional insights:

- With the implementation of an updating activity, the relative amount of old content in the system can be lowered from 81% to 59%.
- Although the value of the system ratios changed, the overall system behavior i. e. the goal seeking behavior stays the same. Any increase in production or updating activities cannot avoid that the growth is finite.

In this scenario, a second activity was introduced. Hence, the workforce must be divided into the two activities for content production and updating. In this context, the question arises how to distribute the scarce resource workforce on the two activities to obtain the best results. Figure 10 shows the influence of *workforce for production* on the amount of fresh pages. The graph shows that an increase in the production workforce leads to a decrease of fresh content pages in the equilibrium. This is a result which is surprising at the first moment as one would have guessed that one of the first measures to increase the amount of fresh pages is to augment the workforce responsible for content production. At a second glance, it soon gets obvious that due to the importance of updating, a single focus on content production does not lead to satisfying results. Though a concentration on content production leads to a temporary effect of more content. But as the system structure causes that an increase of content leads to more content aging and therefore more old content, this effect is quickly counterbalanced. Without enough people for updating in equilibrium, the number of outdated pages cannot be reduced which means that the amount of fresh content will decrease more and more.

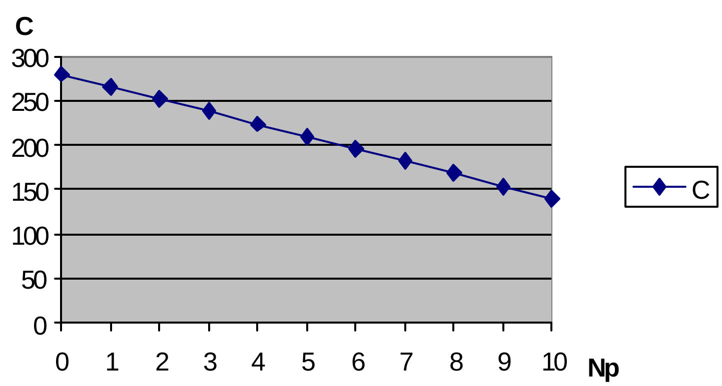

Figure 10: Impact of workforce production [N_p] on fresh content [C]

Figure 11 underlines this insight by showing the effect of a change in the production workforce on ratio$_3$ that indicates the percentage of old content in the system. It can be seen that the more people are involved into content production, the higher the percentage of old content gets in the system, as stated already above.

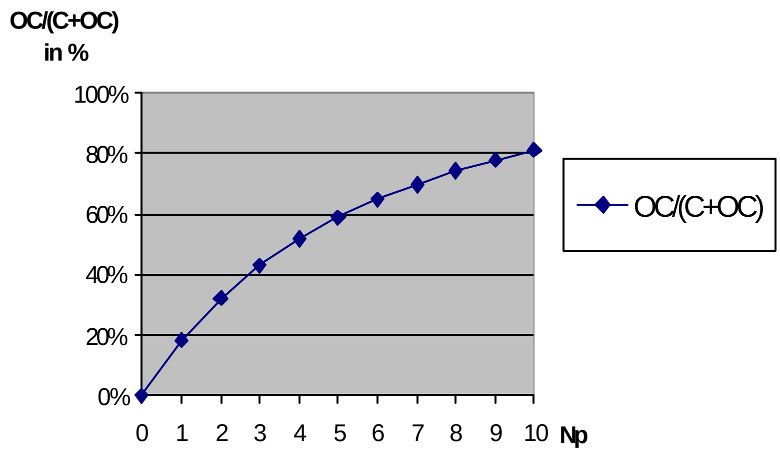

Figure 11: Impact of workforce production [N_p] on ratio3 [(OC/ C+OC)]

It can be concluded that both graphs are of great help to illustrate the effects of a shift of the workforce distribution between production and updating. Therefore, a manager may take these two graphs as an orientation for his/ her decisions about the workforce distribution.

Apart from the discussion about content production and content updating, the aspect of content archiving seems to be important, too. Therefore, the next scenarios will discuss the impact of archiving on the system behavior.

(3) Content production with updating and without archiving

For this scenario, the parameter setting of the updating scenario was kept except for the *variable time to flow out*. As stated above in case of no archiving the value for *time to flow out* will be rather high to illustrate that *old content* stays a long time in the system before flowing out of the system. Therefore, the overall parameter setting in this scenario can be given as follows:

AP_p	= 0.25	AP_u	= 0.5	TA	= 7
h_p	= 8	h_u	= 8	TO	= 100
N_p	= 5	N_u	= 5		

C = 210 pages
OC = 1.000 pages
$Ratio_1$ = C/OC
= 0,21
$Ratio_2$ = OC/C
= 4,76
$Ratio_3$ = OC/(C+OC)
= 0,83

The value of fresh content in equilibrium stays the same as in the updating scenario because it is not influenced by the variable *time to flow out*, which is the decisive factor in this scenario. Figure 12 illustrates that the graphs for *content* are the same for both scenarios. On the other hand, the amount of old content rises up to 1.000 pages, resulting in a ratio of old content to content of 4,76 which equals on the amount of old content in the system of 83%.

Based on these results for this scenario two main insights can be formulated:

- Compared with the second scenario (content production with updating) the "archiving" scenario leads to an increase of 24% of old content in the system. Furthermore, the percentage of 83% is nearly the same as in scenario 1 (content production without updating) with 81%.
- The negative effect of the missing archiving activity counterbalances the positive effect of the updating activity.

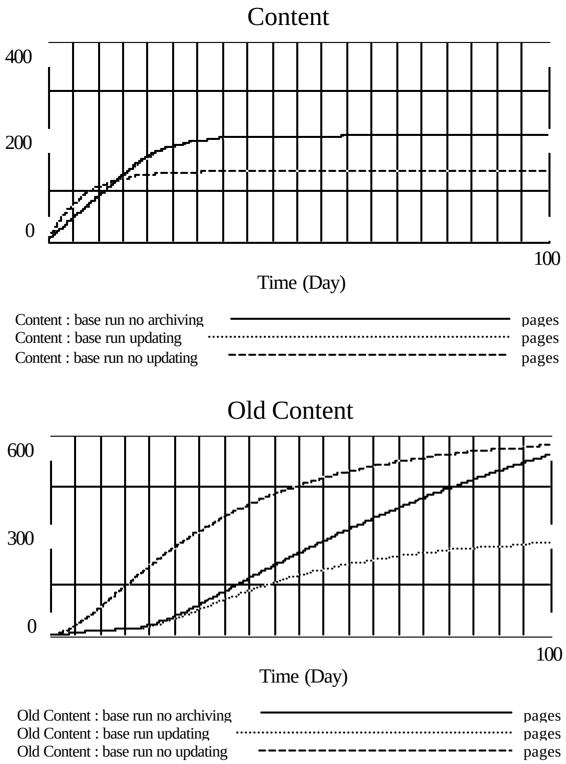

Figure 12: Dynamic behavior of content and old content in scenario no updating, updating and no archiving

To gain further insights the next scenario will focus on a simulation containing a high archiving activity.

(4) Content productio n with updating and archiving

As this scenario focuses on the aspect of archiving, the variable that models the archiving activity, *time to flow out*, is set to a low level. This means that the time that the old content stays in the system is very short which means that it will be archived quickly. The overall parameter setting in this scenario is the following:

$AP_p = 0.25$ $AP_u = 0.5$ $TA = 7$
$h_p = 8$ $h_u = 8$ $TO = 2$
$N_p = 5$ $N_u = 5$

$C = 210$ pages
$OC = 20$ pages
$Ratio_1 = C/OC$
$= 10,5$
$Ratio_2 = 0,095$
$Ratio_3 = OC/(C+OC)$
$= 0,087$

As in the scenario above, the value of content in equilibrium stays the same because it is not influenced by the variable time to flow out, which is the decisive factor in this scenario. Figure 13 illustrates that the value for content in equilibrium is the same for the three scenarios updating, archiving and no archiving. On the other hand, the amount of old content can be lowered to 20 pages, resulting in a ratio of old content to content of 0,095 which equals a percentage of old content in the system of less than 10%.

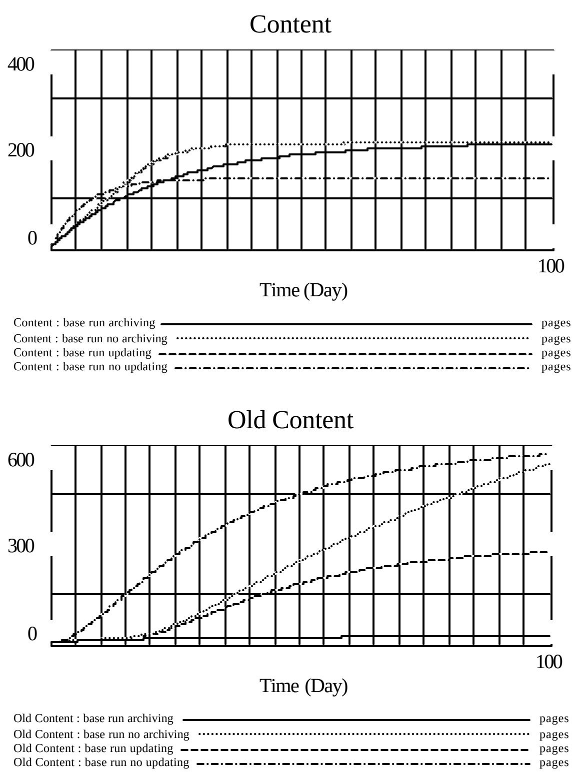

Figure 13: Dynamic behavior of content and old content in scenario no updating, updating, no archiving and archiving

The main insight of the fourth scenario can be summarized as follows:

- The decision for or against archiving has a strong impact on the amount of old content in the system. While updating may lead to a decrease of 22% considering ratio $_3$ (old content compared to total content), a consideration of archiving can decrease the ratio even more. So the percentage is reduced to less than 10%. This means that in scenario1 without any updating a change in the archiving parameter could lead to tremendous lowering of ratio $_3$.

Before giving some last concluding remarks about the overall insights gained by the different scenarios, the values of the main indicators for the different scenarios will be summarized in a table. Table 2 compares the results of the analytical approach with the results obtained from different model simulations. It is interesting to see that the results often differ in a significant way. Even with the smallest time step available in the software used for the research project (Vensim PLE was used) the difference could not be fully reduced. This is due to the limited capabilities of the software, which means that with an advanced version the differences could be nearly decreased for example using a different integration method. Apart from the time step used in the model, the question of time horizon plays an important role, too. As can be seen in figure 12, in the scenario of no archiving the system did not reach the equilibrium state in the presumed period of time. After a look on the parameter setting of this scenario it gets obvious that with an assumed time period of 100 days and a *time to flow out* of equally 100 days, the model does not reach an equilibrium state in the considered time horizon.

	Szenario 1: Content production without updating		Szenario 2: Content production with updating		Szenario 3: Content production with updating without archiving		Szenario 3: Content production with updating and archiving	
	A	V	A	V	A	V	A	V
Content (C) [pages]	140	139,99	210	209,99	210	209,99	210	207,61
Old content (OC) [pages]	600	572,13	300	277,09	1.000	543,85	20	19,77
$Ratio_1$ = C/OC [dimensionless]	0,23	0,24	0,7	0,76	0,21	0,39	10,5	10,5
$Ratio_2$ = OC/C [dimensionless]	4,29	4,09	1,43	1,32	4,76	2,59	0,095	0,095
$Ratio_3$ = OC/ (C + OC) [percent]	81%	80%	59%	57%	83%	72%	8,7%	8,7%

Table 2: Main indicators of the equilibrium analysis on the base of the four different scenarios (A – Analytical approach, V – Vensim simulation).

Given the above results and observations it is interesting to compare the strength and weaknesses of the two used methods, which will be shortly presented in the following.

The analytical solution in this study was based on an analysis of steady state equilibrium. This approach helps to derive precise values for the model parameters in steady state, on the base of analytical expressions relating the system parameters with the equilibrium state of the system. This kind of information would not have been available by help of simulations. On the other hand, the analytical results only show the situation in one single moment, which is in our case the steady state equilibrium. Finally, an analytical approach enables an easier interpretation of the importance of certain system parameters for the development of the system equilibrium state.
The use of simulations helps to overcome this weakness of the analytical approach. With simulations, the behavior through time is made transparent and short-term and long-term effects can be easily portrayed. Furthermore, a simulation model is designed to be transformable and through its examination through time, the dynamic nature of a process is emphasized. However, as stated above, results obtained from a simulation may only be understood as approximation to exact values for example for equilibrium conditions.

7. Summary and outlook

The presented paper gives an overview about the challenges of a portal implementation at a big company on the basis of a case study conducted at DLH. In this context the importance of a controlled editorial process environment for a successful portal implementation is emphasized.

By using a system dynamics model to portray the standardized editorial process developed by DLH, it was possible to simulate the dynamics of the editorial process. A combined approach of a process simulation and an analytical equilibrium analysis allowed performing a scenario based system analysis, which provided several important insights:

- In equilibrium, in case of no updating, total content equals the product of the inflows and the different average delay time. This relationship is known as Little's Law.
- In case of no updating, the three considered system ratios are only dependent on the two time variables *time to age* (TA) and *time to flow out* (TO) in equilibrium. These time variables reflect the different types of content or the different quality criteria. Hence, a change in the ratios can only be caused by a change of the time variables, which means for example a change in the quality standards or the types of content.
- Although content production can be intensified by employing more resources the number of fresh pages in the system is always limited.
- Aging of content is a natural characteristic of every editorial process and therefore updating needs to be done to avoid system "senescence".
- An archiving system should be implemented in each editorial process to avoid the draining of the system by old content.

General insights of this case study can be formulated as follows:

- A process is dynamic by definition and a particular vulnerability of process management lies in the inability to manage dynamic complexity
- The development of a simple physical process model already helps to show how the different activities of an editorial process affect each other. Hence, a decision about the right amount of production, updating and archiving may now be taken in a more informed way

- A formal model is more explicit than a description with words. By building a formal model, the unspoken assumptions are made explicit and compatibility of the existing mental models of the involved staff can be tested.
- Although the persons involved at DLH had a vague and more qualitatively oriented idea about the different insights presented before, a quantitative mapping underlined the urgency and necessity for a deeper understanding of these insights.
- The simple structure of the model already turned out to be valuable to perform a scenario-based analysis. Therefore, the model already served as a “wind tunnel” for organizational process experimentation and may be of great value for future experiments, too.
- For a policy design, first indicators have been developed which show the relationship between quality standards and resource allocation. These ratios and the critical paths developed by relating the ratios with other system variables may serve as a basis for a more detailed process management, which might also include an information network.

Apart from a necessary validation to underline the robustness of the simple model, unanswered questions exist with respect to the following aspects:

- Which effect has a change of the delay structure on model behavior? In the appendix, first ideas concerning this area of research will be presented.
- Can the results on the basis of the simple model be transferred to the four-stock model presented in the beginning of the paper?
- In which way is the physical network of the editorial process influenced by the information network? How should a policy design for the editorial process look like?

Future research will be focused on these topics and results will be presented in following papers. Thus, a subsequent paper will deal especially with the elements of a successful policy design for an editorial process environment inside of a major corporation.

Acknowledgement:

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Appendix

The analysis of content and old content was based on the assumption that there is only one sort of content with a single rate for content aging and for content flowing out. However, in reality there is not one typical content, but various sorts of content with different quality standards. As a consequence, the type of delay can be different, too. In the paper, for reasons of simplicity, two separate first order delays have been assumed to illustrate the rate of content aging and content flowing out. Still, it is also possible to use a second, third or even fourth order delay. To be able to fully map the delay structure of average content, an average delay function consisting of the different delay times should be developed. Figure 14 tries to give a first impression on how in reality a distribution function of the different delay times for different types of content could look like. It shows the pulse response of a predefined distribution function of different types of content. The numbers I to VI reflect the different types of content contained in the considered bulk content.

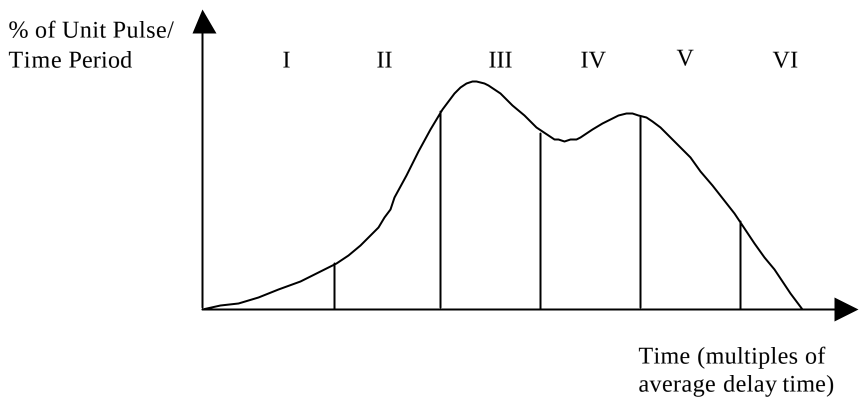

Figure 14: Possible delay distribution curve for a system containing different types of content with different average aging thresholds.

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