Breaking Down Barriers and Walls -
The Evolution of ICT-based Innovation in Primary Education

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1 Introduction

In a small corner of the region of Flanders, Belgium, sits the town of Meulebeke[1] (www.meulebeke.be) with its 11,000 inhabitants and 1250 primary school children (<12 year old). A predominantly textile town until the eighties, Meulebeke has endured the decline of this industry, seeing jobs and incomes disappear, while looking for the new long-term avenues of growth and social well-being. Today Meulebeke is still in the process of re-inventing its future and few stories reveal more the motivation to succeed than the pioneering educational experience of Sint-Amandus Primary School.

At first sight Sint-Amandus Primary looks unassumingly like so many other schools in a developed country. A gentle scratch to the surface however begins to reveal a story of ICT-based educational innovation,[2] a story of endeavour and persistence, invention and trial, new didactic concepts and achievements in the rise of 21st century education. It is ultimately a story of "breaking down barriers and walls" in the practical realization of e-learning,[3] often without more resources than the ingenuity and the will of the people making it happen.

Acknowledgements. I wish to express my gratitude to Lieven Van Parys, the Principal of Sint-Amandus School, Marc Lemiengre, and to all the teachers and students of Sint Amandus Primary School who shared their precious time and experience to make possible the writing of this paper. I also wish to thank Giovanni Serra for his close and valuable collaboration during the research of the Sint Amandus experience of ICT based educational innovation and to Ilaria Falcetta for her excellent comments that helped improve the argument of the paper.

[1] Meulebeke is located 35 kilometers south of Brugge and 40 kilometers west of Gent. Karel Van Mandere, author of the first known art history text, "Schilderboek" or "Painter's book", was born in Meulebeke. There is a small peace museum in an old rail station containing artifacts from the two World Wars.

[2] ICT-based educational innovation (i.e., educational innovation based on information and communication technologies) is here used in the broad sense of the implementation of any form of ICTs to enhance learning processes in schools and in the educational system as a whole. The field has received a huge amount of attention in the last decades and today has a burgeoning literature published in books and journals and increasingly online. More recently, international organizations such as OECD and UNESCO have also sponsored large-scale studies involving many countries. For UNESCO see, for instance, Resta (2002), Haddad and Draxler (2002) and Institute for Information Technology in Education (2004). In turn, the OECD has produced the "Schooling for Tomorrow" series. See OECD (2000, 2001a, 2001b) and OECD/CERI (2003). In addition, OECD and the Centre for Educational Research and Education (CERI) have conducted a comprehensive study of *The Transformation of Schooling in a Networked World* with access to over 90 case studies of ICT-based innovation in over 20 countries across the world. See Venezky, and Davis (2002) and Toomey and Ekin-Smyth (2001). Finally, the Second Information Technology Study in Education (SITES) looked at 174 case studies of ICT-based innovative pedagogical practice from the 28 participating countries. The results are found in Kozma (2003).

[3] In this paper, the concept of e-learning will basically mean the same as ICT-based education (to the extent that education is essentially about learning), although some definitions of e-learning stress the central role played by the internet, particularly, because networking enables the emergence of qualitatively more powerful forms of learning activities and environments. For instance, the European Commission's eLearning Action Plan defined eLearning as "the use of new multimedia technologies and the Internet to improve the quality of learning by facilitating access to resources and services as well as remote exchanges and collaboration." (CEC, 2001a, p.2) Also, the UK's eLearning Strategy raised and answered the question: "What is e-learning? If someone is learning in a way that uses information and communication technologies (ICTs), they are using e-learning. They could be a pre-school child playing an interactive game; they could be a group of pupils collaborating on a history project with pupils in another country via the Internet; they could be geography students watching an animated diagram of a volcanic eruption their

In Flanders, the school system has a rather complex structure. First, the Ministry of Education of Flanders (Dutch speaking part of Belgium) works independently from that of the French speaking part of Belgium. The result is that across Belgium there are 3 main networks: (a) a rather small network organised by the cities and municipalities; (b) a network organised by the State's Ministry accounting for roughly 25% of the school system; and (c) a large "free network" of schools that bases their pedagogical project on the Catholic faith. This network is not formally part of the Church, but a lot of their important leaders have connections. The first two networks have to impart all the types of religion or non-religion lessons (moral philosophy) asked by parents. The "free network" imparts only Catholic religion, hence the name "Catholic network." There are also some other free schools, for instance, Montessori schools. Economically, all schools of the different networks are paid by the Department of Education of Flanders, as long as their curriculum fits the standard goals. The teachers are all paid the same but for the other expenses the "free Catholic network" receive only 60% of the amount given to the state schools.

Sint-Amandus Primary with its 520 students belongs to the Catholic school network. Interestingly, a significant part of Sint Amandus' students are from Muslim background or from other religious denomination, and the school welcome all the children and seeks to accommodate their religious preferences as much as it can within the Catholic context. Thus,

> Most of the children of the Muslim community come to our school because the 'didactical level' is very high. They go to the religion class but they don't have to pray the normal prayers. Mr. Paul (teacher of religion) let them pray their own way. It is not a 'normal' situation for all the Catholic schools. In the other classes of our school, when the children pray, the Muslim children don't …They only 'learn' about our religion. They don't have to 'believe'. We also 'teach' all the children about other religions. ICT and Internet can help here![4]

The schools in the Catholic school network do not necessarily attract students from particularly well-to-do families, but given the smaller support received from the state, families are encouraged to play an active supporting role. The Principal of Sint-Amandus, Marc Lemiengre, confirms that 20% of the school's children come from families with unemployed parents with a monthly income of less than 1250 euro; another 20% come from families that can be considered well-to-do with a monthly income over 4,000 euro; while the remaining 60% belongs to middle class families with a monthly income between 1250 and 4,000 euro.[5]

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lecturer has just downloaded; they could be a nurse taking her driving theory test online with a reading aid to help her dyslexia – it all counts as e-learning …. E-learning exploits interactive technologies and communication systems to improve the learning experience. It has the potential to transform the way we teach and learn across the board." (e-Learning Strategy Unit, 2003, p.6 and p.9) Also, e-Learning Strategy Unit, 2004). Other definitions put the emphasis on "learning" rather than on the "technology" although it is clearly the combination of the two that matters and not just the potential for change made possible by the technology. Thus, Eletti (2004) writes, "e-Learning, literally "electronic learning", is proposed as a modality or, better, as a system of continuous education, where the value resides in the process within which the individual learning activity is integrated. This means that it is not enough to use the network, for the benefit of courses or for the communication between teachers and students, to talk about e-learning." (Eletti, 2004, p.64. Translated from Italian)

[4] Personal communication with Lieven Van Parys, October 2004.

[5] Interview with Principal of Sint-Amandus School, Mr. Marc Lemiengre, January 2003.

The people of Sint-Amandus are proud of their Catholic-school status and they believe that the school delivers high-quality education both reflected in, and resulting from:

?? Long-term permanence of teaching personnel who tend to stay for say, 20 to 30 years, thus fostering an educational community
?? teachers' high motivation and close relationships with students.[6]
?? teachers' continuous involvement in community activities outside the school, often at the request of the community.
?? important level of involvement and contribution by parents to the school, formalized in meetings twice a month between the teachers' Union and the parents' committee to discuss school matters and problems (e.g., financial, safety, didactic, etc.).

> Today we are in front of a new generation of parents willing to be conscious about problems in schools and making proposals to solve them. In the past it was not the same thing. …. In this committee participate all the representatives of the school network. The Priest, the principals, the representatives of parents from each school and the Union take part to these meetings. This year [2003] was the starting time for these meetings. There is a concrete will to work together.[7]

As we enter deeper into the story of ICT-based educational innovation of Sint-Amandus, we shall see that these characteristics play an important part in the experience. Before, however, the following two sections in the paper (sections 2 and 3) offer very brief descriptions of (a) some important elements associated to what has become known as "education for 21st century skills," and (b) basic elements of a framework to understand the nature of processes of innovation. The two sections are not intended to conduct critical analysis or a review of major concepts in the fields of education or innovation. Their purpose is instead instrumental to the narrative of the Sint-Amandus' ICT-based educational innovation, helping to organize the argument and providing relevant contextual factors that will help to highlight the achievements as well as the pending challenges for Sint Amandus. Following these two sections, the paper then proceeds with the systematic dissection of the Sint Amandus' ICT-based innovation process, its drivers, difficulties and solutions, with special emphasis on the transformation and/or emergence of new didactical instruments and practices. The "innovation framework" enabling this systematic dissection is "sociotechnical constituencies" and the "diamond of alignment."[8]

2 Some Elements of "Education for the 21st Century" and the Role of ICT-based Innovation

2.1 Consensus in Educational Policy Circles

One of the important factors in the context of ICT-based experiences such as that of Sint Amandus is the great deal of consensus existing in educational policy circles regarding the needs and challenges facing education in the 21st century. Table 1 confirms this fact by showing the fundamental similarity in the type of educational skills that US and European educational policy-advisory bodies recommend as required for the 21st century. Clearly, in both places, information and communications technologies (ICTs) play a central part in the realization of the educational scenario for the 21st century. For our

6 Interview with Lieven Van Parys, January 2003.

7 Ibid.

8 References are given below as the paper discusses the conceptual framework.

purposes, the confirmation of this consensus and the crucial role given to ICTs is enough, although it is clear that the realization of the educational vision expressed in the contents of Table 1 is not free of problems. For instance, there are issues of resources, details of practical implementation strategies and the rise of new governances, and even the interpretation and borders of some of the key concepts such as the importance of spirit of entrepreneurship and the relation to business in the real-world context. If this concept is not treated carefully, there might the risk of excessive "marketization" of schools and their student population. Indeed, even the centrality of ICTs is open to the risk of "technology push" by suppliers, thus making the technology a "driver" of expenditure rather than an "enabler" of change that enhances the schools' pedagogical processes. One specific issue in this connection is the emergence of free and open source software to challenge the traditional "proprietary governance" of the software market. In short, the visions of educational policy are not unproblematic, but this is concern beyond the scope of this paper.

Table 1. Type of Educational Skills Required for 21st Century

US[9]	*Europe*[10]
Core subjects beyond basic competency, reaching understanding of core academic content at much higher levels. Core subjects include English, reading or language arts, mathematics, science, foreign languages, civics, government, economics, arts, history and geography.	Literature, philosophy and scientific knowledge and awareness help individuals to develop their powers of discernment and critical analysis and to participate in an informed way in debates and decisions concerning critical environmental, ethical and societal issues. Better foreign language teaching is also essential for Europe's multilingual society to achieve its economic, social and cultural potential.
Learning skills to keep learning continually throughout life and comprising three broad categories of skills: information and communication skills, thinking and problem-solving skills, and interpersonal and self-directional skills.	Ability to learn – maintaining the curiosity and the interest in new issues and skills – without which lifelong learning cannot exist.
ICT literacy, i.e., "interest, attitude and ability of individuals to appropriately use digital technology and communication tools to access, manage, integrate and evaluate information, construct new knowledge, and communicate with others in order to participate effectively in society." [11]	Information technology across the board in curricula is a necessity.
Learning emerging content areas: global awareness; financial, economic and business literacy; and civic literacy. Educational and business leaders identify them as critical to success in communities and workplaces.	Learning European awareness, the feeling of belonging to Europe, and ultimately, European citizenship in a context of cultural diversity and broadening of experience and enhancement of skills, including foreign languages.
Teach and learn in context: need to learn academic content through real-world examples, applications and experiences both inside and outside of school.	Absorbing the intellectual and practical contributions of business, research and society as a whole, particularly spirit of enterprise and initiative by facilitating the understanding of the value of enterprise, risk-taking and innovation. Models of successful entrepreneurship should be promoted, particularly of socially responsible enterprises.[12]
Assessment measuring 21st century skills: A balance of assessments — i.e., high-quality standardized testing for accountability purposes and classroom assessments for improved teaching and learning in the classroom. To be effective, sustainable and affordable, sophisticated assessment at all levels must use new ICTs.	Quality assurance systems are essential to an effective education and training system. They enable schools and training institutions to look critically at the value delivered people, identifying strength, weaknesses and hence areas of improvement.

9 Partnership for 21st Century Skills (2003).

10 CEC (2001b, 1996).

11 Programme for International Student Assessment (PISA)

12 Schools should also build on the contacts they have with businesses in their local environment to provide role models of successful businesses as part of their civic education curricula. (CEC, 2001b, pp.11-12)

2.2 ICTs as an Enabler of Qualitative Change in Education

Writing of the role of ICTs and education has a long history preceding the forceful emergence of interactive multimedia and the Internet in the 1990s. Before, the emergence of computers gave rise to terms such *computer-aided education* or *computer-assisted learning* and analogue television became the technology of *distance learning*. The rise of the Internet and *cyberspace*, however, is certainly seen as enabling the emergence of qualitatively more powerful forms of electronic learning activities and environments (i.e., e-learning, see note 3 above). The overall expected result is a new educational dynamics, with new types of roles for teachers and students, new didactics, higher and richer levels of attainment, and ultimately life-long learners prepared to face the challenges of a world in constant change in the 21st century. Levy (1997) has described this transformation in the following words:

> The key point here is the qualitative change in the learning process. … The most promising direction, which reflects the outlook of collective intelligence in the educational field, is that of cooperative learning.
> On the new virtual campus, professors and students will share the available material and informational resources. Teachers will learn along with their students and continuously update their knowledge along with their teaching skills.
> The primary role of education will no longer be the distribution of knowledge that can now be obtained more efficiently by other means. It will help provoke learning and thinking. … It will focus on managing and monitoring learning: encouraging people to exchange knowledge, relational and symbolic mediation, personalized guidance for apprenticeship programs, and so forth.[13]

Such vision is reinforced by Haddad and Draxler (2002) who highlight the teachers' transformation from "transmitter" to "mediator," or, as they prefer to call it from "provider" to "facilitator." They envisage an increase in the number of didactic activities and skills that takes place as the teacher's and the learner's roles evolve from "provider" to "facilitator" and from "passive" to "active" respectively. Figure 1 illustrates this change with the traditional teacher and learner didactic relationship found at the bottom-left side of the diagram in the form of a "provider-passive" relationship dominated by a didactics of 'presentation." As the relationship moves increasingly towards one of "provider – facilitator," the didactic activities and skills become more and more interactive until they reach the status of "collaborative" or "cooperative," in which teacher and learner are both important contributors to the learning process.

[13] Levy (2001, 1997), Batini and Fontana (1997), Alberici (2002) and Alessandrini (2002).

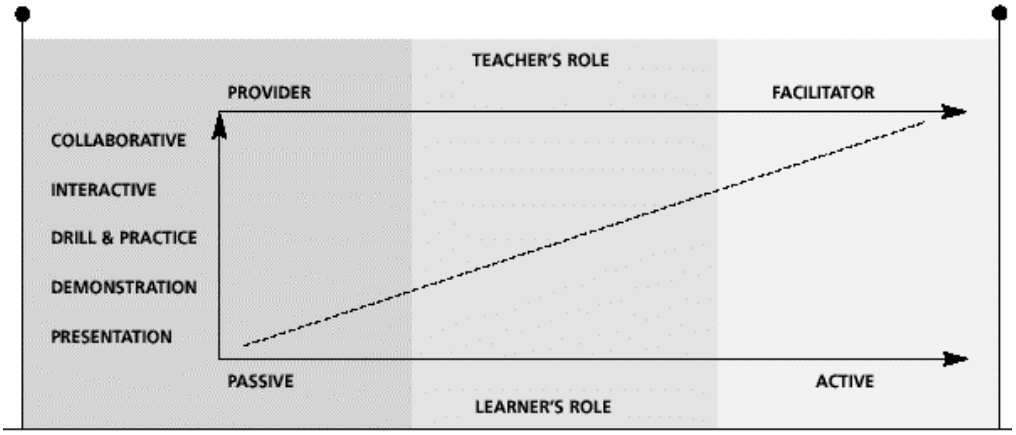

Figure 1. Use of ICTs for different Roles of Teachers and Learners

Source. Haddad and Draxler (2002b), p.13.

Of course, the excitement of these visions should not veil the fact that key didactical concepts such as "active learning, "cooperative learning," "personalized learning" and many others have a long tradition in educational fields such as *didactics*, *psychology of learning*, *cognitive science*, *cybernetics* and *human-computer interaction* largely preceding the educational arrival of ICTs.[14] At the same time, it is plausible to say, that it has been the arrival of ICTs and particularly interactive multimedia computing and communications that has truly enabled the realization of these didactical concepts on a magnitude, richness, flexibility and "boderless geography" qualitatively different from anything we have seen before.

The end result for schools and educational systems across the world is the requirement for innovative change in the practices, technology, and governance characterizing today's learning processes. Such innovative processes will most likely benefit from a holistic approach that recognizes that the real challenge is in fact the emergence of completely new "physical and virtual learning communities and environments." In this environments, intra- and inter-schools "learning communities" will have the opportunity to operate at multiple levels and times, very much as combinations and re-combinations of "communities of practice" in the sense of Wenger.[15] Simultaneously, the opportunity for the systematic "personalization of students' learning processes" will also be enhanced to suit their individual combination of characteristics or personal profile as implied, for instance, in Gardner's concept of "multiple intelligences."[16] Ultimately, this combination system should facilitate the learning community to be a resource for the individual

[14] Greg Kearsley's Theory Into Practice (TIP) database (http://tip.psychology.org/backgd.html) contains descriptions of over 50 theories relevant to human learning and instruction. Among the influential concepts are "social development theory" and "zone of proximal development (L. Vygotsky), "situated learning" (J. Lave and E. Wenger), "social learning theory (A. Bandura), "constructivist theory" and "discovery learning" (J. Bruner), also constructivist "genetic epistemology of J Piaget and "Anchored Instruction" (Bransford and the Cognition & Technology Group at Vanderbilt (CTGV). Indeed, the list is long and span back many decades, reaching the early 20th century and even further back with the work of 19th century educational philosopher J. Dewey and his *Democratic Principles in Education*. (see full text in The Project Gutenberg Etext of *Democracy and Education* by John Dewey, March, 1997 [Etext #852] found at ftp://sunsite.unc.edu/pub/docs/books/gutenberg/etext97/dmedu10.txt. Finally, Conway (1977) offers a matrix with examples of specific educational software to support the practice of some of theoretical educational concepts.

[15] Wenger (1998, 2002).

[16] Gardner (1983, 1999).

learner and, conversely, the individual learner to be a resource for the learning community.

2.3 Basic ICT-based Capacities to Realise the Educational Concept for the 21st Century

This section provides an illustrative idea of the basic technologies and associated skills required by a process of ICT-based educational innovation for 21st century education. The purpose is to highlight that for schools the development, integration and diffusion of a basic set of network infrastructure, hardware equipment, instrumental software, educational content and skills is simply unavoidable. Figure 2 illustrates the ingredients of this basic set that starts with the inner rectangle highlighting the requirement for availability or access to appropriate:

- network infrastructure (e.g., ADSL, broadband cable, wireless, etc. and their associated software)
- hardware equipment (e.g., computers, printers, scanners, etc. stand-alone or interconnected),
- instrumental software (e.g., databases, word processors, spreadsheet, email, browsers, etc.),
- educational content (e.g., software applications related to specific subjects such as math, physics, languages, etc.)

And, in more advanced cases, the presence of structured collaborative e-learning environments, which integrate all the ingredients above, and more (e.g., virtual forums, chat rooms for real-time conferencing, groupware for group interaction and collaboration, etc.), into an ensemble of functionalities that reflect and understanding of learning processes and enabling the implementation of both courses in targeted areas and collaborative educational work between two or more individuals. Also included at this inner level is the requirement for servicing, maintenance, and development of these ICTs. In turn, the outer rectangle highlights the requirement for various skills necessary to realize the educational potential of the ICT-based ingredients into the educational concepts for the 21st century. Also included at this skills level is a research and training capacity to maintain the ICT-based educational/pedagogical skills at the leading edge. Structured collaborative e-learning environments will require skills not only to maintain the environment but also to moderate and manage the evolution of the learning processes, including the respect for the specific *netiquette* adopted for the virtual interactions.

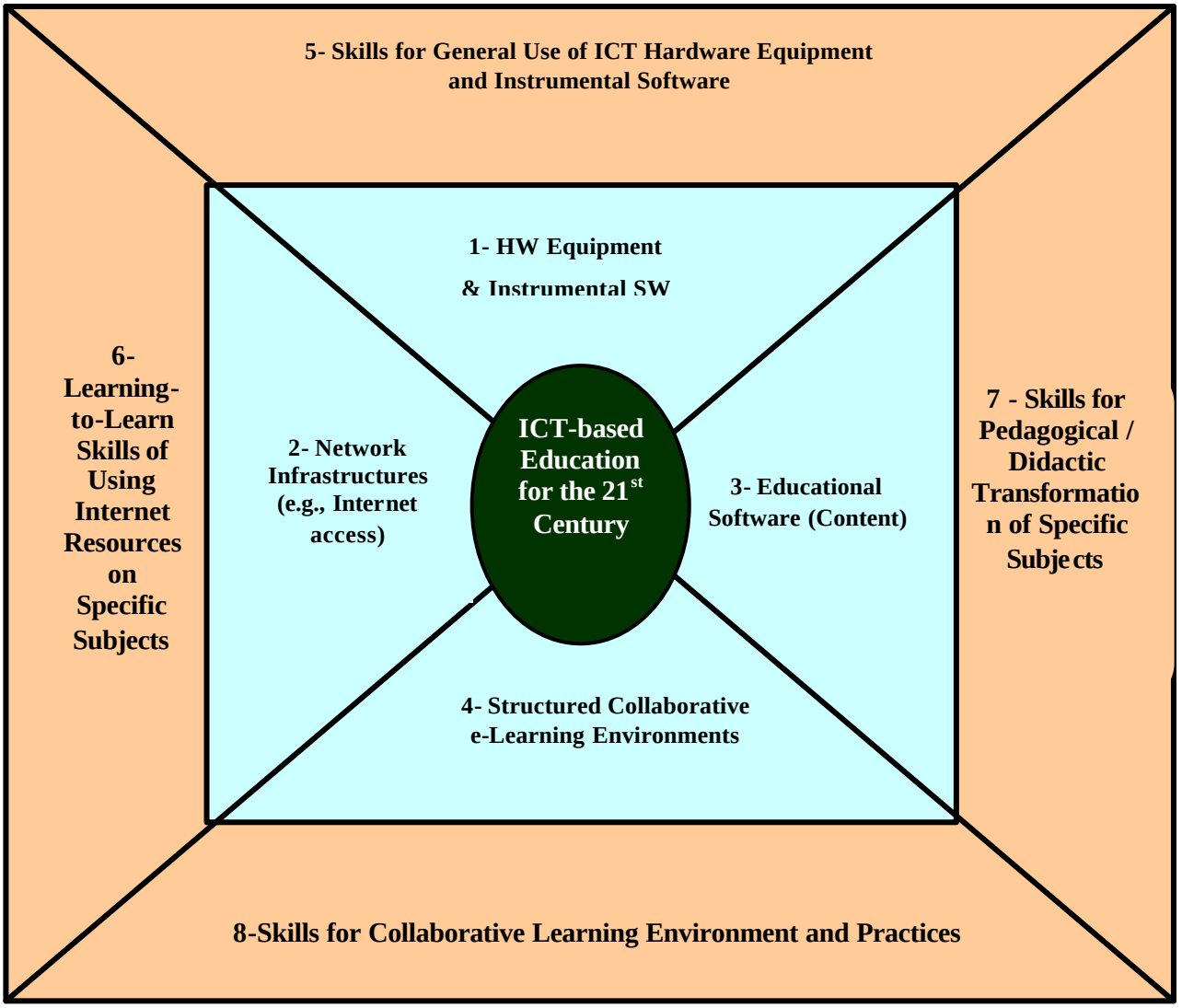

Figure 2. Basic Set of ICT-related Requirements for the Realization of 21st Century Education

For schools travelling the journey of ICT-based educational innovation, the set of ingredients of the double-rectangle of "ICT-based education for the 21st century" provides a reference to contrast the progress and state of development of their innovation processes. Where does the school stand in relation to each one of the dimensions? What has been achieved?

2.4 Holistic Synthesis of Ingredients of ICT-based 21st Century Learning Environment

This section goes beyond the technology and associated skills requirements just described. It makes an effort to synthesise into a more holistic instrument the main ingredients associated with 21st century education identified during the brief discussions of previous sections. They can be broadly grouped into a matrix with the headings of *multiple intelligences*, *didactic attitudes*, *subject-specific knowledge*, *life skills* and *ICT-based knowledge and skills*.

Table 2 illustrates the resulting matrix that, it should be noted, has no intention of being exhaustive. *ICT-based knowledge and skills* is placed horizontally precisely because of its transversal influence on the development of *didactic*, *knowledge* and *life-skills* flows.

Looking at the entire matrix, it can be proposed that the key to the success of the educational challenge of the 21st century lies in the generation of learning environments with governances, processes, mechanisms, activities and assessment approaches that stimulate a harmonious integration of all four sets of learning flows with the demands emerging from learners' specific combinations of multiple intelligences. That is, ideally, the educational system should be able to match the learners' specific combination of multiple intelligences with specific combinations of knowledge, life-skills and ICT-based skills flows. If this is accepted, Table 2 should be also useful to think and construct instruments for the evaluation of progress of mass-customized education.

Table 2. Towards Mass Customization of Education - Multiple Intelligences and Learning Flows in 21st Century Education

Multiple Intelligences[17] *(Students & Teachers)*	**Didactic Flows** *(can all be integrated)*	**Knowledge Flows** *(can all be assessed)*	**Life-Skills Flows** *(can all be assessed)*
-Verbal-Linguistic -Mathematical-Logical - Musical -Visual-Spatial -Bodily-Kinesthetic -Interpersonal -Naturalist -Existential	-curiosity and creativity -motivation to learn -fun to learn (ludic) -participation, responsibility and discipline in tasks -team and shared learning -scientific honesty -fair competition -integration with community -focus and concentration -inclusion -etc.	*Variety of subjects* -English -literature & philosophy -mathematics -science -other languages -civics -history & geography -arts -government -economics -etc.	-initiative / leadership -communication -creativity -problem solving -mnemonics -team-building -communicating across languages -research (including internet) -ICT-based collaborative work -ludic skills etc.
	ICT-based knowledge and skills flows for: ?? general use of ICT equipment ?? learning-to-learn using Internet and other research resources on specific subjects ?? participating in collaborative learning environment and practices ?? preparing, processing, presenting, and communicating knowledge and work on specific subjects		

The preceding discussion leads us to introduce an understanding of the nature of innovation processes through the particular conceptual framework "sociotechnical constituencies" and associated "diamond of alignment." This conceptual instrument, along with the synthesis of Table 2, will facilitate the systematic analysis of the particular ICT-based educational innovation process of Sint-Amandus Primary School.

[17] See Gardner (1983, 1999).

3 Conceptual Framework to Analyse ICT-based Innovation Processes in Schools - Sociotechnical Constituencies and Diamond of Alignment[18]

To facilitate the understanding of the nature and magnitude of the transformation implied in the emergence and full spread of an ICT-based educational innovation in a school, the set of Figures 3, 4, 5 and 6 give first (Figure 3) a simple representation of a school world in the context of other schools and technical, market, pedagogic, and educational policy trends.

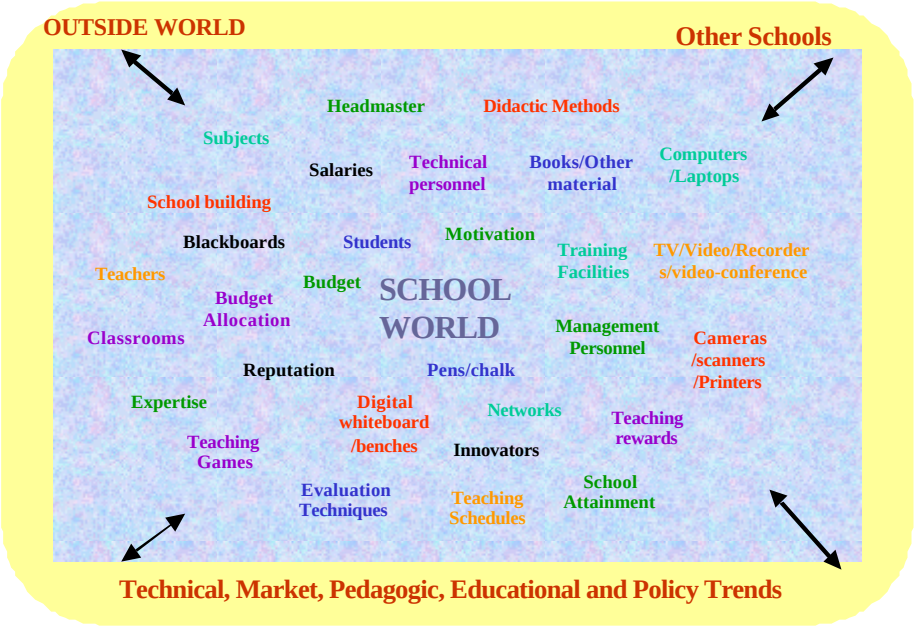

Figure 3. Simple Representation of a School World

Figure 4 then illustrates the birth of an ICT-based educational innovation process inside the school, as represented by the small "ICT-based sociotechnical constituency (STC)" circle right in the middle of the figure. In this respect, the birth of an ICT-based innovation process is equivalent to the birth of an ICT-based sociotechnical constituency. Indeed, this is fundamental postulate of the theoretical framework used in this paper, namely, all innovation and technological processes are in essence an integration of *social* and *technical* constituents. That is, they imply the construction of 'sociotechnical constituencies,' understood as dynamic ensembles of *technical constituents* (hardware, software, etc.) and *social constituents* (people, interest groups and their visions, values, etc.), which interact and shape each other in the course of the creation, production and diffusion of specific technologies.

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[18] The field of innovation and technology has a long tradition and many schools of thought going right back to the writing of Adam Smith, David Ricardo and Karl Marx. It includes work concerned with the determinants of success or failure of products in the market such as the classical SAPHO study of the 1970s, to the work of evolutionary economists and network approaches such as those from the sociology of technology, and also the work on communities of practice already mentioned in Section 2.2 of this paper. This paper does not seek to provide a review of the innovation literature to any extent. It takes the simple avenue of selecting and applying the process-oriented conceptual framework of "sociotechnical constituencies" to deal with the analysis of the evolution of Sint Amandus' experience. A selection of papers on this framework includes Molina (1990, 1997, 1999a, 1999b).

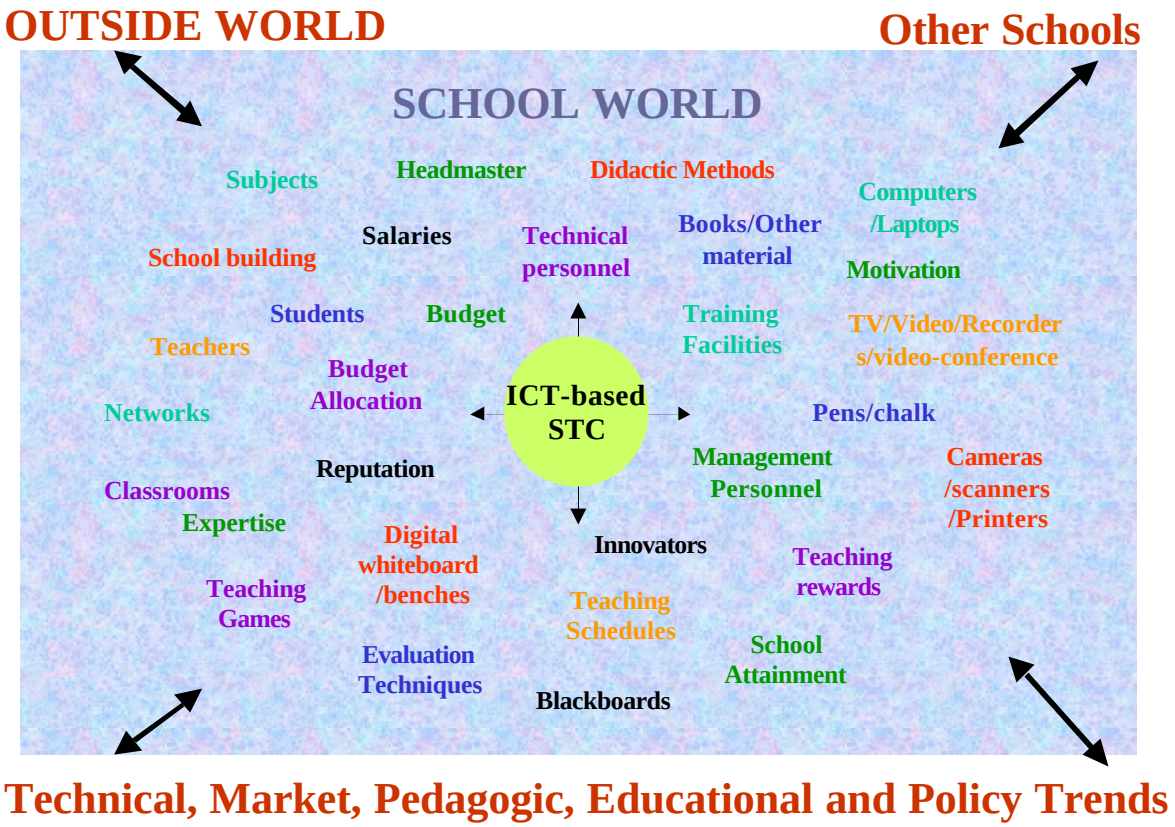

Figure 4. Birth of an ICT-based Sociotechnical Constituency Inside a School

Most importantly, the concept of "sociotechnical constituencies" emphasises the idea of interrelation and interaction in innovation and technological development. It makes it possible to think of technical constituents and social constituents but always stressing the point that in the technological process both kinds of constituents merge into each other. Sociotechnical constituencies are never static; they are always evolving and changing their mix in ways that are reflected in growth or decline. A manifestation of this change may be seen, for instance, in the spread of successful adoption and implementation of ICTs in schools.

Within constituencies, players' interaction may be competitive, collaborative or a combination of both, and the extent to which any given technology such as ICT is diffused and successfully implemented is conditional upon the relative success or failure of the social constituents creating and promoting it. To an important extent the success or failure of the sociotechnical constituency will depends on the ability of the leading drivers or constituency-builders to strike a balance between their individual interests and the development of the constituency as a whole. Figures 5 tries to illustrate the growth of an ICT-based constituency over time and Figure 6 illustrates a situation of success in which the ICT-based sociotechnical constituency (or ICT-based innovation process) has spread completely inside a school.

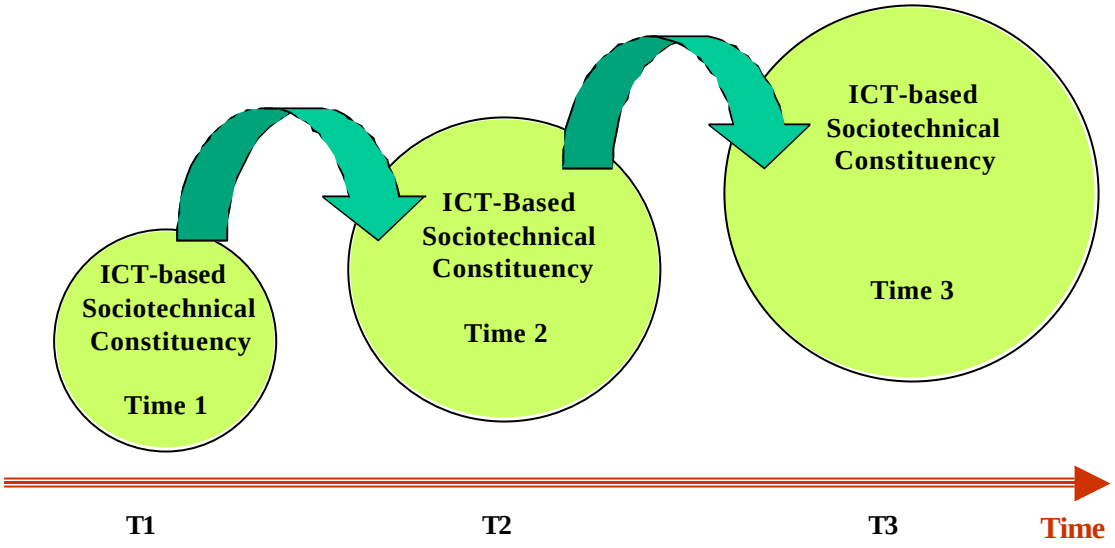

Figure 5. Evolution of a Growing Constituency Over Time

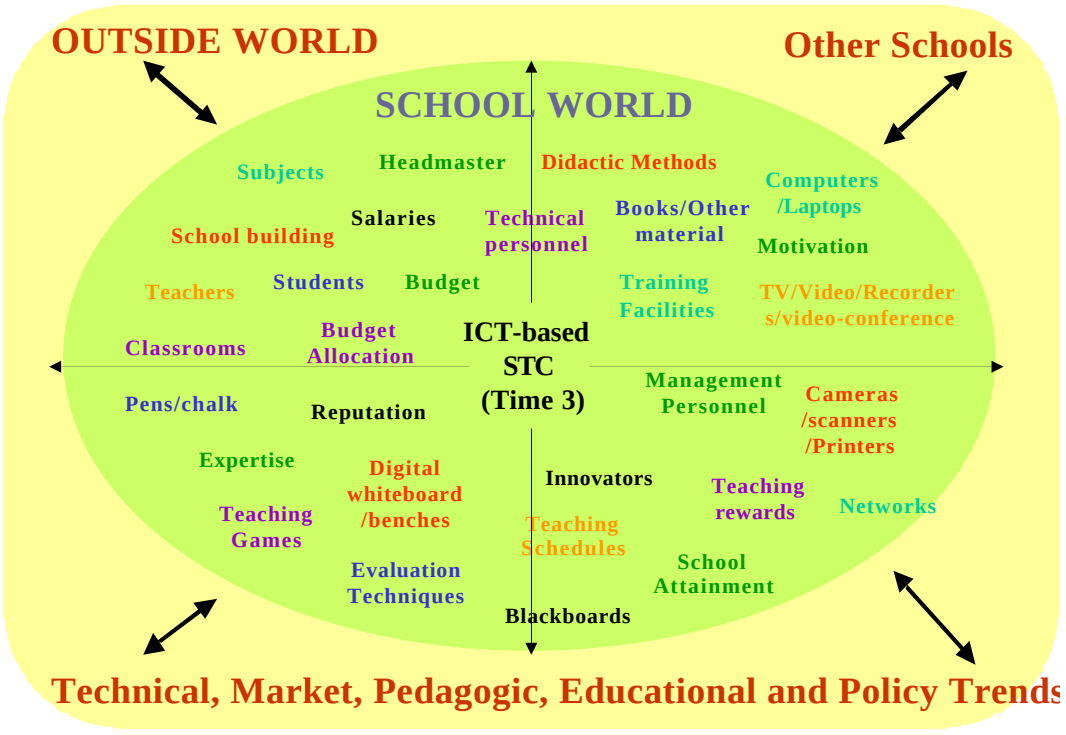

Figure 6. ICT-based Sociotechnical Constituency Spread to All School

Figure 7 provides a more systematic picture of the richness and complexity of an ICT-based constituency-building process in a school. It overviews three levels of intra-school elements the constituency must create and/or involve to be able to succeed in generating a harmonious and fruitful integration of flows of didactic attitudes, subject-specific knowledge, life skills and ICT-based knowledge and skills (see Table 2). These include

the elements of the first inner circle " STC's Material, Financial, Space and Time Resources," the second middle circle "STC's People - Human Resources" and the third outer circle " Intra-school Environment, Organization and Governance." The coloured arrows radiating across the three circles represent the different flows of educational ingredients of 21st century education.

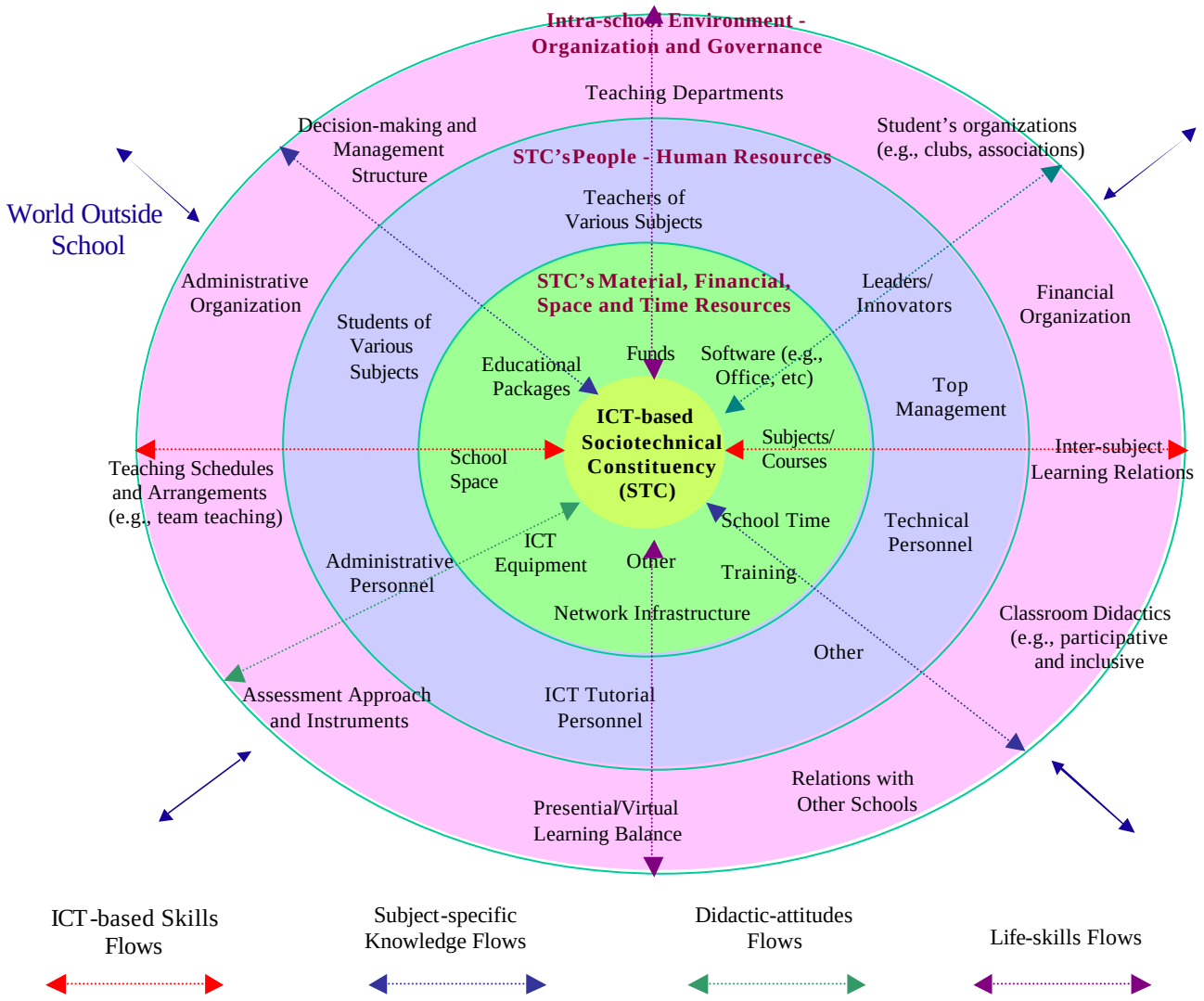

Figure 7. Full Overview of Intra-school Elements the Constituency Must Create and/or Involve, Including Educational Value Flows

The entire process is highly challenging, and there is never a guarantee that these "intra-school elements" will be created and/or enrolled, or that they will be harmoniously integrated into an effective ICT-based innovation educational process or sociotechnical constituency. In practice, it is rare for a constituency to advance simultaneously unhindered across the whole front of aspects. For this reason, some constituencies will look patchy and partial at certain points in time, while others may never achieve full integration of elements, other will, and so on. The effort to achieve this integration is the essence of "sociotechnical alignment," the process whereby all sociotechnical constituencies are built - whether consciously or not.

3.1 Sociotechnical Alignment and the Diamond of Alignment

Having identified that innovation processes imply the build up of sociotechnical constituencies, the next question is: How are sociotechnical constituencies created? What processes are involved? How does a diverse range of interests, involving collaborating as well as competing organizations, evolve into a new capability such as an ICT-based education for 21st century skills? The answer to these deeper questions is found in the process of 'sociotechnical alignment' and its instrument the 'diamond of alignment.'

Sociotechnical alignment is what social constituents try to do (however consciously, successfully, partially or imperfectly) when they are promoting the development of a specific innovation or technological capability (e.g., ICT-based education) either intra-organisationally, inter-organisationally, or even as an service standard.

'Sociotechnical alignment'[19] may be seen as *the process of creation, adoption, accommodation (adaptation) and close or loose interaction (interrelation) of technical and social factors and actors which underlies the emergence and development of an identifiable constituency*. As such, alignment should neither be seen as a mere jigsaw-like accommodation of static available pieces nor as complete and permanent, once achieved. Instead, alignment accommodates the rich picture of competing influences and trends, across institutional settings and governance systems.

The 'diamond of alignment' is the conceptual tool enabling an structured analyses of processes of sociotechnical alignment in constituency-building. Above all, it enables a dynamic analysis of constituency-building processes, thus complementing and deepening the more static identification of a constituency's ingredients given in Figure 7. Figure 8 shows the basic diamond of alignment with its six fundamental dimensions, while Table 3 gives a description of the content of each of these dimensions.

[19] The term "alignment" is commonly found in the literature on implementation of information technology in the business organization. It usually refers to the process of 'matching' business and information systems strategies and, more generally, to deal with the mutual adaptation process involving incoming technologies and user organizations (Leonard-Barton, 1988). For strategic alignment, see Baets (1992) and Luftman *et al*. (1993).

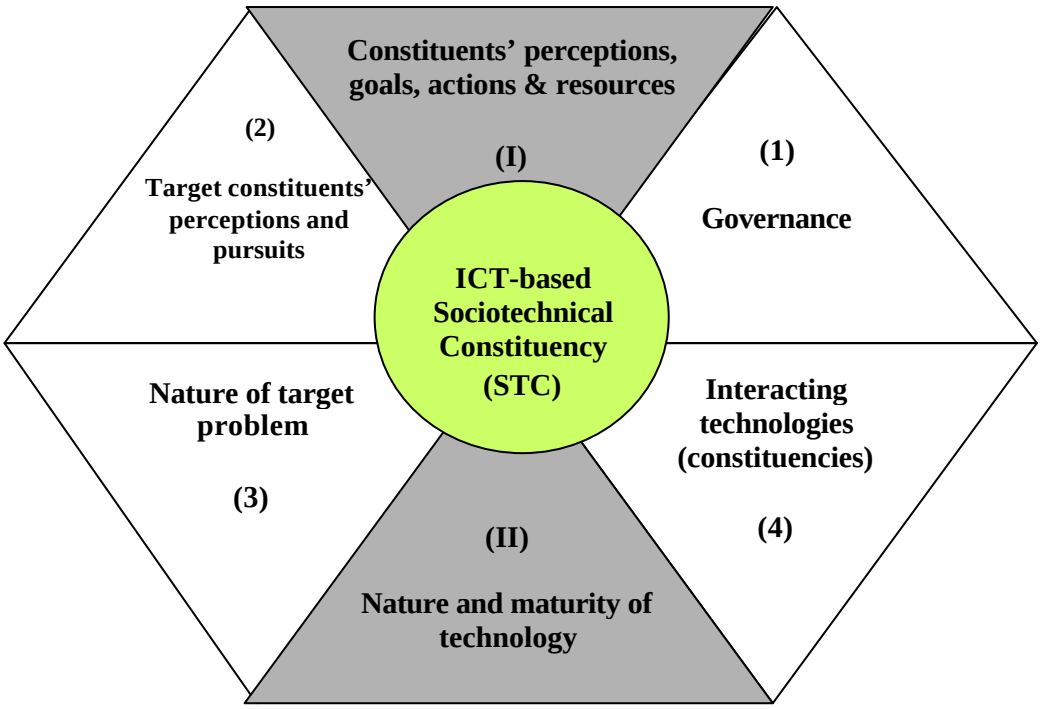

Figure 8. Basic Diamond of Alignment

Table 3. The Content of the Dimensions of the Diamond of Alignment
(I) Constituents' Perceptions, Goals, Actions and Resources This relates to the present state of the constituency's resources: the type of organisation, people, material and financial resources, knowledge, experience and reputation. It also includes other elements such as current perceptions, goals, visions and strategies. ***(II) Nature and Maturity of the Technology*** This dimension highlights the importance of the nature and maturity of a technology for its successful constituency-building process. Adopted strategies must align with the strategic opportunities and constraints implicit in the particular technologies. Thus emerging technologies such e-learning systems imply different requirements from other more mature educational technologies. ***(1) Governance*** This dimension highlights the importance of aligning the constituency-building process with the governance and strategic directions of the organisational and educational environments in which it is expected to flourish. ***(2) Target Constituents' Perceptions and Pursuits*** This dimension relates to the people and organisations the constituency is seeking to enrol. This includes the alignment of perceptions and goals between the innovating constituency itself and its target constituents in organisational and educational environments. ***(3) Nature of Target Problem*** This dimension highlights the importance of alignment between the capabilities of the emergent constituency and the requirements of successfully introducing new technologies and associated practices. This includes alignment between the technology and innovation and agreed technical and service trends and standards in the target area. ***(4) Interacting Technologies/Constituencies*** This dimension relates to the interaction a constituency has with other existing or emerging technologies. No constituency emerges in a vacuum. Other technologies, innovations, trends and standards may impact upon the constituency's innovation in both competitive and collaborative ways.

Dimensions I and II represent the constituency's state of development and nature/maturity of its technology. The ingredients are found in Figure 7. Dimension 1, 2, 3 and 4 contain key factors the constituency interacts with in its process of development. The nature of

the interactions and alignments helps explain the dynamism, direction, achievements and potential for success of the constituency.

Each of the diamond's dimensions influence each other and, put simply, the entire set acts as an overall setting and guide to alignments between people-people, people-technology, technology-people and technology-technology. A successful constituency building process will be a virtuous cycle in which all types of alignment reinforce and strengthen each other. However, mis-(non)-alignments can reverse this process, creating a vicious cycle exacerbating internal and external conflicts and contradictions. Indeed, care must be taken that alignment in certain directions should not involve potential mis-alignments in others.

3.2 Using the Diamond of Alignment

The diamond of alignment can be used to capture the evolution on an innovation process, assessing the strengths and weaknesses (i.e., quality) of its alignments and, consequently, the effectiveness of the strategies pursued until then. It can also be used to research the history of the alignment processes since their origins, through questions related to Dimension I such as:

- Who is starting the constituency-building?
- What are the main reasons behind it? What perceptions have been most influential in prompting the constituency-building process?
- Is there an initial vision for the process? If so, what is it?
- Are there defined goals for the process? If so, what are they?
- Is there a defined strategy the constituency is pursuing? If so, what is it?
- Is the process following the steps or example of some other school or organizations?

At the same time, other questions will enable an assessment of progress of the constituency-building process, for instance:

- Is the original vision or objective on course or has it changed in time? If so, how?
- What are the present achievements? Do they match expectations?
- Are the technical aspects of the ICT-based innovation completed?
- Is the ICT-based innovation implemented across the organization?
- Has the process hit major problems, what are they?

In turn, each one of Dimensions 1, 2, 3 and 4 interacting with the constituency (Dimensions I and II) in the ICT-based innovation process enables the identification of a range of aspects with distinctive influence in the success of the alignment process. These aspects are listed in Table 4 and they can be used to focus the enquiry and assessment of the overall constituency-building process.

Table 4. Key 'Component' Sub-dimensions of Each One of Dimensions 1, 2, 3 and 4

Dimension 1 - Governance (School)

?? Flat decision-making structure
?? Rewards for ICT-based innovators
?? Encouragement to new didactics
?? Teachers' collaboration and teams
?? Assessment appropriate to new educational methods
?? Students' participation in learning

Dimension 2 - Target Constituents' Perceptions and Pursuits

?? Good prospects with target teachers
?? Good prospects with target students
?? Good prospects with Head of School
?? Good prospects with technical personnel
?? Good prospects with administrative personnel
?? Good prospects with senior management

Dimension 3 - Nature of Target Problem

?? Well inside expertise/ capabilities of constituency
?? Very important to school
?? Highly motivating to leaders/innovators
?? Very important to schools' teachers and students
?? Well inside space and time resources available
?? Well inside financial/material resources available

Dimension 4 - Interacting Technologies (Constituencies)

?? Easy technical integration between new and existing legacy system
?? Easy with displacement of obsolete practices
?? High presence of required complementary technologies (e.g., electric network)
?? High presence of useful complementary technologies (e.g., content)
?? Low opposition from competing ICT-based system
?? Effective mechanisms for socializing new mix of technologies

Once an assessment is conducted, the format of Table 3 can be used to summarize the key aspects and issues characterizing the state of each one of the dimensions of the diamond of alignment. The overall result should generate a clear overview of the strengths and weaknesses of the different alignments implied in the process of constituency building. Such overview should be useful to assess or re-assess the quality of the strategies in operation in a given process of constituency building. Form instance, if all the dimensions of the diamond of alignment show a fundamentally harmonious relation to each other, then the conclusion is that the constituency-building strategy and its implementation are effective an sound at least up to that point in time.

On the other hand, if the dimensions of the diamond of alignment show a fundamentally dis-harmonious relation to each other, then the likelihood is that the constituency-building strategy being implemented is either wrong or, simply impossible in the circumstances. This should lead either to the revision of the strategy and its implementation in order to induce re-alignments or, in extreme circumstances, the whole revision and potential abandonment of the constituency-building process.

4 The Constituency-building Story of Sint-Amandus Primary School

4.1 Overview of initial conditions

The start of the STC-building process at Sint-Amandus is not different from other processes of STC-building. An individual with a vision, the interest and above all the will and energy to pursue them begins a journey that will make a great difference in his/her surroundings. In this case, however, the constituency-building story is pioneering in all senses, because the efforts of Lieven Van Parys started two decades ago, way back in the early-eighties when educational systems were yet to discover computers.

Van Parys is an unusual person. He is a primary school teacher who concentrates technical and didactic skills with vision and a drive for innovation. He saw early the importance of computers for schools and begun crossing the borders between his hobby and teaching job. He remembers:

> I started working on computers in 1982 … My first approach to the computer was due to my hobby on astronomy and I had to do a lot of calculations with little machines, but I realised that it was possible to make the same operations with the computer and above all I understood that computer could become an important resource for my school. This was the starting point to realise little programs for writing, painting and mathematics. Afterwards I started to integrate the computer with my lessons and I created a database … so I could find all my lessons done in the past. These databases were very useful when inspectors came to our school and they wanted to investigate on our lessons and didactical tools. [20]

Table 5 uses the dimension of the diamond of alignment to characterize the situation at the start of the constituency building process triggered by Lieven Van Parys. The situation was clearly pioneering and the challenge could not be confined to Sint-Amandus alone, after all the primary school was itself part of the Catholic network and, more broadly, part of the Belgium educational system. Thus, advancing in Sint-Amandus would sometimes imply work to spread progress to the Catholic network, with consequent consolidation of these advances, and so on and so forth, in a process of mutual impulses between the school and the system – the part and the totality.

Table 5. State of Alignment at the Start of Sint-Amandus' Constituency-building Process

(I) Constituents' Perceptions, Goals, Actions and Resources
Constituency-builder or innovator with unusual set of skills. Lieven Van Parys concentrated technical and didactic skills with vision and a drive for innovation.
(II) Nature and Maturity of the Technology
Immature in the context of primary school education, hence little experience upon which to build. Lack of good educational software.
(1) Governance
Not favourable. Fully consistent with a traditional education not including or even considering computers.
(2) Target Constituents' Perceptions and Pursuits
All educational stakeholders, including teachers, school authority, students, parents, educational authorities (e.g., inspectors), etc. They would make available resources for the constituency.
(3) Nature of Target Problem

[20] Interview with Lieven Van Parys, January 2003. Van Parys created the first experimental database in 1984.

Improving educational practice both in classroom learning (e.g., math programme) and teaching administration (e.g., lessons archive in database) through the introduction of computers in the school system. In short, focus was on technology as a means to improve learning and administration. The pursuit of these targets generated others such as the need to train other teachers, etc.

(4) Interacting Technologies/Constituencies

Almost no educational software available. It had to be created and implemented to demonstrate the usefulness of computers. Networking was still years ahead. The school environment was dominated by the traditional approach to education: its skills, methods and technologies.

By the mid-eighties, Van Parys' efforts with computers had become well known and, as time went by, awareness of the potential importance of computers had also begun to grow. In 1985 a training initiative started inside the Catholic network and Van Parys was called upon to transfer skills to other teachers through training. As part of the setting up of the initiative, Van Parys was called upon to demonstrate what could be done with computers in teaching to the Counsellors of the Catholics network who organized the training. He demonstrated how word processing could help with the preparation of lessons, saving time by eliminating the repetitive aspects of this task. The new methods however were not necessarily welcome. The Counsellors were comfortable with the traditional way of writing lessons with a ball pen on a notebook. The didactic argument was that by writing fully each lesson (including repetitive aspects), the teacher gave careful thought and preparation to them. Consequently, "they didn't like the fact of copying, cut and paste possibilities. So we couldn't introduce these tools in the beginning of our teacher training. …[Nevertheless]… we gave the teachers advice to use them because that could motivate a lot of teachers to start with the computer... and the teachers were interested! We had a 'question hour' during our training, so...."[21]

The training initiative was to last for nine years, until 1996, with the training of 1500 principals and about 10.000 teachers.[22] During this period, for a number of years, on the advice of their district Councellors, some schools were not using the software Van Parys was introducing to help teachers with the preparation of lessons. He simply responded with the persistence of the innovator who was determined to take steps towards the future with computers. Eventually, he remembers, in the "last 2 years of the training the climate changed. One of the new counsellors made also some educational software and was now advising the teacher training."[23] Today, the "resistance" is part of history since teachers use computers routinely to communicate and to prepare their lessons.

Van Parys ended his 10-year period of "trainer" of the Catholic school network mostly out of boredom. He was also concerned that his work at Sint-Amandus had not progressed very much.

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[21] Personal communication with Lieven Van Parys, 1st[st] November 2004. Van Parys's opinion was "when you have more time, you can develop other (creative) things for your class!"

[22] During the period of 11 years, sometimes the money for the training was not enough and this resulted in the interruption of the activity. On these occasions Van Parys simply went back to school until the training activity could re-start. The period at school was about 2 years of the full 11 years of the training period. The training consisted of aspects for teachers and aspects for Principals. Thus, "Teachers: What is a computer?, parts,… Educative software: what? how to use it? For principals: what is a word processor, spreadsheet, database?,.. administration with the computer… Some ideas about educational use of computers." (Personal communication with Lieven Van Parys, 21 January 2004)

[23] Ibid.

> It was an overwhelming work because of the lack of trainers at that time. At the end it was very boring, always the same things, the same lessons. At the end it would become a sort of part time work: half day of training and half day of teaching in my school. I had to choose one of the two, and I decided to go back to my school where I could do a lot of things: install computers, create programs, etc.[24]

4.2 Back to School - The Re-start of the Sint-Amandus' ICT-based Constituency

Van Parys came fully back to Sint-Amandus primary school in September 1996. By then the world had moved on and Van Parys himself had contributed to spread computer skills through the nine-year period of training of Principals and teachers. Table 6 summarizes the new state of alignment at the re-start of Sint-Amandus' ICT-based constituency-building process.

Table 6. State of Alignment at the Start of Sint-Amandus' Constituency-building Process

(I) Constituents' Perceptions, Goals, Actions and Resources
Constituency-builder remained the same but with improved skills in computers, didactics and innovation. During his period as trainer, Van Parys had learnt a great deal about teachers' problems and develop ideas on how to tackle them. Marc Lemiengre, the Principal of Sint-Amandus, also understood the importance of computers for his own and teachers' work. He had become Principal in 1984, had been trained by Van Parys and now supported his renewed ICT-based efforts at the school. At the time there were only 2 computers at the school –Van Parys' own personal PCs - and they were in use by the teachers who had taken over Van Parys' class. In addition, 9 out of the 12 Sint-Amandus' teachers had also taken the training.
(II) Nature and Maturity of the Technology
Computers had become a much more mature technology and more educational software was available. Prices had come down but they were still high for school budgets.
(1) Governance
More favourable from the point of view of the school authority and the general environment. The educational authority is in principle favourable but does not make resources available. The classroom is still dominated by a traditional educational approach to teaching not including computers. Close relations with Sint-Amandus' parents will prove helpful.
(2) Target Constituents' Perceptions and Pursuits
Still all educational stakeholders, including teachers, school authority, students, parents, educational authorities etc. School authority is supportive but requires attention.
(3) Nature of Target Problem
It remains the improvement of educational practice both in classroom learning (e.g., math programme) and teaching administration (e.g., lessons archive in database) through the introduction of computers in the school system.
(4) Interacting Technologies/Constituencies
More educational software available, particularly DOS programmes and freeware made by teachers and teacher trainers. This software was useful with good ideas and structure.[25] Networking was around the corner.

[24] Interview with Lieven Van Parys, January 2003.

[25] Some of this software is still useful and can be found at websites such as www.dainamic.be and www.ewoc.be

The assessment of Table 6 shows more favourable circumstances for an ICT-based innovation process at Sint-Amandus, particularly from the cost-performance advances of the technology, the support of the school authority, and the enriched experience and skills of Van Parys - the constituency builder. On the other hand, everything else had to be created and brought together into a successful process of sociotechnical alignment. This included computers, software, new didactical techniques, teachers' acceptance, even time and space resources, that is, where will the computers be placed in the school? And how much time will they be used in the educational processes? Will they make it to the classroom? etc. Where and how to start was the key question facing the constituency-builder. Van Parys' multi-disciplinary skills were useful, since he avoided focusing on technology alone. As he recalls:

> The first real problem was to install computers and to give a concrete answer to the question: "How can I use computer in my classroom?" So I had to organise myself and the first tool I conceived was the "corner work" and I started to make computers for my colleagues. The next step was to make corner works for each classroom. [26]

The "corner work" was a key didactic innovation because not only did it open space and time for the new technology in the classroom, it did it for the right educational reasons, namely, to enrich the learning process of students and teachers in a highly participative and inclusive way. In fact, the "corner work" is not exclusively for computers, it is an entire learning programme of multiple practical activities that includes computers in a proportion of them. In total, "24 corner-work" activities are available to Sint-Amandus teachers and five of these involve the use of computers.[27] "Corner work" also involves coordination of the programme activities between teachers of different classes of the same grade. This coordination involves a systematic grouping of children and activities as well as of the use of space and time in the school. All children participate in all the 24 activities.

Table 7 shows how a typical "corner work" programme works. The case involves 4 classes of the 3rd grade with a total of 96 students. Figure 9 shows some non-computer and a computer-based corner-work activties.

[26] Interview with Lieven Van Parys, January 2003.

[27] List of these activities is found in http://www.sip.be/stamand/hoek.htm. List of activities with explanations and pictures for Geometry "corner work" is found at http://www.sip.be/stamand/meetkunde/klasmeet_eng.htm. Website of related project An@zing Geometry is found at http://www.sip.be/stamand/meetkunde/meettoren.htm (26 teachers from all over the world participate in this activity).

Table 7. Corner Work Operation Involving Four 3rd Grade Classes (96 pupils)

- Third grade has 4 classes, 4 teachers and 96 children
- The 96 children are organized into groups of four (one pupil per class) for a total of 24 groups
- Each teacher takes 6 groups (24 children) in his/her classroom
- Each class has 6 activities/"corners" (1 computer activity and 5 others); thus matching the number of groups.
- Each of the6 groups is assigned one activity/corner per week (40-45 minutes + cleaning time) and they rotate to another in the following week and until all the groups in the same class complete the all six activities.
- Each cluster of 6 groups remains in one class for a total of seven weeks since the first week is allocated for the introduction of the 6 activities to the children.
- Once the seven-week programme is completed, the cluster of six groups rotate to another classroom where they perform another set of activities (or corners).
- Each cluster of 6 groups visits all the 4 classrooms and complete the programme of 24 activities in a total of 28 weeks, including the four introductory weeks.
- The 28-week programme is run twice a year for the same grade or year (e.g., third grade), roughly occupying one school year. Given that the school year has 31 working weeks [28] available, two different programs (geometry or other corner work) run roughly in parallel to each other.

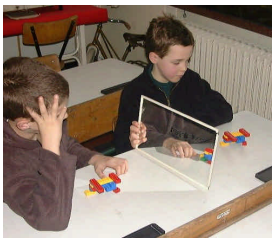

Figure 9. Examples of non-computer and a computer-based corner-work activities

The example of Table 7 is for the 3rd grade only. At Sint-Amandus there are six grades, thus the entire "corner-work" programme runs a few days a week, with the 1st, 2nd, 3rd and 4th grades having the "corner work" activities inside their classes. Fifth and 6th grades use the Media and Computer Rooms given space limitations for group work in their classrooms. The first focus of "corner work" activity was Geometry but today the system also applies to other activities like language and world-orientation techniques, also with 1 computer corner and 5 others.

Not all teachers were equally excited about the "corner work" however. Organising each week "corner work" demanded a considerable effort from individual teachers and the efficiency of the method also demanded co-operation between different classes. This challenged the prevailing classroom governance that was dominated by the traditional approach of imparting lessons and *"the idea of corner work was too distant from that way of working. The old teaching method was the real barrier to the new opportunities offered by computers."* This translated into teachers keeping close to old methods and books, with consequent slowing down of computer adoption. To be fair, there were not

[28] 52 weeks (1 year) - 15 weeks vacation - 2x2 weeks exams - start week at school - end week at school = 31 working weeks.

many computers either, since funds were not available and the main source of computers was Van Parys himself who was assembling computers from recycled stuff. At this stage there were 9 computers for the entire school and Van Parys, having come back only recently, had little time left to work on computers. In practice, he was able to add only one or two computers a month while preparing his lessons and creating traditional didactical material that the school could not afford to buy.

In addition, Van Parys had to nurture the support and encouragement of the Principal and this implied to help with the introduction of computers in the administration of the school as well.

> Very often I had to leave the lesson and go to help the Principal solve his problems. The principal liked my work. My principal was highly-educated and he created his own vision about ICTs. The ICTs were seen as a tool to show the school outside and to put it in a larger context. You can show your ideas to the world.[29]

The Principal confirms: "I have an important support by Lieven" and he sees himself as very supportive of the ICT-based innovation process, stressing that "my role is first of all to facilitate this process."[30]

In this combination of circumstances, Van Parys had to start the approach to the classrooms in a gradual and secure way. He used the constituency-building tactic of "building on strengths" by selecting friends and supporters (i.e., active constituents) to start accumulating strength and generate a demonstration effect that could then be promoted to stimulate the alignment of other target constituents. The tactic worked.

> I started easily, with one teacher, then two and so on. The teacher asked me: What are you doing in your class? Can you show it to me? So I explained that they could do that also in their classrooms. I started with Mr. Paul -my best friend- and little by little with the other teachers. It was a slow process.[31]

In the early days therefore the game of constituency building saw Van Parys working hard and patiently to stimulate the technical, didactical, and human alignments involving teachers, school authority, students, computers, even to the point of creating the generating the computers and didactical innovations. All four combinations of alignment involving technology and people were in operation: technology-to-people, people-to-technology, people-to-people and people-to-technology.

4.3 Taking Advantage of Contingent Opportunities to Advance the Constituency

In September 1998 an opportunity came the way of the emerging ICT-based constituency. Until then Sint-Amandus had separated schools and boys and the constituency had been growing mostly in the boy's school where 6 teachers were sharing 15 computers among their classrooms. In September 1998, the two schools merged and this revealed an unbalance that had to be solved now that everybody was together. The teachers from the girl's school wanted the same opportunity as those in the boy's school. The result was a demand for more computers that led to marked increment in the number of these machines out of two sources:

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[29] Interview with Lieven Van Parys, January 2003.

[30] Interview with Principal of Sint-Amandus, Marc Lemiengre, January 2003.

[31] Interview with Lieven Van Parys, January 2003.

?? a small increase in expenditure from the school that resulted in 4 more computers, and

?? parents "who donated the old computers they had at home or in their offices and I made them operative."[32]

As Table 8 on the evolution of the number of computers at Sint-Amandus by source during 1996 and 2003 shows, the second "recycling" source expanded the number of computers well beyond the financial capacity of the school alone. It represents a central constituency-building technique in the Sint-Amandus' ICT-based innovation process. Twenty-seven computers came this way during the time of the fusion and once this settled *"there were 25 computers, an average of one per class."*

Table 8. Evolution of Number of Computers at Sint-Amandus by Source (1996 - 2003)

End of Year	School Budget	Recycled	Internet-connected•	Broken and Lost
1996		4	0	
1997		9	1	
1998	4	27	4	5
1999	12	77	12	13
2000	18	93	18	22
2001	22	107	22	30
2002	24	134	24	40
2003	31 (total)	156 (total)	38 (total)	47 (total)
Total number of computers at Sint-Amandus today : 140= 156+31-47				

• The first recycled computers on the Internet (Pentium)

Most importantly, as Table 8 clearly shows, "recycling" of parent's donated computers became established as major input to the ICT-based constituency in Sint-Amandus. It had been triggered by a contingent event -the fusion of the two schools- but other factors had also played an important part, including the rapid evolution of computers and the governance of the Catholic network with its close parental involvement in the schools. The rapid evolution of computers meant upgrading to more powerful computers in offices, companies and other places, but it also meant "opportunities for us because we could have those computers that were not able to support new hardware and use them in our school." Of course, Sint-Amadus had the capacity to benefit from this opportunity. Thus, "I repaired a lot of computers and prepared them in order to be used by pupils."[33] The final factor was the arrival of the Internet with its promise of huge educational impact.

4.4 The Internet and the Start of Networked Didactic Innovations

The arrival of the Internet opened up a whole world of new educational opportunities and challenges. Schools and classes could now reach far beyond their physical borders, creating new didactical processes for the benefit of children. As we shall see, not even

[32] Ibid.

[33] Ibid.

languages across countries and oceans do not constitute insurmountable barriers to learn together.

Practical visionaries like Lieven Van Parys were the first to jump to the new opportunity created by "networked" education. Indeed, before the school had access to the Internet in 1997, during 1995-96, Van Parys had started at home to create a bulletin board as a simple instrument to begin establishing contacts with pupils and teachers all over the world. Table 9 shows the evolution of network type, capacity and cost at Sint-Amandus, with 1997 as the year of Internet access and 1999 the year of the beginning of the flat fee partly funded by the government.

Table 9. Evolution of Network Capacity and Cost at Sint-Amandus

Year	Type of Network	Bandwidth	Cost for School
1995 - 1996	Fidonet	2.4Kbit/s modem	0
1997	Internet - WWW	33Kbit/s modem	?
1998	Internet - WWW	56Kbit/s modem	?
1999	Internet - WWW	ISDN	25 euro/month*
2000	Internet - WWW	ISDN	25 euro /month
2001	Internet - WWW	ADSL broadband	25 euro /month
2002	Internet - WWW	ADSL broadband	25 euro /month
2003	Internet - WWW	ADSL broadband	25 euro /month

*From this time onwards the government has subsidised part of the schools' communication costs.

Van Parys was ready for the new and wider possibilities when the Internet came to the school. He proceeded to create the school website. *He envisioned it as an important instrument "to make the school a community where children, parents and teachers could interact.* " He also saw it as the medium to work internationally, expanding the content, relations, and richness of the educational experience of teachers and children at Sint-Amandus. Computers had been only a start of ICT-based innovation in school. Now, the potential for didactic innovations was much larger and not subject to the availability of educational software in CD ROMS. Now the educational content could be found on the web or created through the collaborative experience of teachers and students across networks.[34]

As it had been with computers, Van Parys had once again to lead Sint-Amandus into a new wave of ICT-based innovation. This time he had to persuade teachers and students to become active protagonists in the generation of content and activities for the web site. It was no longer a matter of using an educational package in the computer, it was a matter of participating actively and collectively in the innovation of the educational process. The question was again, How to start this new more demanding phase? True, the level of understanding of computers among teachers was now higher, and this facilitated the process. Nevertheless, it was unrealistic to expect teachers to begin using the web effectively, let alone create content and begin generating international educational relations without support and demonstration of usefulness.

Van Parys set out to fill the gap on three major areas:
?? persuade and support teachers to generate content for placing on the school website;

[34] Details about the history of Sint Amandus' website are found at http://www.sip.be/stamand/door0.htm

?? identify and select web links of educational value for teachers in different subjects; and
?? search and establish collaborative relations with teachers and schools around the world.

On the first area of teachers' content, Van Parys followed the strategy of aligning technology-to-people. Thus

> I started it in a very simple way then I asked my colleagues to create something interesting I could put inside the website. Teacher were motivated to put their own materials on the web site, in this way they had the opportunity to show the best of their selves on the website. You can show it to pupils. The first teacher to adopt the computer in classroom and to be supportive of this process was the teacher of religion.[35]

On the second area of useful links, Van Parys proceeded to start the process himself, demonstrating it, and stimulating all teachers and students to contribute. Thus,

> I did it. I tested them, I looked them in their native language and put them in the website. I selected them into categories. There is a tremendous number of links for a precise matter and it is very difficult to find those that are interesting and above all proper for educational purposes. Also teachers started to send me their interesting links and children are becoming involved in this selection process as well. … I have also a lot of magazines with lists of the best link in the web, but the problem is that most of them are in English.[36]

On the third area of international relations, Van Parys again started the process with exemplary persistence. Thus,

> I started my international contacts in 1997 when the website was born. I sent 5.000 e-mails. It was my first attempt to reach teachers, so I could start with my project. The start was difficult. I decided to send 50 e-mails per day to schools for each region. The challenge was to find active teachers to work with and make projects. Next step was our involvement in the International School-net platform where you can establish a lot of contacts and work with other teacher wherever they come from.[37]

The first teachers Van Parys met through the Internet in 1997 were from Spain and Slovenia and the first project under the name Comic Strip was born. Comic Strip[38] involved all Sint-Amandus classes together with five other classes from schools from Slovenia, Spain and also other Belgian schools, for a total of 5 schools. The project followed Van Parys' didactic vision of international projects, which is fully in line with the concept of 21st century skills. Thus, for Van Parys an international project should contain the following ingredients:

?? use a universal language: drawings, objects, symbols, even geometry.
?? use a universal theme: nature, Children's Rights so you can find it back in the curriculum of all the countries.
?? keep it simple: the tasks should not be difficult.
?? have fun!

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[35] Ibid.
[36] Ibid.
[37] Ibid
[38] http://www.sip.be/stamand/strips.htm

?? learn from each other: co-operative learning.
?? try to involve colleagues in your own school
?? work together with your friends when they organise a project themselves.[39]

In Comic Strip, each class had first to develop a comic-strip character. Then all participating schools had to create their own stories using any of the characters. The resulting comic strips were then placed into an album that everybody could see. In this way, comic strips became the universal language for the children to communicate their thinking and feelings in a way that children from other countries or cultures can relate to and eventually understand.

But not all was virtual since Van Parys' search for international relations was not limited to the Internet alone and, indeed, he soon had the opportunity to meet face to face with his Internet acquaintances. He recollects that 'the first physical meeting was in Malmo, in Sweden. There was a conference where I showed all the contents of my projects. I established a lot of contacts. There were teachers from Sweden, Finland, Belgium, etc." As we shall see below, it was to be the beginning of a rich international activity with very fruitful educational results for the teachers and children of Sint-Amandus.

4.5 The Consolidation of the Internet-Phase of ICT-based Innovation at Sint-Amandus

The foundational work and constant support and stimulation given by Van Parys to Sint-Amandus' teachers and students begun to pay off with a number of teachers beginning to contribute to the emerging ICT-based learning environment by participating gradually in at least three activities:

?? integrating more systematically computers in their classroom activities beyond the use of computers in the normal "corner work" programme
?? using the internet for a variety of activities from email communication to content development, and
?? engaging in a variety of international projects without being discouraged by language barriers.

Taken together, these activities have started the journey of creating and giving shape to the ICT-based (21st century) learning ingredients and environment at Sint-Amandus. The process has been one of "learning-and-creating-by-doing," however, since all seven teachers interviewed had learnt to use computers on their own, with no formal training from the educational authorities. In this context, different teachers have taken different steps, some more incremental, some more advanced, etc. In one class of eight-year old children, for instance, the students are allowed to use the 6 available computers twice a week. In another class, students are allowed to use the computers to reinforce concepts learnt during the teacher's lessons. They are given classroom assignment such as making Powerpoint presentations and/or carrying out further research related to the lessons. In another class with three computers, 22 students reinforce their learning of French (second language in Meulebeke) by sharing the computers with a time schedule of about five minutes per student. They do exercises through CD-ROMs, translating and filling in words. In another class, half of the students work in round tables and a task without

[39] Personal communication with Lieven Van Parys, 21st January 2004.

computers, while the other half carries out a different task using the computer. In the Religion class, the use of computers is at the end of every lesson. Four pupils share the two "corner-work" computers and have the opportunity to do exercises for a period of five minutes within the 50-minutes lesson.

The teacher of Religion, Paul Gernay, and his class are also highly participative in the provision of content for the school website. Gernay, for instance, has adapted the content of his lectures to the Internet in order to give children the possibility to study religion on the net. He has used pieces of text, pictures, quizzes and PowerPoint presentations to make the material more appealing.[40] For instance, he is working on a PowerPoint presentation on the most important religious celebrations of the year.[41] According to Van Parys, in the Catholic school network, Paul Gernay is the first and still only teacher of religion for primary schools who uses ICTs (Internet, e-mail, CD-ROMS) in his lessons. Not surprisingly, inside the Sint-Amandus' website, there are two sections well developed dedicated to Religion under the name of "A Class Apart"(for the lessons) and "Parish" (for the community).[42] For these sections, the teacher and the children participate in the research and preparation of content with and they receive the close support of Van Parys who then places the material on the web. Paul Gernay is firm on his role of making sure that, during his class students use the Internet for Religion and nothing else.

The collection of web links relevant to the educational subjects of different classes is another content activity in which teachers have begun to contribute to the process initiated by Van Parys. At the beginning teachers mainly asked where they could find some information. This was too not sustainable, however, since "each teacher asked me to go in the classroom and help them to solve their problems. But little by little, as the number of my colleagues was growing, it became impossible for me to follow them one by one."[43] In response, Van Parys begun to socialize both the links and the process of finding them (learning-to-learn) through an informal training conducted during the teachers' three-hour monthly meeting to discuss problems and how teaching and learning can be improved.

> I kept diffusing these links during the meeting days. I gave also some lessons to teacher about how to find links using search engines. … Teachers are now also more skilled in looking through the Internet and using the e-mail system in their communication. There is also a kind of competition between teachers and pupils - concerning new technologies differences between children and teachers are less, and children are sometimes in a higher level than teachers. Now is becoming also harder to find good links for our website because it already has good links.[44]

The one area where computers, Internet, content development, collaborative working, etc. have come all together for the benefit of Sint-Amandus' educational environment is

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[40] Interview with Paul Gernay, January 2003.

[41] Paul Gernay wrote a school book on religion as part of a multi-disciplinary team consisting of teachers, inspectors (some are priests) and teachers of religion. The book uses new teaching methods for children of 6 to 12 years old and it is now used a lot of Primary schools. During the work the authors made use of email to sent their papers to each other and communicate.

[42] http://www.sip.be/stamand/catklas.htm and, also, http://www.sip.be/stamand/parochie.htm

[43] Interview with Lieven Van Parys, January 2003.

[44] Interview with Lieven Van Parys, January 2003.

the area of international projects. From the early days of Van Parys' 5,000 emails and first contacts, the number of projects has grown gradually in countries and didactic, knowledge and skills richness (see Table 10 below). The last relationship established was with a Japanese school and, as we can see, language has been no barrier.

> Pupils first met in the "virtual space" of the Internet by exchanging photographs, drawings, pictures depicting the meaning of certain words. Children cannot speak the same language but they have overcome the oral language barriers with the drawing language and using the vehicle of the Internet. In this way children understand and live concretely the benefits deriving from a proper (to their age, to their educational needs, etc.) use of the new technologies.[45]

The most interesting aspects of all the international projects is that they bring with them challenges that demand innovative responses and activities with great richness from the point of view of the development of 21st century skills. Table 10 shows the list of large international projects implemented by Sint-Amandus' teachers and children over the years.

Table 10. Evolution of Sint-Amandus' International Educational Relations

Year	Countries	Schools	Classes	Large Educational Projects
1997	Slovenia, Spain, other Belgian schools	5	all StAmand classes + 5 others	Comic strip project http://www.sip.be/stamand/strips.htm
1998	The Netherlands			(continuation) and start of next project
1999	Japan, The Netherlands, other Belgian schools	10	all StAmand classes + 10 others	Children are the future! http://www.sip.be/stamand/sleutel.htm
2000	Japan, Slovenia, Sweden, Norway, Finland, Austria, The Netherlands, Canada, Portugal and other Belgian schools	15 (over 7000 children from all over the world played the online game (e.g., Singapore, China).	all StAmand classes + 25 others	Amazing geometry! http://www.sip.be/stamand/meetkunde/meetkunde.htm Game is used daily.
2001				(continuation) and start of next project
2002	Japan, Slovenia, Sweden, Norway, Finland, Austria, The Netherlands, Canada, Australia, Ireland and other Belgian schools	15	all StAmand classes + many others (some schools involved all pupils)	The @-team http://www.sip.be/stamand/@team.htm The @-team of Austria (all pupils involved)
2003	Japan, Slovenia, Sweden, Norway, Israel, Austria, Canada, England, Ireland	10	our classes + 20 others	New project: A new world in one, two t(h)ree… http://www.sip.be/stamand/anewworld.htm

[45] Ibid.

2004 -	Building a smaller project with international partners: The Olympics. See http://www.sip.be/stamand/olympics.htm Small projects with Japanese class in between the other projects. See http://www.sip.be/stamand/japan.htm and http://www.sip.be/stamand/meetkunde/japan2.htm Development of practical examples/research for the 5D learning strategy (TASK) promoted by the European School Net. See http://www.sip.be/stamand/5D.htm and http://www.sip.be/stamand/5Dpotatoes.htm			

Following the first "Comic Strip" project in 1977, international projects have clearly become a central component of Sint-Amandus' learning strategy and environment.

The second large international project, "Children Are the Future," came in 1999, followed by the third "Amazing Geometry" the year after. "Children Are the Future" was motivated by the fact that on 20th November 1999 it was the 10th anniversary of the convention on the Right of the Child. The project invited pupils from schools of any part to download a picture of the same child and to colour it as they wished. The children were also invited to answer questions such as "How do YOU change the world" by drawing symbols representing their ideas. The painted pictures and symbol-described ideas were then placed in "kid-forum."

"Amazing Geometry" celebrated the fact that the year 2000 was the International Year of Mathematics. Its aim was to stimulate a "new view" of math in pupils, transforming aversion into curiosity and mis-understanding into awareness. Geometry became the centre of corner-work activity, online co-operative learning and online games. In co-operative learning, the assignment was to build a tower as high as possible using sets of bricks and 20 wooden blocks. The online game was to find the way in 6 mazes in a cube while facing some obstacles along the way. In the corner work, the activity was about how to teach geometry. Drawings and wooden blocks became the "universal language" through which kids communicated.

In 2002 came perhaps the most strategic international educational project of Sint-Amandus: The @Team. The @Team is not one single international project. It is rather a "didactic platform" for international projects that can originate from anywhere in the world. In the @Team, a world-wide team of children and teachers work together in several international projects, always supporting each other in the start up of any new project. Today (January 2004) a visit to the @Team website shows the existence of about 20 teachers from 8 countries and 15 organizations leading over 20 international projects.

The @Team concept implements a variety of didactic ingredients of 21st century learning environment, including the nurturing of more fruitful learning relations between teachers, between students, and between teachers and students. Table 11 provides a number of these ingredients roughly as found in the @Team website. Figure 10 shows the distinctive symbol of the @Team - the yellow cap and also a group of students wearing it.

Table 11. Some Important Didactic Ingredients of "The @Team" Concept
Children love working with the computer. Children can easily learn some computer techniques and make use of content-free software such as a word processing or a drawing tool. Teachers can organise

many amusing activities.
Learning from each other! Kids like to pass on their knowledge and skills to other children. They do it in their own playful way. They demonstrate simple actions, such as colour a figure, draw a triangle or write and send an e-mail. Teachers can easily anticipate and create special learning activities they can observe and direct without too much interference.
Clever boys and girls! Pupils can take over a few computer jobs from their teacher such as start the computer, choose the right programme, shut down Windows in the right way or install a CD-ROM. The teacher has more time for other educational duties and, who knows, maybe the teacher can 'pinch' one or two tricks from their wiz-kid. *Real educators can learn a lot from their pupils.*
Learning in accordance with children' s growth, with caps and medals as nice attributes. Kid's knowledge and skills are growing. Each child works on his/her own level, with hi/hers own possibilities, with his/her own 'history' and background. The @Team has a motivating "assessment" system that rewards the achievement of specific computer skills with virtual medal. (See Table 12 for "virtual medals" system). Most children can earn at least three silver medals before completing primary school. Who wins "gold" a few times is a real computer wizards! A pupil who assist the teacher or a friend with the computer may wear the yellow cap of the @Team!

Source. http://www.sip.be/stamand/@team.htm

Figure 10. The @Team's Yellow Cap and School Children Wearing It

Table 12. "Virtual Medal" System to Reward Achievement of Specific Computer Skills

Level	Which level have we reached already? What can we do for you?
	?? turn on and switch off the computer in the right way ?? start the correct program and choose the right part of it
	?? we can install a program or a CD-ROM
	?? WordPad and Paint, it's easy!
	?? we can handle a 'real' word processor, now and then we make use of a spreadsheet, or a database, or a drawing tool or... we publish our own school paper... ?? we enjoy creating presentations, music, or animations with the help of a computer!
	?? internet and e-mail, no problem!

	?? we create our own webpage on the internet!

Source. http://www.sip.be/stamand/@team.htm

The "yellow cap" is a particularly useful concept to stimulate responsibility and co-operative learning in activities in the school and through the international projects. It has also become an "identity" symbol for co-operative work across countries and language barriers. The imaginative development of concepts such as the "yellow cap," the "virtual medals," the "corner work," the many co-operative projects using "universal language," etc. are all a far cry from the passive "knowledge-supply" approach to education. They are the way and ingredients with which innovating schools are constructing the ICT-based learning environments of 21st century education.

The final aspect of Sint-Amandus' international activity is to join other relevant networks to become part of networks of networks. Sint-Amandus is an active member of European Schoolnet, the European network of teachers working on ICT-based education and, in 2000, it was also selected by the Ministry of Education to represent Belgium in the European Network of Innovative Schools (ENIS). Characteristically, Sint-Amandus has established its presence in these networks through the contribution of high educational value. As Van Parys describes:

> Within the European Schoolnet there is a project the 'Virtual School'; I am member of the department Primary Education. With this team we search for freeware on the Internet and we study the different programs if they are useful or not. We have now downloaded, tested and evaluated maybe 10,000 programs. A lot is 'rubbish'! but we have now a selection of 500 'good' programs.[46]

Furthermore, Van Parys and other three members of the Schoolnet's "Virtual Team" (Fernand Mesdom, Geert Kraeye and Marc Gorremans) decided to go further and begin to structure "lessons plans" in which the "educative programs" can be integrated . The result of this work is 70 lesson plans where 250 of the educative programmes can be integrated. The work is written in Dutch and the Ministry of Education has recently decided (mid-January 2004) to make a book of it, printing 5,000 copies to be distributed free to all schools in the Dutch-speaking part of Belgium. This is a very revealing example of how the local and international dynamics reinforce each other in the educational environments of 21st century education. What has been the impact at Sint-Amandus?

5 Flows of Attitudes, Knowledge, Skills and Experience at Sint-Amandus

Looking back at Table 2 with all the flows of 21st century education: didactic attitudes, subject-specific knowledge, life-skills and ICT-based knowledge and skills, it is clear that Sint-Amandus has been making good progress although no formal evaluations of the process exists. Teachers however report positive impacts[47] and they largely coincide in that, thanks to computers well integrated in the classroom's activities, children (and teachers) have more opportunities, become more active and creative in the educational process and the results are better. The reason is that pupils feel more motivated,

[46] Personal communication with Lieven Van Parys, January 2004. The selection of the 500 "good programs" can be found at http://vs.eun.org/eun.org2/eun/en/vs-primary/entry_page.cfm?id_area=23

[47] Interviews with teachers from different classes at Sint-Amandus, January 2003.

entertained, exercise more responsibility, and they also work together and help each other inside co-operative learning processes. Even students lagging behind benefit since, as a Math teacher specifies, the use of computers improves the attention of those pupils who were less keen to follow the traditional lessons. The international projects play a major part in these developments since, among other aspects, children learn to know each other, to use the computer as a communication tool, and also English language and other more forms of communication through "universal languages" such as pictures, drawings and even geometry.

In the process, Sint-Amandus pupils are also learning basic ICT-based skills, particularly, the different skills that children should improve during the year before they transfer to secondary school. At the minimum, these are: (1) capability to search for documentation and information in the Internet, and (2) capability to communicate through the Internet via e-mail. At Sint-Amandus, however, pupils also learn to make presentations using Powerpoint and searching in the Internet for images, say, of their city, or images to make Christmas cards with the computer. Some of this work extends into homework, although this is not compulsory since not all children have computers at home and Internet connection costs money while in the school student and teacher access is free. This enables the teacher of Religion to add solidarity to the didactic ingredients of the Sint-Amandus since, as a matter of principle accepted by all children, he gives priority in the classroom computers to children not having computers at home. Thus, "we have families in our community that cannot afford computers at their homes, and I say as a teacher that the priority has to be given to those pupils who don't have. For this is a point of principle."[48]

An important change in relation to traditional "passive" education is that learning about computers transform teachers into students who can benefit from the pupils, especially since formal training is lacking. In addition, at Sint-Amandus there are leading student who have deeper knowledge about computers and help others to solve their problems with the PC ("tutor-pupils"). In this context, teachers teach but are also coordinators and facilitators of the student resource in the learning process. For instance, once an assignment is given the more skilled pupils do them with computers, while the others work with the book and then match their results on the PC with the help of the leaders (who wear the @Team yellow cap).

In this way, the students and teachers become learning resources to each other and the range of didactic attitudes, subject-specific knowledge, life-skills, and ICT-skills flowing inside the classroom is much richer (e.g., "tutor-pupils" learn communication skills, responsibility, inclusion, etc. and teachers gain knowledge of ICTs and ICT-based learning processes). There is the feeling that results can be better, for instance, at the moment the time dedicated to the traditional lesson is considerably longer than the time the lesson makes use of computers. In this respect, the perception is that a central problem remains the lack of resources for proper teacher training.

Looking back, with all its achievements and difficulties, this is the way in which the "learning community" envisioned by Van Parys is beginning to take shape. There is however still a long way to go along the path towards 21st century education.

[48] Interview with Paul Gernay, January 2003.

6 Challenges to Overcome in the Path to 21st Century Education

Sint-Amandus' excellent work has not gone unrecognised. Indeed, the School has won five prestigious awards, including the largest global competition of ICT and education projects the Global Junior Challenge award in 2002 in Rome. Figure 11 shows the awards:

?? eLearning Award 2001 with project "Children Are Our Future."
?? Global Junior Challenge with "The @-team"
?? eSchola - eLearning Award 2002 with "The @-team"
?? Prijs van Minister van Onderwijs - Pioniersprijs Basisonderwijs 2002 with The @-team" and again in 2003 with project "Fifth Dimension."

QuickTime™ and a
GIF decompressor
are needed to see this picture.

Figure 11. Awards Won by Sint-Amandus' ICT-based Innovative Projects

The awards have helped energize Sint-Amandus and have confirmed that they are on the right track for the future. Lieven Van Parys has been deservedly touched by the recognition.

> The winning of the Global Junior Challenge is a kind of culmination of the first process of my project. Simple drawings, pictures have become famous. This is a great thanks to the continuous work of the teachers. The Global Junior Challenge is something more than an ICT challenge, it is a challenge to build peace, it can be called *The Global Peace Challenge*. It has been a great moment and reward for the school. [49]

At home however Sint-Amandus can feel proud of the achievements but cannot "rest on the laurels." The hard work must continue unabated since many aspects of the constituency-building process leading to the 21st century ICT-based learning environment are still far from reaching its full potential. Moreover, as Principal Marc Lemiengre

[49] Interview with Lieven Van Parys, January 2003.

reminds, the process of ICT-based innovation at Sint-Amandus is very much a bottom-up process without strong support from government educational authorities.

> There is not a strong support by governmental institutions. It is not very good. They always say that they have no money. The government invests very little in computers. Last year [2002] the school received an amount of money to buy only three computers![50]

Regarding the present hardware/software situation, for instance, Table 8 has shown how over the years "recycled" computers have contributed about five times the number of computers the school has been able to acquire through its equipment budget. Clearly, Sint-Amandus has been extremely fortunate to count on the multiple skills of Lieven Van Parys. But this has meant that the school has now become the victim of its own "recycling success," since the Department of Education has decided not to give any more money for hardware and software to Sint-Amandus from 2003 onwards. They think that the school has enough computers given that their target is '1 computer for 10 children'. Since Sint-Amandus has an average of about one computer per four students, the numbers make the decision appear fair and consistent. Unfortunately for Sint-Amandus, the decision makes the error of not considering that "Most computers are old!"[51] given precisely the fact that they are recycled. The end result is that the school is likely to begin to fall behind, not in numbers, but in the power and quality of its computers. Moreover, only 38 of the total 140 computers available at Sint-Amandus today are connected to the Internet and, although not all computers need be connected, a level of 27% connectivity seems rather low. Interestingly enough, most children have computers connected to the Internet at home but the downside is that they have to pay for connecting while in the school access if free for students. Not surprisingly, Van Parys sees a lot of work ahead for the next five years: "There are a lot of things that still don't work. I have to show pupils how to use programmes, how to use computer as a whole … We have to create knowledge about a lot of interesting projects … We have to face the obstacles by the Ministry of Education that is not giving a proportional support to the educational needs of teachers and students."[52]

In the meantime, ICTs continue to evolve in variety and capacities creating other educational opportunities for the school. For instance, Sint-Amandus bought a new digital camera in 2003 with the result that some teachers are now making at the end of the school year a CD-ROM for parents, containing a lot of pictures of class activities (some in PowerPoint). This product helps strengthen parents' involvement with the school and in their children education. The CD-ROM acts as an extension to the website but it has a more personal touch.

On the teacher/student front, not all Sint-Amandus teachers are equally supportive of ICT-based learning. Indeed, there are teachers that still prefer the traditional teaching approach and do not like to use the computers or the corner work. This upsets the realization of Principal Marc Lemiengre's vision for the future in which he sees pupils learning on their own and from each other in co-operative learning processes. For him the main obstacle is not only the lack of resources but also the teachers' attitude. Sint-Amandus however is not really far from reaching a situation in which all teachers are

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[50] Interview with Principal of Sint-Amandus School, Mr. Marc Lemiengre, January 2003.

[51] Personal communication with Lieven Van Parys, January 2004.

[52] Interview with Lieven Van Parys, January 2003.

active members of the ICT-based constituency. Van Parys estimate that from a total of 23 class teachers, 18 of them are already active constituents with five still to join (target constituents) and gradually evolving. Indeed, the full change may come from the students' reported motivation of working with computers, simply because "the motivation" of one group (the user-pupil) eventually becomes "the pressure" for another (the supplier-teacher). This is confirmed by some of the teachers who coincide in that there is a growing pressure by pupils who would like to spend more time with the computer and are demanding extra lessons to learn to use it.

Teachers' own learning processes, however, suffer from the lack formal training and support from the educational system. This makes Van Parys the inevitable point of arrival to continue with the form of teachers' training and support that he can arrange in the midst of other activities. [53] He is encouraging teachers to improve their skills by using their computers at home, for instance, making databases, lesson plans, etc. "I'm pushing and supporting teachers in this direction also because for me it is difficult to have meetings with teachers all the time." He is also continuing with the practice of concentrating training time in the scheduled three-hour monthly meetings when teachers discuss what they are doing and how teaching and learning can be improved.

Indeed, this time saving is absolutely necessary since Van Parys is also now entrusted with the expansion of the Sint-Amandus' ICT-based constituency-building process to the broader Catholic School Network. Thus,

> I need to expand all what we realised in this school to other schools. I have to start again but at the same time I think that I will be able to go faster because some of the concepts already working here have been implemented, like the concept of the corner work even if without computers (they are using other materials). I have to find new software and teach teachers how to use them. This is not simple, because lot of software have a complex structure and their integration in the lesson can be never taken for granted.[54]

And again the support activities must involve the Principals' offices.

> I have to create databases, to install programs and teach them how to use computers. They have powerful machines but are used at the 10 per cent of their power. They have laptops. In most of cases they are not aware of all what they could do with those machines.[55]

Computer recycling is already under way. In 2003, Van Parys recycled almost all computers for the other 4 schools of Meulebeke where he also works as ICT coordinator. At the same time, a full day dedicated to computer training is under preparation. This training will take place in the schools' own environments to enhance the familiarity of the computer experience for teachers. This time an advantage for Van Parys is that he is no longer the lonely pioneer as the very beginning of this story. Other Sint-Amandus teachers may perhaps help as multipliers of the ICT-based innovation experience of the

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[53] Of course, constant improvement of facilities is another way to facilitate teachers' involvement. In January 2004, for instance, Van Parys made a second computer class with 12 old PC's in a building with 12 classes that until now did not have such facility and "a lot of teachers responded positively since they can go now to the computer class with their whole class with all the pupils." Personal communication with Lieven Van Parys, January 2004.

[54] Interview with Lieven Van Parys, January 2003.

[55] Ibid.

school. Indeed, he reflects: "maybe one day, in the future, it will be possible to use also other teachers."

Until that day however a lot will continue to rest on the shoulders of Van Parys and his dedication to ICT-based educational innovation in primary schools. One wonders whether the educational system provides full support to such dedication, covering costs and paying for the many extra hours spent in so many valuable contributions. The reality is not so, as it was perhaps possible to anticipate from the earlier discussion about funding. Indeed, Van Parys tells that as an ICT coordinator of primary school he pays a great deal by himself. For instance, "I pay the costs for the development of the website and the projects, including hardware, software, ADSL, web space (+100Mb), sending costs. The work on the website is done at home in late evenings. You can see it as a hobby."[56] Likewise, the work done for the Schoolnet's virtual school -downloading, testing, evaluating, writing the book- "is all done in our free time and we do it gratis. When we come together, the travelling costs (and hotel if we stay for a few days, mostly during vacation) are paid by the ministry."

Lately Van Parys has launched an international project -"A new world in one, two, t(h)ree"[57]- that involves sending not just "intangible things" around the world, but indeed "tangible things" (e.g., rubbish, wires), This project is much more costly than previous projects. Van Parys however has not been deterred by the challenge. He is now collecting "empty ink cartridges for recycling. So I hope to earn some money that we can invest in this project."[58] Dedication and innovation are surely changing the world of education. One wonders how much could be achieved if educational authorities and policies were to support fully such a force for change.

6 Present State of Alignment Sint-Amandus' Constituency-building Process and Lessons of the Experience

Since September 1996, the time Van Parys returned to Sint-Amandus clearly the school has made a lot of progress along the path towards ICT-based 21st century education. In fact, as often happens with pioneering experiences, the path itself has been created along the way through the invention, trial and implementation of new concepts and practices that begin to realize the aspirations contained in the vision of 21st century education. For the same reason, the Sint-Amandus experience is also fruitful in constituency-building lessons for ICT-based innovation in the context of a primary school.

7.1 Present State of Alignment Sint-Amandus' Constituency-building Process

As we have seen, there are still many challenges for the future but Sint-Amandus is building from a strong foundation of leadership and socialization of the new practices both internally and externally, particularly with the international network. This is reflected in the highly increased richness and harmonious progress made in all dimensions of the diamond of alignment of Sint-Amandus' constituency-building

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56 Personal communication with Lieven Van Parys, January 2004.

57 http://www.sip.be/stamand/anewworld.htm

58 Personal communication with Lieven Van Parys, January 2004.

process. Table 13 updates the broad assessment of the state of Sint-Amandus' alignments.

Table 13. Present State of Alignment Sint-Amandus' Constituency-building Process

(I) Constituents' Perceptions, Goals, Actions and Resources

The main constituency-builder remained the same and the top authority of the school is a strong supporter and facilitator of the process. Many teachers are also no longer "target constituents," they have become members of the constituency actively using ICTs in their classes and in the international projects. Yet, not everybody is an active member and teachers' attitudes are still reported as an obstacle. In terms of hardware and networks, Sint-Amandus has reached a very high number of computers (140) and computer/student ration (roughly 1 computer/4 students) thanks to the "recycling" programme run by Van Parys with the support of parents who donate computers. The "recycling" success has had its downside in the fact that educational authorities eliminated the school's budget for computers in 2003. This leaves Sint-Amandus with only the recycled computers that tend to be old and therefore deprive the school from the benefit of the more powerful machines. Connectivity has also improved dramatically from 2.4Kbits/s modem in 1995-96 to ADSL broadband from 2001 onwards and, above all, Internet became available at a subsidized flat fee of 25 Euro/month for all school. Only 28% of Sint-Amandus computers are Internet-connected however, leaving much room for improvement. Educational content (software) has become almost unlimited through access to Internet and as teachers are able to develop their own content and place it on the Internet. The range of didactic concepts implemented at Sint-Amandus is also rich, with the consolidation of the "corner work" programme, the use of the computers in classrooms, and the emergence of the large and successful international programme of projects, including the "project platform" - the @Team. With these projects, the Sint-Amandus ICT-based constituency-building process has extended internationally creating a virtual educational environment of major mutual benefits between the "local" and the "global" dimensions of the constituency-building process. The innovative quality of these activities is reflected in the five awards won by Sint-Amandus, including the Global Junior Challenge. Van Parys is also now helping expand the ICT-based constituency-building process to the entire Catholic network. One problem remains the lack of resources for formal training from the educational authorities, with the result that teachers have largely learnt by themselves, with the support of Van Parys, leaving room for improvement, for instance, in the pedagogical exploitation of computers in the classroom. For the future, a stronger socialization of the entire process at Sint-Amandus / Catholic network will also demand greater socialization of the hugely strategic role played by Van Parys in all aspects of the process among more teachers and technical personnel.

(II) Nature and Maturity of the Technology

Computers have progressed hugely in processing and communication capacity since 1996 and this process will continue unabated. Multiple other ICT productivity tools are also enriching the ICT infrastructure of educational environments, for instance, printers, scanners, digital cameras, projectors, digital whiteboards, desks, etc. The emergence of the Internet and World Wide Web have created an enormous reservoir of content and above all the possibility of generating virtual or e-learning educational environments for collaboratively creating and implementing activities, course modules, etc. In short the technology of 21st century education is already here, although their affordability by all schools (educational e-inclusion) is still a matter to be tackled by societies.

(1) Governance

At Sint-Amandus, governance is very favourable for ICT-based innovation. The Principal sees his role as facilitator and parents have an important level of involvement and contribution that has been crucial for the success of the "recycling policy." Meetings twice a month between the teachers' Union and the parents' committee maintain a continuous to focus on school matters and problems. The government educational authority is favourable to ICT-based innovation but this has not translated into resources such as training and, lately, new computers. Lack of training does not help with the necessary cultural shift the

entire school must eventually make towards ICT-based 21st century education. Thus, part of the teaching personnel still remains within the old mindset of passive education.

(2) Target Constituents' Perceptions and Pursuits

Many target constituents have become active constituents since 1996-97 and, with the emergence of the international projects, teachers and students from other countries can now be seen as part of the constituency-building process of Sint-Amandus. The same can be said of the alliance Sint-Amandus has for instance within Schoolnet - the European network. The constituency-building process continues, however. In fact, it will always continue as long as new teachers, students, authorities and other stakeholders come into the Sint-Amandus' ICT-based sphere of action and/or influence. Thus, today, teachers, parents, pupils, government educational authorities, European educational funding authorities, etc. remain very much target constituents of the Sint-Amandus process and, clearly, of the Catholic Network process.

(3) Nature of Target Problem

The broad target problem remains ICT-based innovation for the improvement of the education Sint-Amandus delivers. Over the last few years, however, with the simultaneous advance of technology and educational concepts and practices, this has acquired the more specific reality of "21st century education" - very much as expressed in Table 2 (i.e., didactic attitudes, subject-specific knowledge, life-skills and ICT-based knowledge and skills). In fact, the experience of Sint-Amandus has shown evidence of most of the ingredients of "21st century education" in Table 2, including the emergence of a "virtual-physical learning environment" with a rich collaborative local and international dimension. The development of this "virtual-physical learning environment," however, is still at an infant stage and the achievement of its the full potential for 21st century education will remain the target problem for the foreseeable future.

(4) Interacting Technologies/Constituencies

The technology of the ICT-based educational innovation process has grown and will continue to grow in diversity, capacity, and inter-connectivity, thus favouring the richness of the "virtual-physical learning environment" emerging at Sint-Amandus. There are no fundamental limitations to this process apart from the limitations of the schools' financial resources. In this respect, an interesting development is that of "free/libre and open source software" (FLOSS). FLOSS is eliminating the costs of licensing software and it is giving rise to new low-cost computers that promise an eventual dramatic expansion of hw/sw access for all individuals. The educational software available in FLOSS however is today less than for the "proprietary" camp, although in the educational environment there is a long tradition of software sharing. A shift to FLOSS also requires re-training of teachers. For the constituency-building process at Sint-Amandus, it will be strategically important to keep a close watch into the evolution of FLOSS and begin to benefit from it as the occasion becomes propitious.

7.2 More Detailed Evaluation of Present State of Alignment Sint-Amandus' Constituency-building Process

Figures 12a, 12b, 12c and 12d provide a more detailed evaluation of the state of the process of sociotechnical alignment at Sint-Amandus. Each of the dimensions 1, 2, 3 and 4 have been positioned into a "spider web" and decomposed into six key factors which can be given a marking from 1 to 10, depending on the strength of the alignment. The resulting pattern per dimension helps to visualize where the strength and weaknesses of the constituency-building process are and, consequently, help in devising strategic responses for the future. For instance, dimension (1) governance shows a high degree of alignment of the constituency-building process with Sint-Amandus' organizational governance in all key factors, with the weakest being "assessment appropriate to new methods" and the strongest "students' participation in learning. This corroborates the points made in the discussion about students being a source of pressure for change. In turn, Figure 12b shows immediately that the most difficult "target constituents" are in fact "administrative personnel" and "senior management," with all others not far from reaching active membership of the constituency. Figure 12c assesses the constituency's alignment with the nature of the target problem and reveals the weakest area of the Sint-Amandus constituency-building process: available resources and, particularly, financial and material resources. Indeed this message has already

emerged with clarity from the analysis of the Sint-Amandus experience. One solution would be to re-align the nature of the target problem to the available resources, but this is likely to reduce dramatically the pioneering role and practice of Sint-Amandus. If schools are to reap the full benefits from ICT-based innovation there seem to be little option that to continue advancing towards ambitious 21st century visions, responding with dedication and inventiveness to the resource problem, indeed, making the concept of "available" much more elastic than it would be if schools remain attached only the resources given by educational authorities, very much in the form that Sint-Amandus has done so far. Finally, Figure 12d assessing key factors of "the constituency-building process' alignment with interacting technologies" reveals that the integration with legacy systems and displacement of obsolete practices are processes that still require effort at Sint-Amandus, while the marking of "useful complementary technologies" such as educational content shows that this factor is playing a positively effective part. Interestingly, the factor "required complementary technologies" such as network infrastructure still has considerable room for improvement at the school.

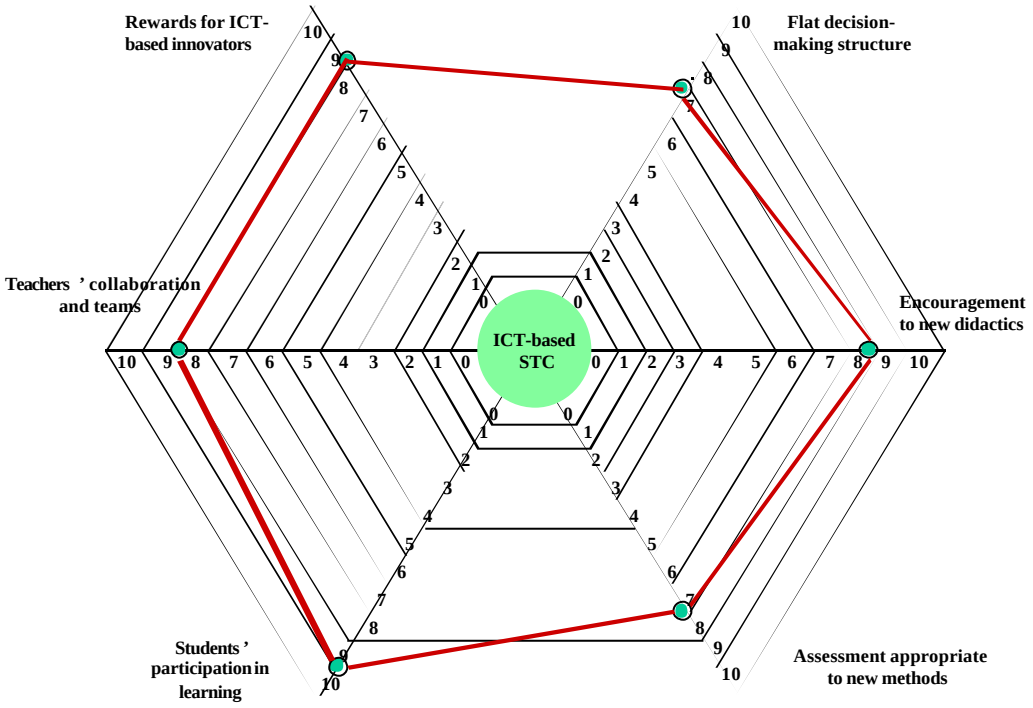

Figure 12a. Assessment of Constituency's Alignment with Organizational Governance

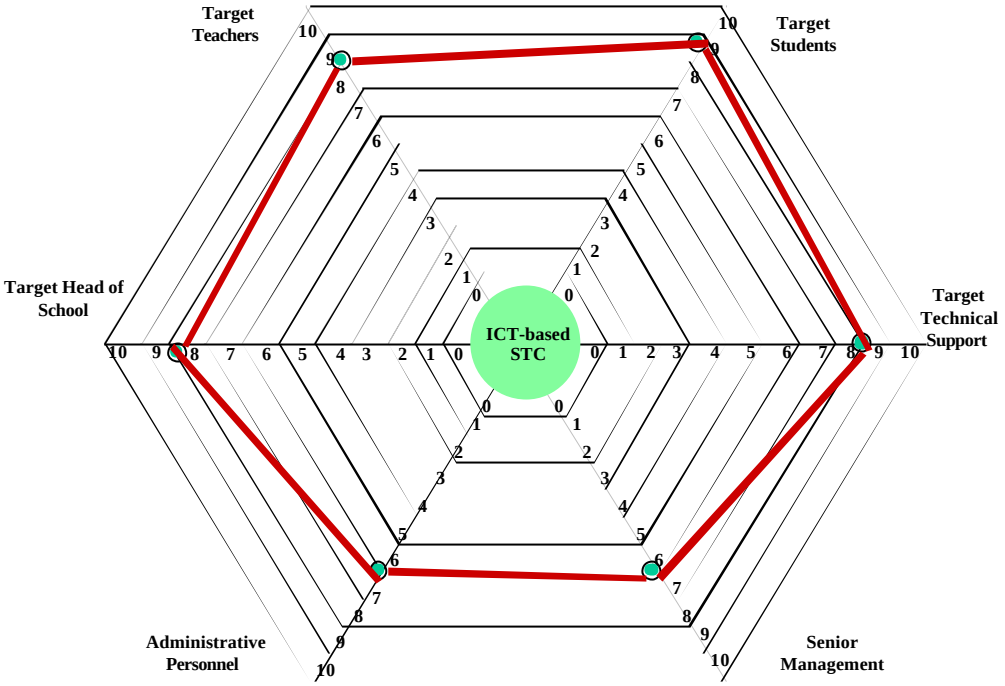

Figure 12b. Assessment of Constituency's Alignment with Target Constituents

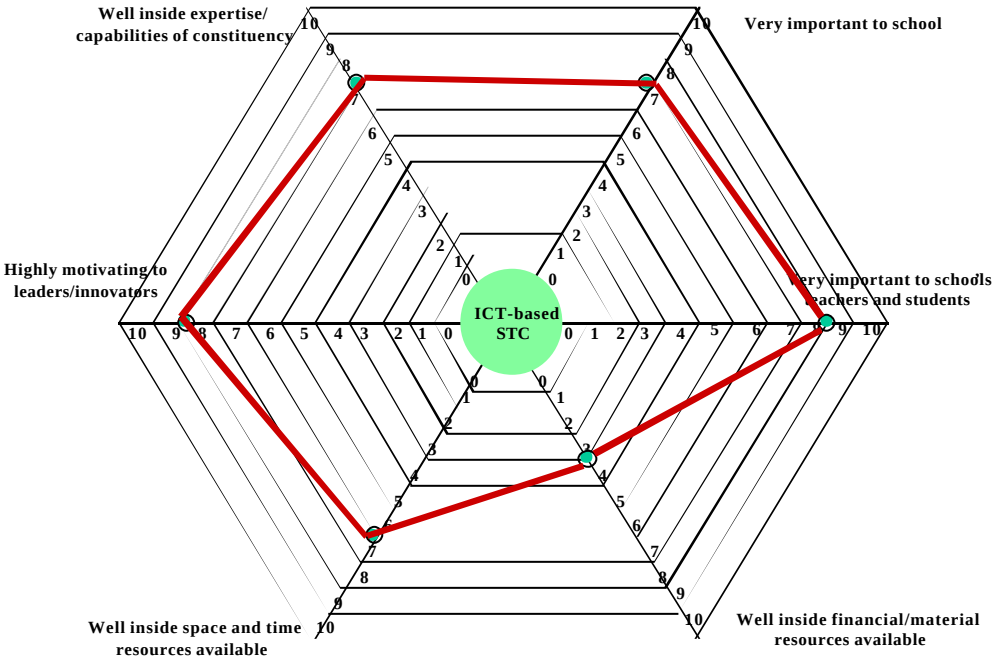

Figure 12c. Assessment of Constituency's Alignment with Nature of Target Problem

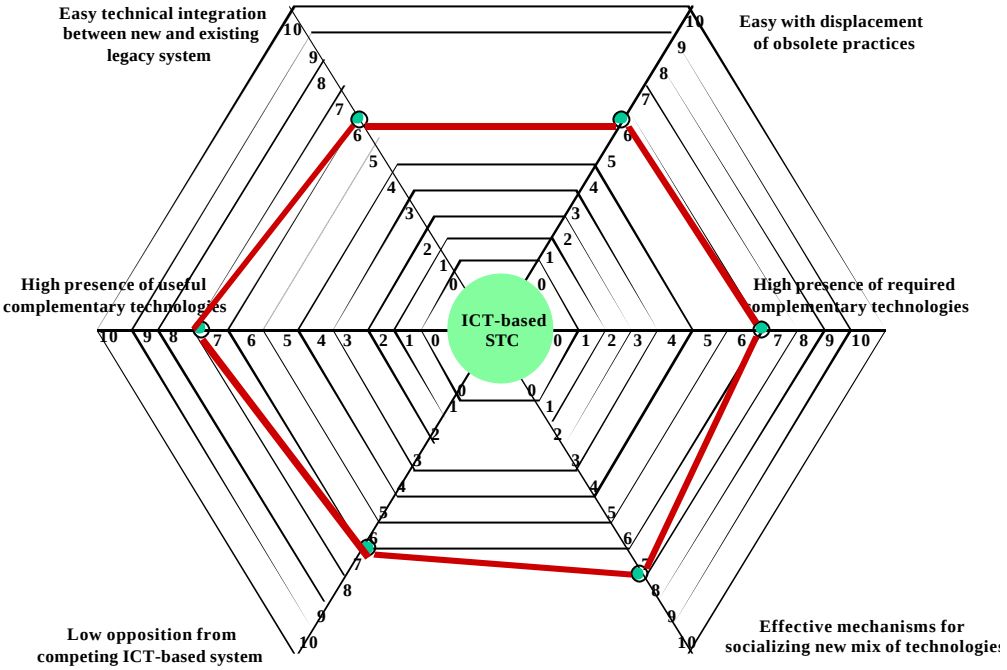

Figure 12d. Assessment of Constituency's Alignment with Interacting Technologies

7.3 Lessons of Sint-Amandus Experience of ICT-based Innovation

The story of Sint-Amandus' ICT-based educational innovation has revealed many lessons of effective constituency-building "techniques" implemented to tackle concrete constituency-building challenges. Below, the paper synthesizes some of the most important for the benefit of other constituency-builders engaged in similar processes of school innovation.

Challenge 1. Gain and/ maintain the support of the top school authority.
Technique 1. Closely demonstrate and continuously support the school authorities in the use and usefulness of ICTs for school management tasks
At Sint-Amandus, the Principal of the school, Marc Lemiengre, saw the importance and need for computers for his own work and Van Parys took care of providing the continuous support necessary to reinforce the positive experience with computers. This also reinforced the Principal's support for the introduction of computers in the classroom.

Challenge 2. Seeking to introduce computers in the classroom for the first time.
Technique 2. Focus on problem-solving or opportunity-exploiting, not on the technology per se.
At Sint-Amandus, the computers gained a gradual opening of space and time in the classroom through the didactic innovation of the "corner work" programme of 24 activities, of which five involved the use of computers. The first focus of the "corner work" programme was Geometry and the computer-based activities were highly integrated and meaningful. Once computers are in the classroom, teachers can take incremental steps in using them during their lessons, for instance, by allocating some

time at computers for students to do some relevant exercises. Eventually, they may begin to use it to release their time for students who need more attention, by allowing the most advanced students to work in the computer in tasks where the computer is appropriate.

Challenge 3. Seeking to persuade teachers to begin to use the Internet transforming their own lessons and generating their own content.

Technique 3a. Start with more favourable teachers/, support them, and make their cases exemplars

At Sint-Amandus, Van Parys started with his closest friend, the teacher of Religion, Paul Gernay, who was also enthusiastic about the potential of computers for his work. Gernay has transformed his lessons and placed the material on the web and is now developing other materials. Van Parys has supported Gernay all along and has created two websites that show the work done by the teacher and students of religion. Gernay's experience is an exemplar that other teachers can relate to and Van Parys has used to persuade others to begin a similar journey.

Technique 2b. Start by asking all teachers to develop some content on some favourite theme and reward them.

Van Parys asked teachers to select a favourite topic and create a piece of work that he himself placed and gave exposure on the web. This sought to touch on teachers' closest interests to make a positive association with the facilities offered by the web and, thus, encourage further use.

Challenge 4. Seeking to stimulate students to learn to use the computers through reward system

Technique 4. Create and apply appealing rewards system for students

At Sint-Amandus, the @Team's Yellow Hat and the "virtual medals" are part of a system that reward progression in computer skills with medals and the right to wear the @Team's distinctive Yellow Hat and become "tutor-pupil" for other pupils who have not yet achieved the same degree of learning of the specific computer skill being taught. In this way, the Yellow Hat is also an empowering device to allocate greater responsibility to those students who have learnt faster and can help others and, consequently, the teacher to make true the more cooperative learning environment of the 21st century.

Challenge 5. Seeking to overcome school's financial limitations to expand number of computers

Technique 5a. Build on strengths, determination and "recycling"

At Sint Amandus, the limited financial resources for computers did not deter Van Parys to get through "recycling" about 5 times (156) the number of computers acquired through the school budget (31). In this process he built on two clear strengths: (1) his own computer skills and interest and determination to applied them for the benefit of the school, and (2) the school governance that favoured a close involvement and contribution of parents to the school. Van Parys has been able to obtain and repair over 150 "recycled" computers over the years.

Technique 4b. Take advantage of favourable contingent circumstances

The merger of the Sint-Amandus' "boys" and "girls" schools in September 1998 created a favourable conjunction as it revealed an unbalance that led to a demand for more computers as teachers from the previous girls' school wanted the same facilities as those in the previous boys' school. This prompted a response by parents and a marked increase in the number of "recycled" computers.

Challenge 6. Seeking to cope with increased demand for support from teacher

Technique 6. Move from one-to-one interaction to collective forms of knowledge socialization

Once the demands of the one-to-one approach to socializing ICT knowledge and information generated too much work for Van Parys, it was time to move on to a more collective "training." This was the case, for instance, with the dissemination of relevant web links for teachers. Initially this was a one-to-one process. Then it grew and begun to consume a prohibitive amount of Van Parys' time. At this point, the socialization of both the links and the process of finding them shifted to a kind of informal "training" conducted during the teachers' three-hour monthly meeting during which they discuss problems and how teaching and learning can be improved.

Challenge 7. Seeking to start and build up an international educational network relevant to the school

Technique 7a. Search and persist until identifying good and active partners

Finding good and active educational partners on the web may take time, although today there are many more established networks than the time when Van Parys started. Van Parys engaged in the process with persistence, sending 5,000 emails, until he identified and begun to establish working relations with a small core of partners.

Technique 7b. Build and strengthen the international network through real educational value

Sint-Amandus has reached a high degree of international activities and projects involving many countries and generating a great deal of didactic, knowledge and skill flows for all participants in the network. The constituency-building approach taken in this process contains multiple ingredients, amongst the most important:

?? generating meaningful, attractive and valuable educational activities and projects. More than 20 appealing projects connecting children across the world are part of the innovative award-winning project platform, The @Team.

?? respond creatively to the challenges presented by international collaboration. For instance, language differences did not deter collaborative networking. The problem has led to the development and use of the concept of "universal language," for instance, through the use of pictures, drawings, geometry, and even "classroom rubbish" exchanged by the schools to make "artworks." The use of "universal language" is complemented by the preferential selection of "universal themes" (i.e., relevant to school curriculum of all countries) for the schools interactions (e.g., children rights).

?? establishing and nurturing an ethics of collaboration with, and support to, each other's initiatives. An important element of this ethics is the obligation of the members of the network to provide an early support to a project started by any of them. This is also an opportunity to try to involve other colleagues in the schools.

?? join other relevant networks to become part of networks of networks and help generate high educational value. Sint-Amandus is part of the European Schoolnet and represents Belgium in the European Network of Innovative Schools (ENIS). It has helped to "benchmark" 10,000 educative programmes leading to the selection of 500 of "good value," and deepening the work with the generation of 70 "lesson plans" that can integrate 250 of the selected "good programmes."

?? exploit opportunities to energize through participation in awards of excellence. Sint-Amandus has won 5 awards including the global award for ICT and education projects, the Global Junior Challenge run by the City of Rome.

Challenge 8. Seeking to transform the challenge of the advancing ICTs technology into opportunities for the build-up of the constituency

Technique 8. Mix innovative attitude with awareness of problem-solving or opportunity-exploiting potential of new technologies.

The arrival of Internet at Sint Amandus opened almost immediately a major innovation effort both inside the school and towards te outside world. In fact, it signalled the emergence of the physical-virtual learning environment in which computers, Internet, content development, collaborative working, local-international synergies, etc. have come all together for the benefit of Sint-Amandus' educational environment.

The process of constituency-building continues at Sint-Amandus and other challenges exist and, no doubt others will emerge in the future. Some of the challenges will be easier to tackle, others harder. In the process, the accumulated constituency-building experience will help, but constituency-builders will always have to be ready to find creative and innovative responses, since in the struggle to invent the future there are no real recipes, only wisdom, ingenuity and the determination to move forward to new frontiers.

Challenge 9. Seeking to advance the ICT'based innovation process without full resources
Technique 9. Dedication and inventiveness change the world of education

Van Parys has no access to the all the resources necessary to cover the full range of ICT-based innovation activities at Sint-Amandus. His answer has been dedication and inventiveness, donating his time, his work and even paying a great deal by himself. For instance, "I pay the costs for the development of the website and the projects, including hardware, software, ADSL, web space (+100Mb), sending costs. The work on the website is done at home in late evenings.

Bibliography

Alberici A., *Imparare sempre nella società della conoscenza*, Mondadori, Milano, 2002.

Alessandrini G. (a cura di), *Pedagogia e formazione nella società della conoscenza*. Atti del Convegno nazionale 2001 della Società italiana di pedagogia, Franco Angeli, Milano, 2002.

Baets, W., Aligning Information Systems with Business Strategy, *Journal of Strategic Information Systems*, Vol.1, 1992, pp.205-213.

Batini, F. and Fontana, A., *Comunità di Apprendimento*, 1997.

CEC, Communication from the Commission to the Council and European Parliament, *The eLearning Action Plan: Designing Tomorrow's Education*, 28.3.2001 COM(2001a)172 final, Brussels.

CEC, *Teaching and Learning: Towards the Learning Society*, White Paper on Education and Training, Brussels, 1996.

CEC, *The Concrete Future Objectives of Education Systems*, COM(2001b) 59 final, Brussels, 31.01.2001.

Conway, J., *Educational Technology's Effect on Models of Instruction*, 1997, found at http://copland.udel.edu/~jconway/EDST666.htm#cogapp.

Dewey, J., *Democracy and Education* (full text in The Project Gutenberg Etext, March, 1997 [Etext #852] found at ftp://sunsite.unc.edu/pub/docs/books/gutenberg/etext97/dmedu10.txt.

e-Learning Strategy Unit, *Progress towards a Unified E-Learning Strategy*, Department for Education and Skills, 8 April 2004, UK.

e-Learning Strategy Unit, *Towards a Unified e-Learning Strategy. Consultation Document*, Department for Education and Skills, July 2003, UK.

Eletti, V., *Che Cos'e l'e-Learning*, Carocci Editore, Roma, 2004.

Gardner, H., *Frames of Mind: The Theory of Multiple Intelligences*, Basic Books, NY, 1983.

Gardner, H., *Intelligence Reframed: Multiple Intelligences for the 21st Century*, Basic Books, NY 1999.

Haddad, W. and Draxler , "The Dynamics of Technology for Education" in Haddad, W. and Draxler, A. (eds), *Technologies for Education: Potentials, Parameters and Prospects*, UNESCO and AED, Paris and Washington, 2002b.

Haddad, W. and Draxler, A. (eds), *Technologies for Education: Potentials, Parameters and Prospects*, UNESCO and AED, Paris and Washington, 2002a.

Institute for Information Technology in Education (IITE), *Information and Communication Technologies in Secondary Education*, IITE UNESCO, Moscow 2004.

Kearsley, G., Theory Into Practice (TIP) Database, found at http://tip.psychology.org/backgd.html)

Kozma, R. (ed.), *Technology, Innovation and Education Change. A Global Perspective*, International Society for Technology in Education, PLACE, 2003.

Leonard-Barton, D., Implementation as Mutual Adaptation of Technology and Organization, Research Policy, No.17, 1988, pp.251-267.

Levy, P., *Collective Intelligence: Mankind's Emerging World in Cyberspace*, Perseus Books, Cambridge, Mass., 1997.

Levy, P., *Cyberculture*, University of Minnesota Press, Minneapolis, 2001 (first published in 1997).

Luftman, J., Lewis, P. and Oldach. S., Transforming the Enterprise: The Alignment of Business and Information Technology Strategies, *IBM System Journal*, Vol.32, No.1, 1993, pp.198-221.
Molina, A., Transputers and Transputer-based Parallel computers: Sociotechnical Constituencies and the Build up of British-European Capabilities in Information Technology, *Research Policy*, No.19, 1990, pp.309-333.
Molina, A., Insights into the Nature of Technology Diffusion and Implementation: The Perspective of Sociotechnical Alignment, *Technovation*, Vol.17, Nos.11/12, 1997, pp.601-626.
Molina, A., The Role of *the Technical* in Innovation and Technology Development: The Perspective of Sociotechnical Constituencies, *Technovation*, Vol.19, 1999a, pp.1-29.
Molina, A., Transforming Visionary Products into Realities: Constituency-Building and *Observacting* in the Case of NewsPad. *Futures*, Vol.30, No.9, April 1999b.
OECD, *Learning to Bridge the Digital Divide*, OECD, Paris, 2000.
OECD, *Learning to Change. ICT in Schools*, OECD, Paris, 2001b.
OECD, *What Schools for the Future*, OECD, Paris, 2001a.
OECD/CERI, *Networks of Innovation: Towards New Models for Managing Schools and Systems*, Paris, 2003.
Partnership for 21st Century Skills, *Learning for the 21st Century. A Report and a Mile Guide for 21st Century Skills*, Washington, 2003.
Resta, P. (ed.), *Information and Communication Technologies in Teacher Education. A Planning Guide*, UNESCO, Paris, 2002.
Toomey, R. and Ekin-Smyth, C., *ICT and the Quality of Learning. An Overview of the Australian Case Studies*, OECD/CERI ICT Program, 14 May 2001, found in http://www.oecd.org/dataoecd/31/52/2732684.pdf.
Venezky, R. and Davis, C., *Quo Vademus? The Transformation of Schooling in a Networked World*, OECD/CERI, 2002.
Wenger, E., *Communities of Practice: Learning, Meaning, and Identity*, Cambridge University Press, Cambridge, 1998.
Wenger, E., McDermott, R. and Snyder, W., *Cultivating Communities of Practice*, Harvard Business schools Press, Boston, Mass., 2002.

URLs cited in the paper

ftp://sunsite.unc.edu/pub/docs/books/gutenberg/etext97/dmedu10.txt.
http://tip.psychology.org/backgd.html
http://vs.eun.org/eun.org2/eun/en/vs-primary/entry_page.cfm?id_area=23
www.dainamic.be
www.ewoc.be
www.meulebeke.be
www.sip.be/stamand/@team.htm
www.sip.be/stamand/5D.htm
www.sip.be/stamand/5Dpotatoes.htm
www.sip.be/stamand/anewworld.htm
www.sip.be/stamand/catklas.htm
www.sip.be/stamand/door0.htm
www.sip.be/stamand/hoek.htm.
www.sip.be/stamand/japan.htm
www.sip.be/stamand/meetkunde/japan2.htm

www.sip.be/stamand/meetkunde/klasmeet_eng.htm
www.sip.be/stamand/meetkunde/meetkunde.htm
www.sip.be/stamand/meetkunde/meettoren.htm
www.sip.be/stamand/olympics.htm
www.sip.be/stamand/parochie.htm
www.sip.be/stamand/sleutel.htm
www.sip.be/stamand/strips.htm