ACCELERATING A NEW ON-LINE COURSE DEVELOPMENT THROUGH A CONCURRENT APPROACH

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ABSTRACT

The main purpose of this paper is describing a case study where a team developing an on-line training seminar applied a concurrent model (empirically developed) to face a challenge where time to market was at stake. The experience is compared with a traditional step-by-step approach applied to a previous course development.

Designing, developing and launching a new on-line course, requires project management processes and skills. Coordinating activities, resources, stakeholders and achieving the quality of the learning outcomes in time is at the essence. Teams involved in these initiatives comprise authors, instructional designers, web designers, programmers, sales and marketing people, vendors and a coordinator. The endeavor becomes even more challenging when market conditions require the team to shorten the usual development time. An empirically developed model of concurrency was applied to face these stringent conditions. It consists of three main components: parallel execution, integrated teams and convergence on information (López Miranda A., 2007).

Preliminary results show that this "accelerated" method succeeded. The duration was shortened, the quality of the learning outcomes improved and teams' morale boosted. Problems and resistance to apply the new way of working are explained in this paper. Conclusions are presented suggesting how to extend the model to other situations.

Keywords: Fast product development, parallel development, concurrency, simultaneous development teams.

INTRODUCTION

The objectives of this work are presenting a case story where a concurrent model was introduced to accelerate the development of on-line course. Experiences are shared and recommendations to future applications are explored.

Designing, developing and launching a new on-line course might be a daunting endeavor. There are on-line training programs that comprise several courses, themes and subthemes

representing more than 50 hours for the student to read lectures, answer questions and solve tests. These "big" programs require teams of 10 to 20 persons to be developed in time, at budgeted cost and within the quality of the course material. In all, the project consumes easily more than 10,000 human hours

Literature on how to reduce product development is abundant and is mainly published in three academic and practice communities: Project Management, Concurrent Engineering and New product development.

Project management (PM)

Since the late 1960s, PM has been thought of a set of control techniques – largely centered around cost and scheduling – helpful in bringing a project in "on time, in budget, to scope". In fact, nearly all these techniques were all developed between about 1910 and the late 1970, mainly under the disciplines of operations research (OR) and operations management (OM) (Morris, 1997). Some, like Gantt charts and Critical Path, are very well known; others are less "famous" but they contributed greatly to schedule and control projects like for instance the GERT (Graphical Evaluation and Review Technique) (Pritzker, 1968). There have been few PM specific tools developed since the late 70s, though Critical Chain – more a practice than a tool – is an exception (Goldrath, 1994).

Projects are considered to be initiatives to achieve unique or new products or services in a specified time (PMBOK, 2017). Project management is a combination of rigorous life cycle-driven processes, strong control, and effective organisational delivery. All projects follow the same basic life cycle: a move from concept/opportunity identification and feasibility, through planning and execution/production, to hand-over these unique or new products or services, and ending with a project closure (Figure 1). The "single point of integrative responsibility" is another core project management concept (Archibald, 1995).

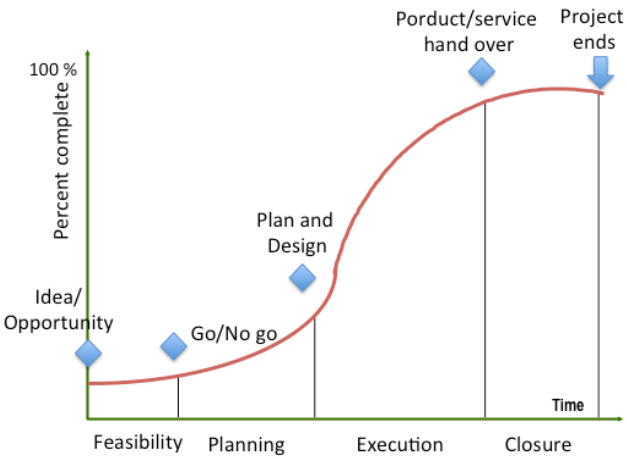

Figure 1. Project life cycle

Within this life cycle, project management emphasises that:

- The process must be followed rigorously: no stage should be missed; significant resource should be put into the early stages; control applies to all stages;
- There should be a "hard gate" between each stage where progress to date is reviewed and the decision taken on whether to continue, reiterate, or abandon; and

where decisions regarding how to proceed in the next stages are taken.

- Project control acts both for the overall project from early in the project life cycle and for each individual phase.

Normatively, the literature would suggest a range of 'best practices'. For example, there should be an effective relationship between the project sponsor and the project manager (HMSO, 1995). Project teams should be aligned and integrated; they should consist of all those who can contribute to the overall project success (Marketing & Sales, R&D, Design, Development, etc.). Their work should be aligned to the Project Strategic Implementation Plan and Project Success Criteria/KPIs. Procurement and contracting practices should support supply chain alignment and integration. Time will be required to create the appropriate "culture": trust, commitment, openness, energy, and enthusiasm are essential. Communications must be clear and effective. Leadership is central in developing the drive to meet the project goals (Dinsmore, 1984, Pinto, 1998).

The use of the project life cycle as the guiding model to implement PM methodologies in organisations has also been criticised as a new form of "re-bureaucratisation" (Hodgson, 2004) or a model by which "discourse technologies can redesign work processes, turning them into norms, rules and prescriptions, representing established consensual praxis" (Raisanen and Linde, 2004:118). Williams (2005) also criticizes the prescriptive nature of Project Management claiming for the need of proposing new Project Management styles contingent upon project types. To avoid rigid, step-by-step procedures, the PM communities of practice are adopting the so-called "agile practices" from software development methodologies like SCRUM and Extreme Programming XP. The new version of the PMBOK includes recommendations to adapt these practices (PMBOK, 2017).

Concurrent engineering

Engineering products in a concurrent way is not a new concept. Pioneers of the automobile industry like Henry Ford and Ransom Olds practised, to a certain extent, "the philosophy of what we now call CE" (Jo et al, 1991: 35). Concepts like "multifunctional teams", "integrating design and manufacturing functions", "customer focus", and "time to market" have been in the literature since the 1920s (Smith, 1997). According to Hobday et al (2005) the application of multidisciplinary teams working concurrently at the outset to develop weapon systems in a more efficient and effective way was a fundamental principle of systems engineering during the Cold War era. These principles were later applied in the automobile and electronics industries and "terms such as concurrent engineering are now common place" (Hobday et al, 2005: 1121).

Arguably the most extended definition of CE is credited to Winner et al., 1988. They established that:

"Concurrent engineering is the systematic approach to the integrated, concurrent design of products and their related processes, including manufacture and support. This approach is intended to cause the developers, from the outset, to consider all elements of the product life cycle from conception through disposal, including quality, cost, schedule, and user requirements".

CE is aimed at shortening the lead time; emphasising the response to customer expectations; and considering all elements of the product life. Moreover, literature purports gains not only on these aspects, but also on quality, costs and performance (Hartley, 1997).

The Institute for Defence Analysis, for instance, lists over sixty CE tools (Evans, 1993). As an example, Winner et al. 1988 proposed a classification that includes the basic elements shown in Table 1.

Many benefits of applying CE have been reported and can be summarised as developing products in less time and cost and with better quality. Hartley (1992), list the following benefits:

- Improving the quality of designs, which results in dramatic reductions of engineering change orders (greater than 50 percent) in early production.
- Product development cycle-time reduced by as much as 40 to 60 percent through the concurrent, rather than sequential, design of product and processes.
- Manufacturing cost reduced by as much as 30 to 40 percent by having multifunction teams to integrate product and process designs.
- Scrap and rework reduced by as much as 75 percent through product and process design optimisation.

New Product Development

NPD has been named variously as Product Development, New Product Introduction, Integrated Product Development, Integrated New Product Development, Concurrent Product Development and so on. In this paper we define product development as "the transformation of market opportunity and a set of assumptions about product technology into a product available for sale" (Krishnan and Ulrich, 2001)

Cooper's *Winning at New Products* (Cooper, 2000) takes a strong process-driven look at how new product selection should be married into company strategy, marketing and product technology but then goes on to emphasise the importance of developing the product through a rigorous development life cycle.

The Machine that Changed the World (Womack et al, 1990) started a series of influential studies that emphasise the practical issues associated with the management of the product development process (Clark and Fujimoto, 1991, Cusumano and Noboka, 1998). It has useful concepts on the role of the "heavy weight product manager" (Shusa – Large Project Leader) and particularly on the engineering/management issues taken to compress product cycle time in new auto product development. These lessons, based on experiences of the Japanese way of working, were soon related to simultaneous engineering or CE.

Relatively few sources (compared with PM and CE) were found listing NPD methods, tools, techniques or taxonomies. Rather, NPD authors focused more on strategies, organisational structures, and processes management issues. Table 2 presents an example of NPD tools as classified by Wheelwright and Clark (1992) and (McGrath, 1996). Note that Project Management and other CE related tools like QFD and Design for Manufacturability are included.

Table 1. Classification of CE elements proposed by Winner et al (1988)

B.1 Engineering process initiatives	**B.3 Formal methods**
B.1.1 Multifunction teams.	▪ QFD
B.1.2 Design documentation management.	▪ Design for assembly
B.1.3 Tracking the (customer) requirements.	▪ Fault tree analysis
B.1.4 Process design.	▪ FMEA
B.2 Computer and other technology support	▪ Group technology
B.2.1 Information management and communication	▪ Simulation (Soft Mock-up)
B.2.2 Integrating technologies	B.3.1 Process measurement and control
B.2.3 Production technologies	B.3.2 On line process control

Probably, one of the most convincing evidence of the effectiveness of parallel development is the study developed by Clark and Fujimoto in the automobile industry (1992). Japanese companies developing activities in parallel achieved superior project lead-times than its "western" competitors which normally executed the activities serially. Japanese companies applied a simultaneous problem-solving approach consisting of overlapping activities and fostering a two-way intense information exchange between upstream and downstream functions (**Error! Reference source not found.** left). This method differs substantially from to the traditional serial process where the information is passed in one-shot from upstream to downstream functions (**Error! Reference source not found.** right).

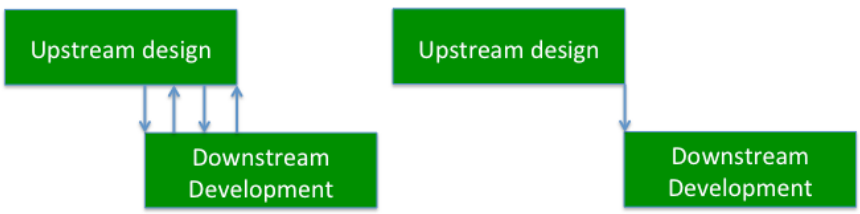

Figure 2. Simultaneous problem-solving approach (left) and serial approach (right)

Through the simultaneous problem-solving approach problems between upstream and downstream functions are detected early on and solved by multidisciplinary teams while these problems are identified too late in the serial approach (after design freeze).

Table 2. NPD methods, tools and techniques

Author	Methods, tools, and techniques
Wheelwright and Clark, 1992	The design-build-test cycle QFD Design for Manufacturability Project Management and Execution Computer Based Design Systems (like CAD/CAM)
Mc Grath, 1996.	QFD Design for Assembly and Manufacturability. User-Oriented Design Design and Execution Tools Project Management and Execution Tools

Controversially, Morris (1997) detailed a long history of project failures because of overlapping or "fast-track" practices. Eisenhardt and Tabrizzi (1995) surveyed 72 companies in the fast-pace computer environment finding that "surprisingly" careful planning and overlapping did not reduce product development time. Williams et al. (1995) warned about the "vicious circle" of parallelism because of the risk of rework that produces more delay than in the sequential procedure.

AN ECLECTIC AND EMPIRICALLY DEVELOPED MODEL

A research was launched to develop a conceptual framework to explain the relationship between PM, CE and NPD so that managers can benefit from a dovetailed application (López Miranda, 2007). Four case studies were developed to empirically explain this relationship.

The data gathered from the case studies was obtained from three different sources: interviews, document review and observation. People involved in the development of new products were interviewed, that is, project managers, product managers, heads of program managers, team members, heads of functional disciplines and people who administered the NPD process as well as heads of PM and NPD training programs. In total 36 persons were interviewed taking on average 2 hours each.

Although complete and illustrative, Winner et al (1988) definition of CE is difficult to understand and operationalize because of its many concepts. Hence, based on the constant comparison method (Gephart, 2004; Suddaby, 2006) data were analysed and a simpler definition of CE was proposed:

> *CE is an approach for designing products or services through the application of multidisciplinary teams working in parallel and converging on data and knowledge.*

This new definition is composed of three components that will be described and are shown

in Figure 3 in the form of a “mind mapping” tree, hereinafter will be called concurrent model.

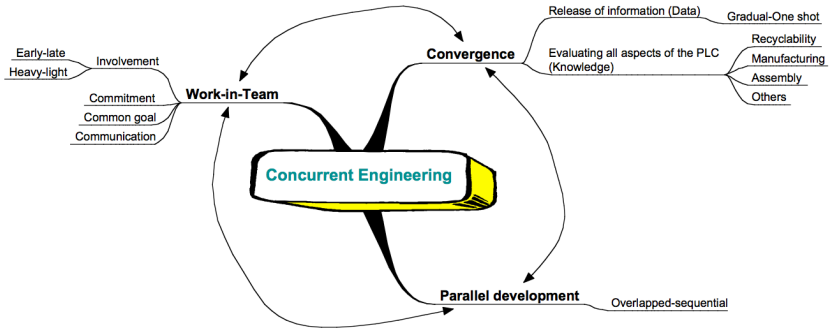

Figure 5-4. Conceptual structure of concurrency

Figure 3. Concurrent mind map type model

Parallel development. Parallel development refers to the simultaneous problem-solving approach described among others by Clark and Fujimoto (1992) where downstream activities start before upstream activities finish and this occurs through an intense information exchange to avoid rework (**Error! Reference source not found.**). However, three companies considered that parallel development was indeed a risky strategy because the risk of rework as reported by Morris (1995) and Williams (1997). In one company managers considered that the sequential approach was riskier because of the over-the-wall syndrome. Hence, field research is still needed to shed light on this debate.

Work-in-team. Working as a team implies that the members of multidisciplinary groups work together in pursuing a common goal. Many managers and specialists within the four companies agreed on the relevant aspects that characterise effective work-in-team, amongst others, multidisciplinary problem-solving, common goals, commitment, collaboration, and good levels of communication.

The project manager might compel (or inhibit) project teams, “against their natural inclination”, to address simultaneous problem solving, to join together early-on in the project, or to enhance communication

Convergence. It means that data and knowledge tend to one point of focus from which are shared and used by the different users. Four different forms of convergence were observed in the companies: meetings, co-location, on-line information, and public boards which are shown in Figure 4. Firstly, teams converged or met to work together either as collocated teams (in Companies 1, 2, and 3) or in meeting rooms (in Companies 1 and 4). Besides, Companies 1, 2, and 3 used different tools to converge with on-line information, such as instructions appearing on Intranets. Several program and project managers showed the typical “war rooms” with boards hanging on walls, containing project information to all team members and project stakeholders. On these walls were Gantt charts, design sketches, product breakdown structures and so on. These boards were visual instruments to converge on information as well.

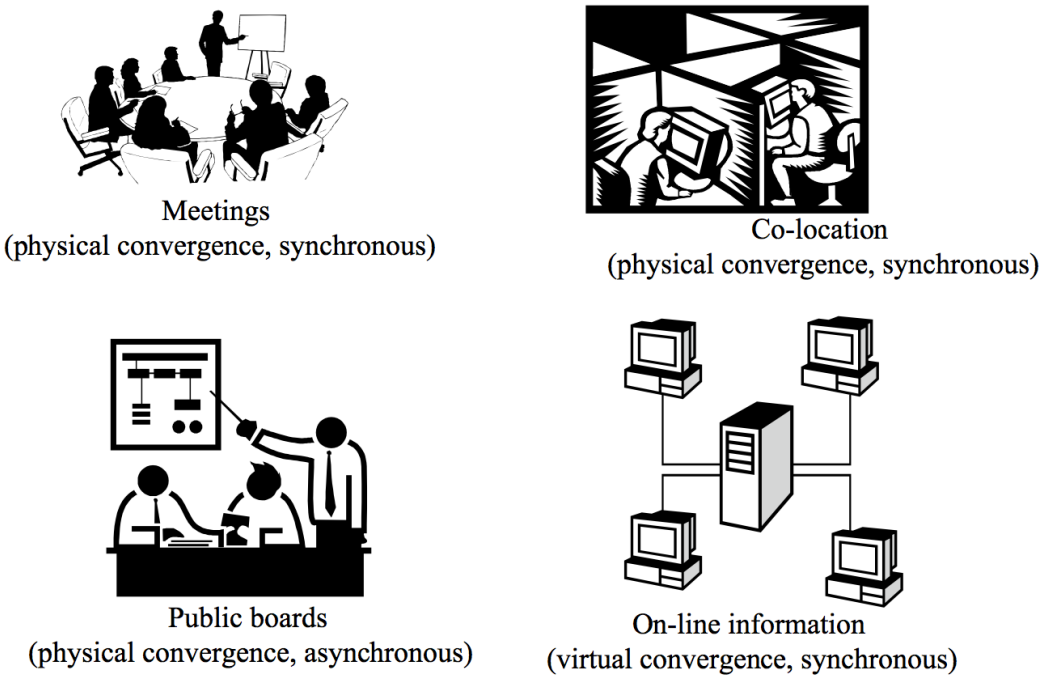

Figure 4. Four types of convergence on information

Regardless of the form of convergence, the goal was the same: to share information in order to expedite decision-making.

CASE STUDIES

The Tecnologico de Monterrey, which is between the list of 200 best universities in the World (QS Ranking, 2017), produces on-line education programs since 1989. It is without questions one of the pioneers in this growing industry where a fierce competitiveness is taking place worldwide and names like Cursera, Udemy and Udacity to name a few appear as the market leaders.

The organisational unit producing and operating these programs is the On-line Programs Direction organised in departmental units like production, design, innovation technology and operations. The unit in charge of marketing and sales belong to the Continuous Education Vice Presidency and the authors of content work in different academic faculties. In all, three organisational units and six departments take part in the design, development, selling and operation of these on-line programs.

Two different stories are presented, the first started in December 2009 where a Project Management (PM) on-line training program was developed to be open to the public in January 2011, one-year preparation. The second story initiated in November 2017 where a re-designed version of the PM on-line program had to launch to market in April 2018, five-months preparation. The short time to develop the new program was set by the commercial department arguing that success depended greatly of the time to market.

Case 1 Following the step-by-step process

In November 2009 the On-line Programs Direction started a project to produce and

commercialise a Project Management (PM) *Diplomado*[1]. The project would comprise the following steps, content generation, instructional design, graphical design, web programming, marketing, sales and launch to the public. Figure 5 shows the organisational units taking part in the development. As can be seen, all department units belonged to the On-line programs Direction except the content experts, authors from different academic faculties.

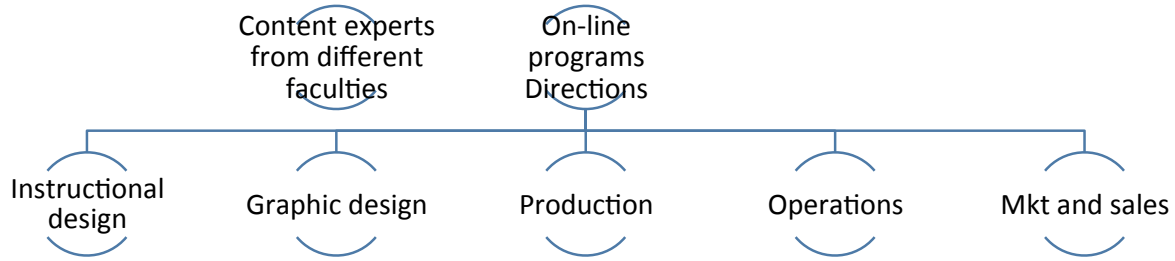

Figure 5. Organisational units involved in the first on-line *Diplomado*

The different stages of the project were planned sequentially to ensure that information passed complete from one to another as the traditional, low risk step by step project management process mentioned in the literature. Figure 6 shows a simplified view of the chronogram to display the parallel approach deployed in Module 1. Modules 1 to 4 started at the same time because each corresponding group of resources was available. Module 5 to 7 started until after the resources were released. Sales department started marketing and promoting 5 months before the starting date because at that time they had enough content to design advertising material.

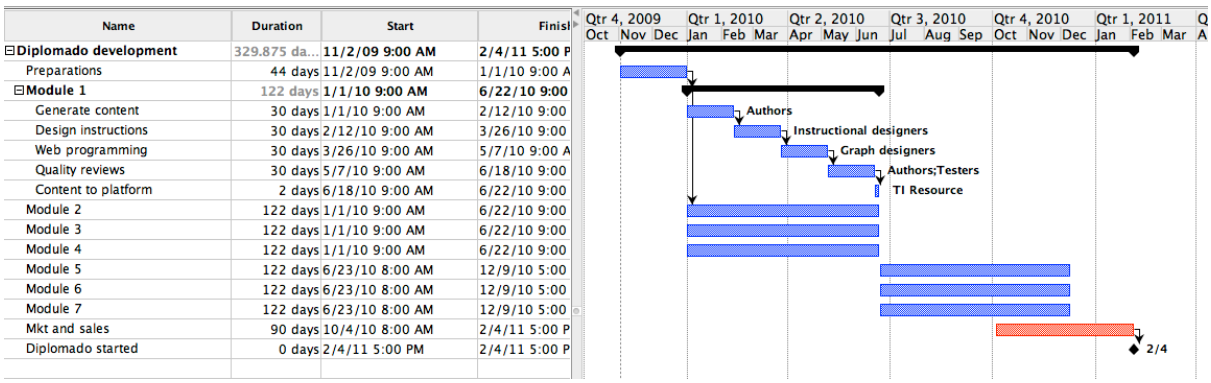

Figure 6. The sequential development

[1] *Diplomado* is a training program at Tecnologico de Monterrey whose length is at least 96 course room hours or its on-line equivalent and if it is successfully passed, the professional student receives a *Diploma*. Usually, it consist of 8 modules of 16 hours each.

Authors developed content and passed the information to instructional designers who reviewed it entirely before giving feedback. The means to manage this written communication was by e-mail and attached documents. The version control was dealt according to each one individual way of working, i.e., there were no common rules.

Some of the problems mentioned in the literature review section arose soon. The use of asynchronous e-mail increased the time to review since the receiver of the document had a pile of e-mails to read on a sort of waiting list. After certain time the mail was open to review the content and later sent back in a different version to the original sender. This cycle was repeated three to six times depending of the theme to develop. Many times the sender and receiver found themselves using a different version of the document and had to meet together to clarify what was the last version.

Another problem emerged due to the "pass the ball" effect. By the time authors believed that they have finished their content material, instructional designers asked them to develop complementary and supporting material. This caused the authors to review again the whole content to plan for these extras, complaining that instructional designers should have asked that from the very beginning. Instructional designers replied the need of learning support material emerged only after reading the original content.

Once the authors and instructional designers finished the review, the latter transferred the "raw texts" to graphic designers, which in turn passed their visually rich material to web programmers who converted it into on-line content. The process from instructional designers to web programmers lasted around one month. Authors took part in quality reviews at the end of the development process. These reviews took long time (see activity Quality reviews in Figure 6) because reporting correction had to be done by using detailed templates, sent by mail and many times receiving questions back from developers about the corrections request.

There was not an explicit strategy to promote teamwork amongst the project stakeholders. Each actor was responsible for their work and passed it to the next. This caused the groups to work rather individually or by silos. For instance, authors belonged to different faculties worked individually and joined together once in a while to plan or decide about integration. Similarly, instructional designers worked functionally together, as well as programmers, graphic designers and so on. A clear effect of this way of working by silos was that when mistakes or delays emerged, each one blamed the others.

The *Diplomado* was released to the public in February 2011 at the planned date, but involving more hours than originally planned mainly due to re-work and review sessions. The sales goals were achieved and the first customer satisfaction surveys indicated on average an 8 out of 10. Grammatical mistakes, lack of references and some missed links were some common incidents commented by participants.

Case 2 Developing the seminar by applying the accelerating model

The on-line *Diplomado* that started in 2011 was steadily operated and sold during six years counting on average 1,000 participants per year. However, it was evident that the technology used to produce it was out of date. The so called MOOCs (Massive Open Online Courses) and its highly interactive, user friendly and rich content were disrupting the traditional way of learning through on-line courses, not to mention the attractive freemium option, usually without granting a course recognition. The competitive disadvantage and the release of the new standard upon which the *Diplomado* was grounded, ignited the decision to start the

project to renew it.

The re-design of the new program started in December 2017, its content would be aligned to the new standard and a set of innovative educational tools applied. The target, set by the commercial department was aggressive: the program had to be launched the first week of April, that is, five months to develop and lunch. The endeavour happened to be nearly impossible on light of the past experience.

To complicate the matters the organizational units tasked to design, develop produce and sell on-line courses had been fragmented and therefore the interfaces increased (Figure 7). A new organisational unit was set tasked to plan and manage the whole course portfolio (one department) and to market and sell the courses (other department).

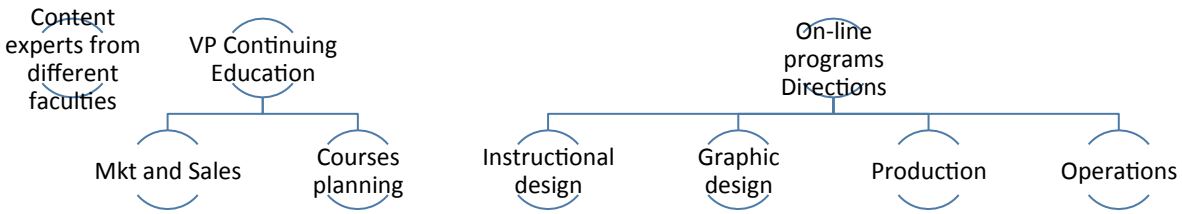

Figure 7 Organizational units involved in the development of the second on-line *Diplomado*

Due to the stringent conditions, the author of this paper proposed the application of the concurrent model. Three main approaches would be implemented through this "accelerating" method: a) a parallel development; b) a platform for converging on information and; c) better way to work-in-team, or CE (Figure 3).

Parallel development. As the old *Diplomado*, the new learning content consisted of seven modules, now called Journeys or "Trayectos" in Spanish, each divided in three or four courses. The design phase would be executed with five authors and four instructional designers. These lasts resources would be all available at the beginning of January and at that point in time they should be fed with content. However, authors would not finish their Journeys by the end of December because of the content extension and holiday seasons. It was then decided to disintegrate the planned development by Journeys and to work based in their constituent short-duration courses.

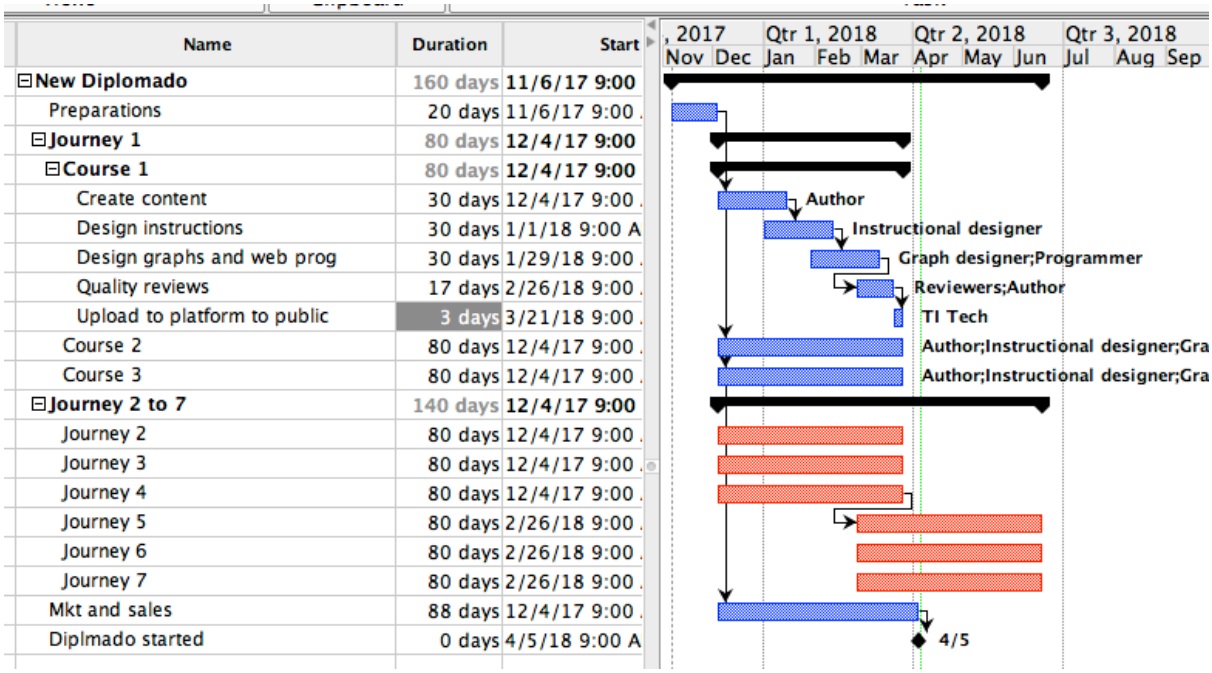

Figure 8. Parallel approach executed by courses instead of by Journes.

Figure 8 presents a schematic chronogram of the real one used to execute activities in parallel and assign resources. Note that:

- The essence of parallel development is shown in Course 1 constituent activities where downstream actors started before downstream actors finished.
- The Quality review activities took in general less time because of the intense communication amongst team members.
- The Marketing and sales activities started practically since the beginning unlike the first *Diplomado* experience that started at the end.

Unlike the past experience, this time the authors (upstream) shared content information with industrial designers (downstream) throughout the whole design phase. Instructional designers made preliminary reviews and gave feedback to authors. This information exchange in both directions improved the quality of the content and reduced the "pass the ball" effect mentioned in the literature review section.

For parallel approach to work efficiently, it requires an intense communication and the person's willingness to work with preliminary non-finished information (Clark and Fujimoto, 1991). At the beginning, the upstream actors of the development did not get use to this new condition and receiving constant feedback of downstream actors was to them somehow irritant. Accustomed to the old way, some instructional designers still requested that the learning content be finished before starting their job. Soon they realized the convenience of a more agile way of working instead of passing and receiving batches of information.

Converging on information. One of the lessons learnt of the case 1 experience was that storing information in individual computers resulted in versions confusion, information missing, and lack of integration and poor documentation. Hence, it was proposed to work by

storing and sharing information in one common and central repository of information. This decision turned to be productive but nonetheless difficult to implement.

The first barrier was technological, the shared central file was located in Google Drive platform and team members were requested to install the local Drive in their computers to synchronize the files instantly. Several computers and laptops were not synchronizing because of incompatible operative systems, access permissions or unknown causes.

The second problem was that of peoples' resistance to share. They were afraid of editing or deleting important information. Others considered that their content was not ready to be shared and read by others.

The third problem was lack of expertise. Many persons in this group had not worked with shared platforms so they did not even know that files were automatically synced in their local computers and the central file and therefore created back up files.

These initial limitations caused that actors preferred to work individually and after having a batch of information, they uploaded it, then causing delays because other persons could not start working. Fortunately, the constancy of purpose of the group leaders and the higher rate of productivity of those sharing information produced a positive effect and drove the change. There were also rules to share information safely, for instance, the information on the central file was weekly backed up.

Instant group communication was introduced using mobile Apps. Through these applications different design cells of people converged rapidly on messages regarding questions, criteria applied or how the solved problems. At the beginning, this abundance of text-message information was considered disturbing by some people not accustomed to it but soon they realized the benefits.

Instructional designers and web programmers were requested to sit together to ensure quick information exchange. As proposed by the model, co-location is a mean to converge physically on information (see Figure 4).

Work-in-team. Case 1 story showed that content experts were treated as "providers" because they were professors or authors whose job was to deliver learning content without any other involvement in downstream development phases, other than reviewing. This delivery role was changed to let them become part of the whole development team. Hence, they took part on commercial decisions like naming the program, marketing information and even the price. They could also raise comments regarding the templates proposed by instructional designers.

Regular meetings were held inviting all actors along the development to avoid the "broken telephone" syndrome. These meetings increased communication clarification, mutual understanding and trust. All team members were invited to a team building sessions and to celebrate the achievement of important milestones. In case 1 content authors did not met even once with programmers or marketing people.

Noteworthy was the early involvement of Marketing and Sales department. They started by surveying participants of the "old" *Diplomado* in order to get insights to improve the new one. Meetings were held where the whole team, including marketing experts, decided early on the price and the name of the program based on customer survey inputs and an incipient content outline. Advertising started almost at the beginning of the design stage and a webinar was casted showing thrillers with graphic materials already designed.

CONCLUSIONS & RECOMMENDATIONS

Preliminary and successful results and outcomes can be presented despite the fact that the *Diplomado* design and development has not been finished by the time of the writing of this paper. First, the program achieved the stringent time-to-market target and started in the planned day. Registration reached record audience, 470 participants, more than twice the expected goal of 200. The development cost was on budget. The quality of learning content was improved since a much more attractive and interactive user interface was set on place.

The end of the story is not yet to be told. Customer satisfaction has not been surveyed since the first generation has not ended. Moreover, two or three program generations along with customer satisfaction survey results and sustained or growing sales are needed to validate success.

The accelerating model proposed to approach this project proved to be more effective. It allowed the team to achieve the time-to-market target in four months, two months less project duration compared with the past development. The quality of the learning content was improved due to an intense cycle of producing – reviewing texts in parallel, at the same time, not on batches. Documentation was improved due to the fact that all files were in the same repository. There are not different versions nor different names of the same file but solely the final ones.

Although the work-in-team was clearly improved as compared with the Case 1 development, more should have been done to reinforce the team spirit, like team building sessions or an initial kick-off event to motivate the whole team to achieve an aggressive target. Likewise, a celebration event should have taken place the same day the training program started since the time target was achieved.

The method can be applied in general to design and develop courses and products because of similarities in stages, resources and market goals. Some conditions might apply related to the non-tangibility of services versus the tangibility of products. Likewise, some adaptations have to be done if dangerous products or services are developed since safety of persons is at a highest priority.

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