Blended Learning and Consulting for Resource Limited Enterprises
The Case of a Prototyping, Production and Logistics Service Centre at a Business Incubator in Brazil

J. Antão B. Moura[1], Marcelo A. de Barros[1] and Francilene P. Garcia[1,2]
[1]*Systems and Computing Department, Federal University of Campina Grande, Campina Grande, Brazil*
[2]*Technology Park Foundation of the State of Paraíba, PB, Campina Grande, Brazil*

Keywords: Blended Learning, Blended Consulting, Prototyping, Production and Logistics Support Services, Financial Restrictions, Business Incubator, Collective Intelligence, Lab Virtualization, Validation, Case Study.

Abstract: Start-ups and other innovative, but small enterprises – such as those associated with business incubators - usually have financial limitations that hinder their attempt to properly address product and service lifecycle challenges. Some of these challenges regard aspects of prototyping, production and logistics (PPL). Inability to properly address PPL challenges sometimes delays time-to-market too long, causing the company to fail. In order to assist companies to efficiently address PPL challenges, a low-operating-cost, risk-seeking, PPL Service Centre is being planned for an incubator in Brazil. In order to account for financial restrictions, the Centre's operations are to be based on blended learning pedagogy but expanded to encompass provision of consulting services and access to laboratory and workshop' facilities. Creating such a Centre is timing consuming and resource intensive. Therefore it must be demonstrated that the investment will be worthwhile. A small investigation has been conducted which has looked into the PPL needs of technology-based enterprises associated with the incubator. The results have been used to specify and initially operate the Centre to allow for a more blended style in service provision. This paper summarizes the investigation, its results and the Centre's initial operation and preliminary achievements.

1 INTRODUCTION

Innovative but "micro" and small enterprises (MSEs) have budgetary restrictions that limit their capacity to invest in staff training and consulting services to address barriers and problems throughout the life cycle of their new products or services. This is true everywhere (Tiwari and Buse, 2007) but appears to be the norm in emerging markets such as in Brazil. Indeed, "need of investments" appears frequently in surveys of technology-based MSEs by the Technology Park Foundation of the State of Paraíba (www.PaqTc.org.br) in Brazil.

Available funding to Brazilian MSEs tends to be destined for innovation, research & development (R&D) activities. Albeit their importance for market success, activities later on the lifecycle, such as prototyping, production, logistics, marketing (including market acceptance tests of prototypes) and sales are historically allotted little investment. Over the years, PaqTc has observed that a significant percentage of failures of incubated MSEs can be attributed to inadequate attention to and actions in prototyping, production and logistics (PPL) in anticipation to or in support of marketing & sales (M&S) operations.

To reduce the failure rate of its MSEs and to alleviate their difficulty in securing investments for PPL, PaqTc with sponsorship from the Brazilian Research Council (CNPq) decided to plan and operate a PPL Service Centre that has low fixed costs and offers accessible and effective solutions to PPL problems. This position paper presents the planned centre whose service and operations extend Blended Learning (BL) principles to encompass and mix training, consultancy and workshop practicing.

BL refers to an instructional environment where interactions between instructors and trainees take place face-to-face (such as in a classroom where the interactions are mostly "synchronous") and using Information and Communications Technology (ICT)-based facilities (for asynchronous interactions, such as participating in a Web course through a computer or smart phone). ICT-based facilities allow

Antão B. Moura J., A. de Barros M. and P. Garcia F..
Blended Learning and Consulting for Resource Limited Enterprises - The Case of a Prototyping, Production and Logistics Service Centre at a Business Incubator in Brazil.
DOI: 10.5220/0004342504770483
In *Proceedings of the 5th International Conference on Computer Supported Education* (CSEDU-2013), pages 477-483
ISBN: 978-989-8565-53-2

the trainee to have some control over time, location, sequencing and pace of the instruction he or she receives. In addition, online courses reduce the cost of attending lectures taught by top calibre instructors: (Horn and Staker, 2011) argue that BL grew out of online courses for students who were taking higher level classes in rural K-12 school districts in the US which could not afford bringing a teacher in for face-to-face sessions.

Its potential for cutting costs and instructional media flexibility make BL pedagogy central to modern training programmes. Again quoting from (Horn and Staker, 2011, page 3): "Bleak budgets coupled with looming teacher shortages amidst an increasing demand for results are accelerating the growth of online learning into blended environments… (in order for schools) to do more with less." On a cautionary note, (Garrison, 2004) points to BL implementation complexity with the "challenge of virtually limitless design possibilities and applicability to so many contexts".

The context of interest here is that of on-the-job training and problem solving in PPL at start-up or other innovative MSEs under financial duress. Actual problem solving usually requires consultation with experts or practioners besides effective training to grasp and adopt the solution to be implemented. The specialized bibliography brings little insight on applications of BL principles to training on PPL activities let alone to consulting on PPL. This paper contributes by adding to such insight.

This paper proposes a specification for a PPL Service Centre that applies BL principles to facilitate creative and effective solutions to PPL staff training and PPL problem solving through asynchronous learning/consulting networks of risk-seeking experts (in an ad-hoc community of trust) and sharing of (possibly) virtualized (i.e., over-the-internet-accessible) lab/workshop resources and facilities.

The foregoing discussion leads us to posit the research question (RQ) this paper addresses as: "Can BL principles be applied to training and consulting services to address PPL problems effectively and efficiently?" Here, we assume this question will have been answered positively if stakeholders of MSEs which are (potential) clients of the proposed PPL Centre declare they are satisfied the specified services will help them address PPL problems successfully in a cost-effective manner. Since work on the Centre has just started and it is still on-going, the remainder of this position paper only provides a preliminary answer to the RQ. (An answer with greater confidence requires a longer observation interval and work towards that is on-going.)

2 RELATED WORK

Much of the rich bibliography on BL in Conference proceedings (e.g., CSEDU, 2009-12) and in Journal articles (JALN, 1997-2012) reports on applying BL approaches to improve instructional cost and effectiveness in academic, government and corporate settings covering disparate areas such as: Humanities and the Arts (Spohrer and Cassidy, 2012); Engineering (Rouvrais et al., 2005) and related fields – e.g., IT; and, Health (Brandt et al., 2010). The bibliography reveals that BL has become the basis for most employee orientation and training programmes worldwide – see for instance, (Internexia, 2011) for human resource development programmes in general. On the other hand, reports on BL for PPL professionals are almost non-existent. (Manesh and Woll, 2007) describes a conversion effort by Intel Corporation from a classroom to a BL approach for on-the-job training of equipment operators; the authors observe gains in costs, lead time to proficiency and production.

The greater part of the reported work, however, regards experimentation with BL for teaching (JALN, 1997-2012) or by large corporations – such as IBM and Intel in the high tech industry (Bersin, 2004). Albeit some of the works address financial restrictions (Horn and Staker, 2011), the focus is on curriculum design and learning performance.

Also, BL principles appear to have been applied to consulting services sparingly. One exception is (Work Write, 2012) which offers mentoring and consulting on documentation writing – such as software online help. We found no reports on mixing BL and consulting to address PPL problems.

This paper proposes delivering training and consulting coupled with sharing of infrastructure in a more blended style as a way of: i) improving skills in designing and applying solutions to PPL problems by professionals of small enterprises through interactions with a community of invited, specialized consultants and practitioners; and, at the same time, ii) meeting financial restrictions typical of these enterprises. The proposal is a new application of BL in the sense that it includes "blended consulting" and resource sharing through favours from partners. As such, the paper contributes to the literature on BL.

3 NEEDS AND REQUIREMENTS

In 2012-Q2, PaqTc interviewed executives from 7 MSEs in North-eastern Brazil - the region of the

Park's operations since its founding in 1984 and one of the poorest in the country. These MSEs produce hardware bits as part of services for boat building, engineering, home automation, musical devices, sports instrumentation, point-of-sale software and mobile communications – one company has been functioning for over 25 years; another for over 10 years; and the rest, close to 5, having been incubated at PaqTc for the last two. All were selected based on their (eventually) successful PPL experiences and their knowledge of PaqTc's operating limitations. Unstructured interviews (Denzin and Lincoln, 2005) with the executives elicited information on their past and current PPL needs and solution requirements to serve as basis for the PPL Centre specification.

3.1 MSEs' PPL Needs & Problems

According to the interviewed executives, existing courier or transport services sufficed for logistics at least initially, when the company ordered parts to build prototypes or to deliver small production lots. Also, stock keeping did not pose much difficulty. On the other hand, major PPL problems for MSEs arose during construction of prototypes, running pilot tests and organizing production. Prototyping problems were particularly pressing at the start-up stage.

To address these major problems, interviewed executives indicated their MSEs need(ed):

i) "professional advice from expert consultants";
ii) "better knowledge and information about PPL activities, procedures, best practices and tools" – be it to properly contract (and eventually to become independent of) consulting services in i) or to leverage the scarce resources (funding, staff and facilities) available internally or at PaqTc's incubator to better align PPL activities to R&D and M&S goals;
iii) "guaranteed access to performance-and-quality-enhancing prototyping infrastructure such as a laboratory, workshop or equipment";
iv) "information on import procedures and forms" for certain prototype components and parts; and,
v) "a minimal, separate PPL budget" to pay the expenses incurred in tending to the above needs.

The above MSEs' "wish list" clearly indicates the need for blending training with consulting and supporting these blended activities with availability of adequate information and infrastructure. Since it is not usually in the mission of an incubator to tend to need v), the planned Centre would attempt to ease the rest. Although not a requirement, but because of need v), use of multiple media is a natural economic choice for the delivery of services.

3.2 Requirements for the PPL Centre

Requirements for the PPL Centre are derived from the target MSEs' profiles and needs and the incubator's characteristics and goals:

i) Internal preparedness – the overall goal of the PPL Centre's services should be to ensure MSE internal capabilities towards PPL activities.
ii) Comprehensive coverage – services should be provided in areas that impact PPL (not just for PPL proper) in a comprehensive and integrated manner (e.g., training, hands-on experiments, consulting, information & equipment access and technical assistance).
iii) MSE-orientation – Service provision should use material, language, practices, tips, check lists and real-world examples in a way that is accessible and of interest to MSE professionals (e.g., there is little use in examining "production at Intel").
iv) Customization – since PPL problems may vary with industry, target-market, staff and infrastructure specialization, so should the services provided for solving them (i.e., services should be customized to match the client MSE's characteristics and its needs).
v) Minimalist permanent structure – to reduce initial investment and fixed operating costs of staff and infrastructure.
vi) Sustainability – the PPL Centre should charge for services and facilities it offers client MSEs.
vii) Simplicity and affordability – information and services rendered by the PPL Centre should be efficient in terms of clarity and cost, leveraging PaqTc's and partners' resources (facilities, know-how and time), to achieve the most return on the (small) disbursement by the client MSE.

4 A PPL SERVICE CENTRE

The mission of PaqTc's PPL Centre is, first and foremost, to identify and facilitate solutions for prototype building and testing problems faced by start-up, micro and small enterprises. It should also support these enterprises in production and logistics aspects. Complementarily, it should help these enterprises develop internal PPL-problem-solving capabilities. This mission addresses requirement i).

To take care of requirements v) and vi), the Centre's permanent staff is to be kept to a minimum needed to coordinate actions. The Centre's Coordinator should preferably be a well-connected,

retired PPL professional who could work part-time to assist MPEs and recruit and engage consultants.

To keep costs low, consultants will be engaged on an expertise, just-in-time, ad-hoc and taskforce-oriented manner. They may be compensated by client MSEs in the form of direct payment for services rendered or through some joint-venture arrangement (stock option, share of results of product being considered, etc.). The Centre is to retain a percentage of consultants' compensation for its financial sustainability.

The remaining requirements drive the Centre's service specification.

4.1 Services

The PPL Centre is illustrated by the rectangle in Figure 1. Initial services are organized into 4 groups: A, B, C and D. BL principles are employed in the service specification of groups A and B and to integrate all four groups. A scaled down approach of collective intelligence – in the sense of harnessing collaboration within a community rather than a "mass" (Glenn, 2009) of expert, multidisciplinary consultants – is used to support service provisioning in groups A and B. New services may be added as needed. Next, each group is discussed in turn.

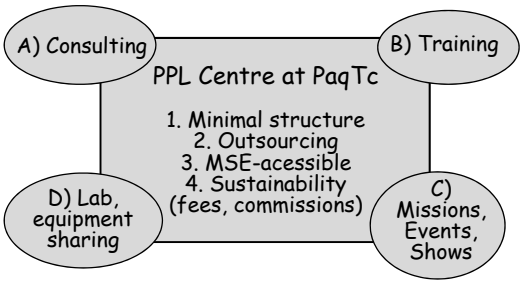

Figure 1: PPL Centre's Service Areas.

A) **Consulting:** includes services for diagnosis and solution of PPL problems and may also encompass complementary (pre-, during- or post-production) consulting on production financing, Project Management or M&S for proof of concept and market acceptance tests, for instance. (Indeed, there may be no point in enhancing production if one has difficulty making sales.) These services are to be supported by:

i) Identification, selection and engagement of expert consultants who may not necessarily be local, but could be anywhere in the country or even in the world. The use of Web conferencing and Voice over IP (VoIP) facilities allows participation of remote consultants *blended* with face-to-face sessions by local consultants and client MSE's professionals in a BL-type environment. Further, consulting activities may be integrated with multimedia training and hands-on equipment practice or via computer simulation ("equipment or lab virtualization") for better leverage of the solutions to be deployed.
ii) Customization and delivery of information and assistance on Supply Chain Management (SCM) for niches of interest (IT, agribusiness…) – for PPL activities, MSEs need to know which and where major suppliers are out there; supplying conditions (quantity, quality, shipping, price, payment, maintenance & support, returns); etc. Delivery of such information may be done using a blend of media, as an e-learning experience or even by underpinning consulting services.

B) **Training:** face-to-face, online or blended-type courses on PPL aspects. Courses may be offered asynchronously or synchronized with consulting activities and may include visits to and exchanges with centres of excellence in PPL (Pisano, 2010) and on-the-job training. Interviewed MSEs have demanded courses on "SCM for MSEs", "PCP for MSEs", "3D Prototype Modeling/3D Computer-aided Design" and "Additive Manufacturing". The SCM course, which has already been offered and evaluated (see 5. Validation), consists of a blended training-consulting solution comprising a 6-hour classroom experience, 8 hours of Web-based activities and a 4-hour web consulting session for on-the-job applications. Participants were taught about SCM concepts and software and integration to Enterprise Resource Planning (ERP) modules. Consulting through Skype and Web video conferencing was brought in to explore ERP issues. Web activities consisted of attending Webinars from software suppliers and discussion with instructors (similarly to blended consulting) and (asynchronously) watching videos on supply chain business processes.

C) **Missions, Events and Shows:** organizing and charging for MSEs' joint participation in business missions and in PPL events and shows, even asynchronously from training activities, is a way to strength and expand PPL professional networking, enhance MSEs' awareness and self-reliance towards PPL activities and reduce costs.

D) **Infrastructure and equipment sharing:** the Centre will arrange for client MSEs to share (rent) PPL labs, workshop and equipment (ex., CNC

lathe, 3D printer). It may provide its own facilities (it is setting up an additive manufacturing lab), or collaborate with partner institutions such as local universities or manufacturers which may have PPL lab/equipment spare capacity to share. Sharing postpones capital outlay by MSEs and improves partners' resource utilization (and hence, their ROI). If sharing is done over the Internet, one gets virtualization of workshop activities (e.g., 3D design or additive manufacturing) or equivalently, a *blended* lab (Campoy et al., 2011) or workshop.

5 PRELIMINARY VALIDATION

The proposed PPL Centre is in its early stages of existence. Work to bring its specification closer to market reality and to validate its results is on-going. Preliminary validation efforts however, provide evidence the Centre is (already) useful to MSEs. Evidence is in the form of face validity perceptions of entrepreneurs; evaluation of adequacy and usefulness of training services; and, a case study of provisioning blended consulting services.

5.1 Face Validity Test

We say the PPL Centre has face validity if it "looks like" it is going to lead to a positive answer for the research question (RQ) in section 1.

To test the Centre for face validity, we conducted a survey research (Denzin and Lincoln, 2005) with 22 professionals who represented or worked with over 300 MSEs: the 7 interviewed executives (section 3); 3 professionals from the Brazilian Agency for MSEs (Sebrae); 6 from PaqTc's incubator; and, 5 independent PPL consultants and practitioners. After a presentation on the PPL Centre, the surveyed professionals were asked to comment on the service specification and to indicate what they thought the answer to the RQ would be.

After suggesting minor adjustments to the specified services (incorporated in section 4.1 already), the respondents, unanimously, gave "yes" as an answer (the corresponding Guttman scaling was "Yes", "No" and "Not sure"). Again, note that face validity means that the PPL Centre's blended services "look like" they will work, as opposed to "have been shown to work". Some evidence to the latter is detailed next.

5.2 Evaluation of a SCM Blended Course

Twenty eight professionals from 20 companies of varying sizes (from micro to very large) and industries participated in the BL-based course on SCM (subsection 4.3B) in September 2012. After completing the course and seeing a presentation on the Centre's services, they were asked to answer the research question and to evaluate the SCM course contents and its BL delivery approach.

They were unanimous in responding the research question positively; and, 90% of them said the course contents and blended training/consulting delivery method were "good or very good" (from a "very bad, bad, average, good and very good" set of Linkert options); the remaining 10% opted for "average". Comparison of results from non-BL classes on SCM taught three times previously indicate a higher satisfaction level with the BL-based SCM course mixed with blended consulting: "…more motivating and effective than just the traditional classroom-only or BL-only approach".

5.3 Case Study of Blended Consulting

As a start-up in North-eastern Brazil, RG Electronics (RGe) innovated on special effects pedals for electric guitars. RGe faced difficulties in producing the pedals; difficulties worsened as the company incorporated new products in its portfolio.

An ad-hoc team of 3 independent consultants was assigned to serve RGe. Consultants worked for free (but could have negotiated some sort of compensation). Work sessions were conducted in a blended manner: face-to-face and through the Internet and phone. Early (physical) visits to RGe revealed a recently hired production team with experience in circuit board assembly and tests but no experience nor knowledge on production planning and management. In fact, the production environment was shared with other company's activities and the CEO functioned as PPL fire-fighter frequently, which led to inefficiencies.

The consulting team recommended RGe's production professionals take the "PCP for MSEs" course (subsection 4.3B) and RGe appoint a production manager (other than the CEO). In addition, they also identified other barriers – namely, just-in-time or "sales-synchronous" production; M&S team and partners' compensation policy – which needed addressing to minimize negative impact on production. Financial barriers were eased with sponsorship arrangements that consultants

made for RGe to participate in trade and innovation shows in other regions of Brazil – from where the company engaged in regional M&V actions and in contacts with suppliers. Two months after consulting with the PPL Centre, RGe's CEO stated that "the company is now better organized and production is running more smoothly". When answering positively the RQ, he also indicated the "blended services will have a long-lasting, positive contribution to other MSEs in major PPL aspects".

6 CONCLUSIONS AND RECOMMENDATIONS

The main contribution of this position paper was the proposal for blending training and consulting services for effectively and economically dealing with prototyping, production and logistics (PPL) problems at micro and small enterprises (MSEs). Blending is enacted here in the more traditional way of blended learning (BL) which uses multimedia delivery and also in mixing and complementing training with consulting (and vice-versa) and integrating that to information sharing and infrastructure virtualization.

The proposal was investigated as to its adequacy and usefulness to MSEs through a preliminary validation effort. The results are encouraging and albeit their little statistical significance, they suggest that the research question may be answered positively – i.e., that it is possible to specify and provide a blend of training and consulting services with support from BL-like infrastructure virtualization to provide effective solutions to MSEs' PPL problems at low costs.

Upfront economy in executing designed solutions ("use of additive manufacturing" for instance) is made possible by fostering a community of risk-seeking consultants and by sharing (possibly through virtualization and renting) underutilized PPL facilities from partners.

The proposed blended service approach seems naturally more comfortable for clients, better performing and more economical. In the case studied, it was less costly (fewer trips and physical meetings) and faster (no displacement overhead for the involved consultants). We recommend it be tried in incubator settings where MSEs have to be assisted but have a small capacity to pay for services. On-going work will further investigate the validity of this recommendation.

ACKNOWLEDGEMENTS

We thank executives in the investigation of section 3, all those in the initial validation campaign and anonymous referees for their comments and recommendations. This work is being sponsored by the Brazilian Research Council (CNPq) under contract No. 554373/2010-6.

REFERENCES

Bersin, J., 2004. *The Blended Learning Book: Best Practices, Proven Methodologies, and Lessons Learned*. John Wiley & Sons.

Brandt, B. F., Quake-Rapp, C., Shanedling, J.., Spannaus-Martin, D., Martin, P., 2010, *Blended Learning: Emerging Best Practices in Allied Health Workforce Development*, Journal of Allied Health, Vol 39, No 4, e167-e172.

CSEDU, 2009-12. Proceedings in www.informatik.uni-trier.de/~ley/db/conf/csedu.

Campoy, A. M., Campelo, J. C., Serrano, J. J., Alonso, M., Coll, S., 2011. *Practical Student Teaching through Integrated True, Virtual and Remote Laboratories*. In CSEDU 2011, 3rd International Conference on Computer Supported Education, 382-385, SciTePress.

Denzin, N. K., Lincoln, Y.S., 2005. *The Sage Handbook of Qualitative Research*. 3rd ed. Sage. ISBN 0761927573

Garrison, D. R., Kanuka, H., 2004. *Blended learning: Uncovering its transformative potential in higher education*, Internet and Higher Education 7 (2004) 95–105, Elsevier.

Glenn, J. C., 2009. *Collective Intelligence - One of the Next Big Things*, Futura 4, Finnish Society for Futures Studies, Helsinki, Finland.

Internexia, 2011. *Blended Learning for the Time-Starved Employee*, http://www.internexia.com/index.php/news, accessed Sept. 30th, 2012.

JALN, 1997-2012, Journal of Asynchronous Learning Networks, Volumes 1-16.

Hon, M. B., Staker, H. C., 2011. *The Rise of K12 Blended Learning*, In pdf from www.innosightinstitute.org, accessed Oct. 1st, 2012.

Pisano, P., 2010. *Innovation by Collaboration among Firms. A New Methodology - Building Theory from Case Study Research and Simulation Models*, In CSEDU 2010, 2nd International Conference on Computer Supported Education, 106-113, SciTePress.

Rouvrais, S., Maille, P., Gilliot, J. M., Madec, G., Guyomar, A., 2005. *Migrating Learn-by-doing Engineering Curricula to Blended Learning*. In World Conference on Educational Multimedia, Hypermedia and Telecommunications 2005, 4053-4058.

Spohrer, J., Cassidy, K., 2012. *Blended Learning in a Liberal Arts Setting: Preliminary Findings*, In Symposium by National Institute for Technology in

Liberal Education (http://symposium.nitle.org).
Tiwari, R., Buse, S., 2007. *Barriers to Innovation in SMEs: Can the Internationalization of R&D Mitigate Their Effects?*, In Proceedings of the First European Conference on Knowledge for Growth: Role and Dynamics of Corporate R&D (CONCORD 2007).
Work Write, Inc, 2012. www.workwriteinc.com, accessed Sept. 27th, 2012.