PROCURING FOR INNOVATION: THE INTEGRATING ROLE OF INNOVATION IN CONSTRUCTION PROCUREMENT.

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Innovation has been one of the key issues in recent business and research agendas of business organisations and all their stakeholders. Meanwhile, a number of reviews around the world have raised grave concerns on the state of the construction industry. The perceived dearth of R&D activities and innovations is often cited as the main issue that has stunted the development of construction organisations. Recent research has argued that the development process in construction from concept, to detailed design and construction is akin to the process of using R&D to deliver successful innovations in manufacturing industries. This paper develops and compares two models describing the organisation and process of innovation and that of construction procurement. The study shows that one of the key differences to be that the development of the "idea" of the new product in manufacturing has the ability to generate a centrifugal force that would pull together several competing paradigms. The fact that there is no "captured" customer in the manufacturing industry as in construction seems to pull the different parties and disciplines together more strongly in order to ensure a successful product. This points to the potentially integrative benefits of innovations in construction procurement systems in the first instance; and secondly across related operational, educational-training and technological systems.

Keywords: creativity, group dynamics, innovation, procurement, risk.

INTRODUCTION

Innovation has been given increasing importance in business and research agendas of commercial and manufacturing organisations. Meanwhile, construction industry reviews in many countries continue to highlight serious deficiencies and inefficiencies (Egan, 1998, Construction Task Force, 1999). The observed scarcities of R&D activities and innovations are seen as significant barriers that restrict the development of the construction industry.

Recent research has shown that the development process in construction from concept to detailed design and construction is similar to the process of progressing from R&D to successful innovations in manufacturing scenarios (Dulaimi et. al. 1996). It has been argued that the structure and organisation of activities in an R&D environment are comparable to existing project organisational models and procurement frameworks deployed in construction projects.

Both processes, essentially, aim to find a solution to a problem or a need. They also share similar aspirations. Liker et. al (1999) argue that the main issue in product development in the manufacturing industry is "reintegrating" what has been divided as organisations and their products become more complex. They also argue that the

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bringing together of design and manufacturing processes used to occur, at the early stages of industry, inside a single mind. The issue of integration of the design and manufacturing is evidently fundamental to the realisation of a successful innovation.

This paper will examine both a manufacturing/business model of product/process innovation and that of construction procurement. The aim is to set an agenda for a planned research project that will bridge the gap between these two models. The first part of this paper focuses on examining the experience of innovation in the manufacturing and business organisations. The second part of the paper revisits the rationale in developing construction procurement frameworks and the advantages of injecting integrative innovations.

DISSECTING INNOVATION

The realisation of new ideas in general industry scenarios results from the collaboration of two very diverse operations: R&D and manufacturing. These two operations occur in two very different environments. Those involved in the R&D phase work in an environment that fosters creativity and innovation. This environment also allows greater tolerance to uncertainty and risk. Greater effort is made by management to break down barriers, such as concerns for “this is not how we do things here”. On the other hand, the manufacturing/production phase environment is considerably constrained by details and the need to meet deadlines and budgets. Precision planning and programming activities dominate operations by technicians and professionals in this phase.

The above description suggests that the two phases are independent with different management organisations, cultures and styles. The successful management of the development and production of new products would require integration of the two phases with management appreciating and synergising the different cultures and styles. In managing innovation the organisation will need to link the two phases without stifling innovation and at the same time not losing sight of the needs of the future product. The new idea will need to cross successfully from R&D to manufacturing. Assigning each phase to a separate organisation, with different management priorities and objectives, will create several problems in the effective transfer of the new technology. For organisation “A” to develop the design or the concept of a new product or technology and then ask organisation “B” to produce or use the new technology or product would increase the risk of failure of this innovation. Being new and innovative the technology maybe viewed by organisation B as strange and risky and may in fact increase the risk of failure of the new idea.

To rely on contractual agreements (and corresponding procurement arrangements) to limit their risk, both organisations may face the problem of identifying all potential risk aspects of a new, non-tested product and technology. In a study of such innovation Egbu et. al. (1998) reported the case of a manufacturing company, involved in the production of construction materials, which had to introduce a new automated system. Before doing so the company sent staff to experience and learn how a similar system was being used in another organisation. Those staff will bridge the knowledge gap and address the concerns of “this can not work here”. An alternative strategy for these proposed joint ventures is for both organisations to support each other by making technical, commercial, or managerial information and advice readily available to enhance the chances of success. Hence, managing the

creation and transfer of knowledge within the two 'phases', will be central to the success of the new product or technology.

Is being new always good?
To examine the impact of designing a new product on the manufacturing phase there is a need to investigate the issue of "newness". A growing body of knowledge challenges the traditional view that the newness of the product or technology holds the key to its success. Research has distinguished between newness to the firm and newness to the market (Goldenberg et. al. 1999). Research has also shown that newness to the firm is correlated with failure rather than success (Cooper 1985). Goldenberg et. al. (1999) hypothesised that the market favours innovative products that require adjustments to produce them. This is important to the above argument regarding the relationship between organisations A and B, i.e. the designer and manufacturer. Significant efforts are needed in the introduction and sharing of the knowledge and new ideas generated by organisation A in order for them to be adopted and developed successfully by organisation B.

THE EVOLUTION OF PRODUCT DEVELOPMENT

The role of R&D in product development should not end until the end of the whole product development process. However, this role will start to phase out in the cross over to the manufacturing/production phase. Hence, the continuous improvement role of R&D should be integrated with the manufacturing process to ensure improved quality, value and continuous assessment of the product design in the light of market and technology development. Such improvements will ensure extended life and viability of the product, as well as increased customer satisfaction. Figure 1 explains the different phases of evolution of a new product or process. The step-by-step description of the development process here is mainly to explain the different activities and their relationships. In practice there will be elements of marketing and manufacturing during the opportunity identification phase as well, for example. Similarly, R&D inputs will continue, although with more constraints into the technical development stage.

COMPETING PARADIGMS

The cultural difference between organisation A (responsible for the development and design of the new product) and organisation B (responsible for manufacturing the new product) is evident. There is evidence of the high cost in failing to effectively integrate design and manufacturing (Susman and Dean, 1992). This cost can be associated not only by failing to develop the best design of the product that can be efficiently manufactured, but also by the inability to market and deliver the new product to the customer as fast as possible, at the right time, and before competitors.

Drawing parallels with the construction industry, the development of the design and the construction of a building or structure requires the coming together of different groups and organisations. One of the main challenges to success will be whether this network of organisations will facilitate or hinder the development of more innovative solutions. There would be several competing paradigms that tend to dominate and influence the structure, attitude and practices deployed on a particular project or manufacturing/ commercial scenario (see Figure 2). The main assumptions of each paradigm would direct organisations to achieve best performance by giving priority to their particular aspects of project development. For example, the main assumption in

the legal and contractual paradigm is that to ensure a successful project would require the development of contractual relationships and document(s) that clearly identify the rights, obligations and roles of the different parties. In examining the innovation process, the centrifugal force created by the innovation champions will need to bridge the gaps between these competing paradigms. In doing so there is a need to address the differing thrusts of the organisations functioning under these paradigms. Such differences will also translate to differing cultures.

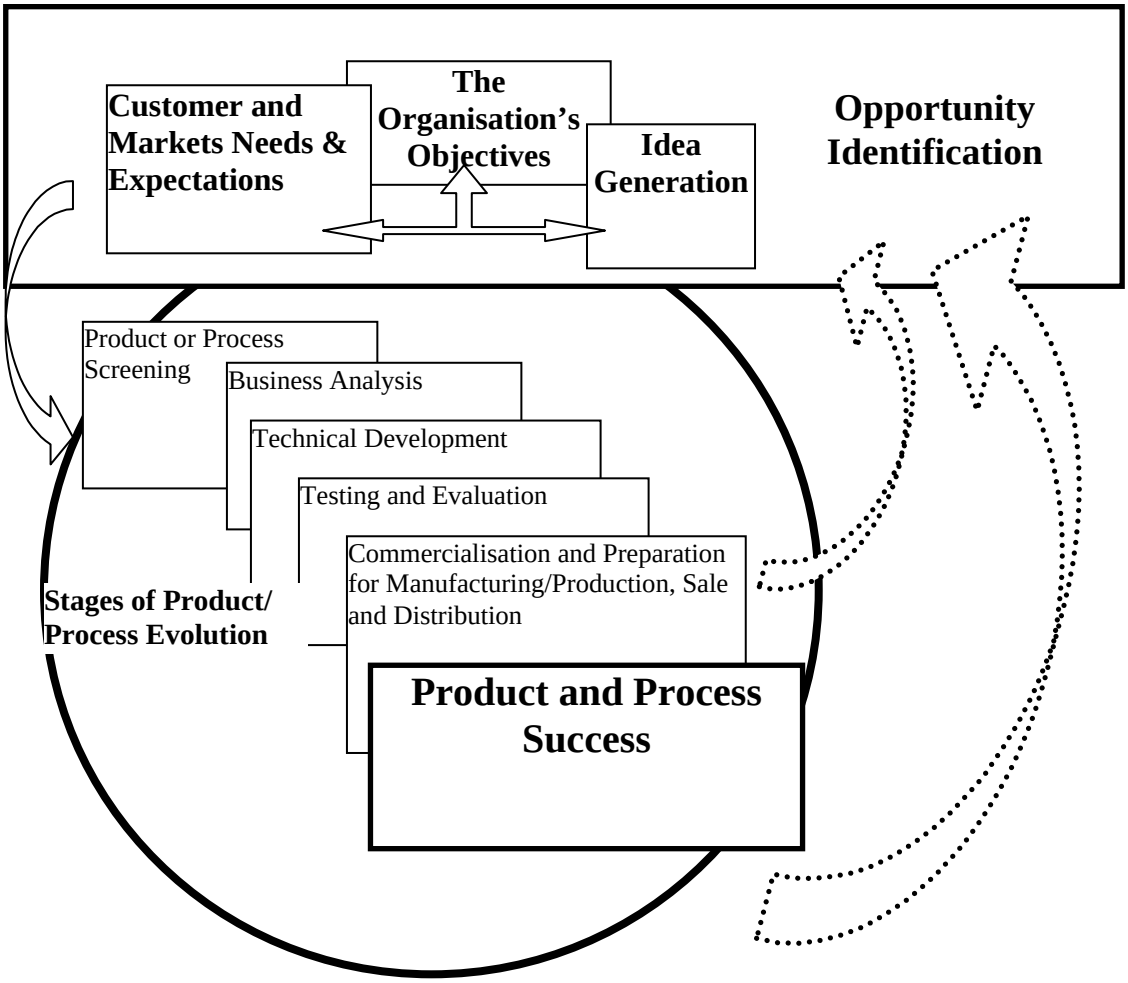

Figure 1: Outline of Product Evolution

One way to distinguish between the functioning of the different groups is to use the "organic" vs. "mechanistic" categorisation (Burns and Stalker, 1961). The advocates of the mechanistic approach will argue "*standardisation helps provide control over the development process to keep costs and production development to a minimum, while enabling organisational learning across product generation"* (Leonard-Barton, 1992; Ward et. al., 1995). However, organic practices "*provide the social integration necessary to overcome barriers segregating functional specialists from one another and are especially needed to the extent tasks are dynamic, innovative and novel"* (Liker et. al. 1999). Figure 2 indicates that the main challenge during the product development cycle is the re-integration of the different groups/organisations. Liker et. al. (1999) have criticised the lack of research into how cross-functional integration affects performance at later stages of the new product development. Hence, the challenge will be *"technical embodiment of standardisation at mid-stream of the*

development process so as to encourage constructive adaptation of creative ideas in anticipation of the realistic capabilities of downstream processes" (Nevins and Whitney, 1989). This may be perceived an imposition of a restraint on creativity. However, such imposition is 'mid–stream' in the cycle, where the product has to go through screening, business analysis and testing (see Figure 1), rather than during idea generation.

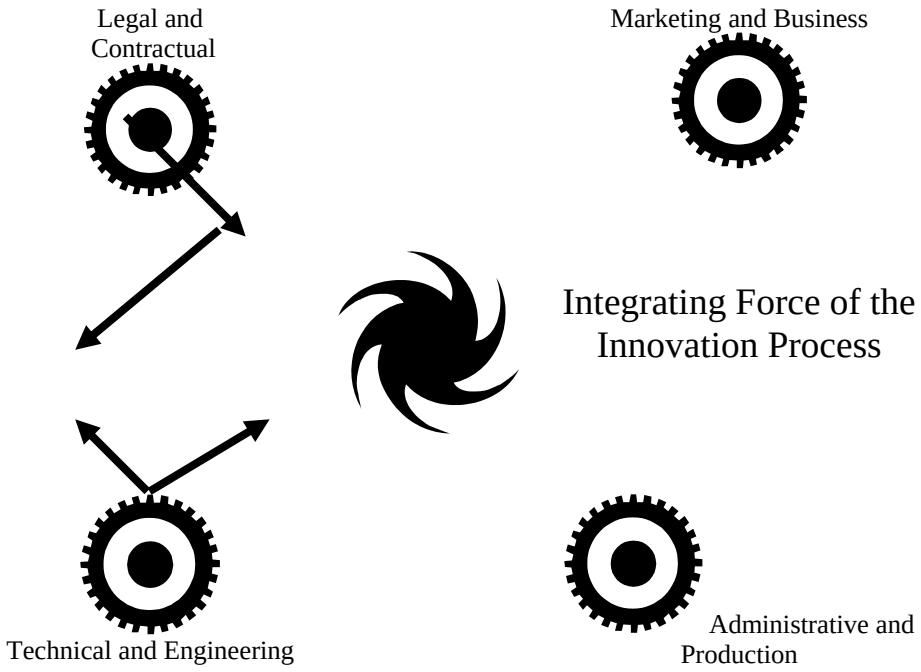

Figure 2: The Competing Paradigms in Product Development

A further challenge will be for the groups and organisations involved down-stream of the development process. Such groups will need to increase responsiveness to the needs of the design engineers to rapidly differentiate their product from those of their competitor. *"To accommodate new and redesigned products, manufacturing operations are often transformed to flexible, pull systems with small runs so product can be redesigned to meet changing customer requirements with minimal tooling time and cost"* (Anderson and Pine 1997). From the above it can be argued that the re-integrating force will need to pull the competing paradigms to subscribe to a pragmatic and dynamic middle ground that requires the different groups and organisations to recognise the fact that to achieve their own objectives, 'space' must be found to allow the competing paradigms to coexist.

SHIFTING PARADIGMS IN CONSTRUCTION PROCUREMENT

Barriers to Innovation in Conventional Procurement Systems

'Master Builders' who conceived, designed, procured materials for, and organised the construction of impressive structures not so long ago, were apparently quite innovative. Surviving evidence of the diversity of designs, and also of construction methods, testifies to their initiative. The paradigm shift that later separated design from construction skills was mainly driven by great expectations of achieving significant efficiencies through specialisation. Unfortunately this also led to a degree of standardisation that has stifled innovation in general.

Furthermore, contractual frameworks that were erected to support these segregated services, further polarised the service providers, for example by creating climates of mistrust and providing for rigorous 'policing' of contractors in a vicious cycle, based on assumptions that their interests would always conflict with those of the client in a 'zero-sum' game. Risks were imposed through increasingly rigid contract documents. These were periodically tightened to plug any 'loop-holes' that had led to claims and disputes, pitting clients and their consultant designers/supervisors against contractors in, often, bloody battles that debilitated the industry.

Such developments raised further barriers against potential innovations by discouraging avoidable risks that may lead to claims from the 'other side'. Risk averse and adversarial attitudes thus restricted 'journeys' to well-trodden paths, deterring detours that may have otherwise improved technologies, encouraged innovations and significantly boosted managerial efficiencies.

Yet another facet of this procurement paradigm that stunted the development of industry systems was the 'lowest price' selection criterion that supposedly extracted efficiencies from contractors. This criterion now often dominates the selection of designers as well, although 'technical' capability/potential is theoretically assigned the higher weighting. This raised a third set of barriers to innovation. Such barriers also explain the relatively low expenditures on R&D in the construction industry (Ofori, 1997; Kumaraswamy, 1998). Long-term improvements were sacrificed on the altar of short-term cost slashing that left little time for experimentation with innovative ideas.

Pendulum swing back towards Integrating Construction Services

The 'divorce of design from construction' was lamented as far back as the 1960's, for example in the Banwell Report on the UK construction industry. Adversarial attitudes generated many problems and militated against the multi-disciplinary teamwork that was needed to handle the usually complex construction projects. A re-integration of the principle construction services through single-source 'Design & Build' became increasingly popular and was even advocated in governmental policy statements (e.g. in the Hong Kong Financial Secretary's Budget Speech in October 1993) and high powered recommendations for industry improvements, as for example in a 'strategic thrust' (one of six) towards 'an integrated approach to construction' (Yuan *et al.*, 1999). Further integration of downstream and upstream links in the supply chain was seen in the resurgence of BOT (Build-Operate-Transfer) or PFI (Private Finance Initiative) type public-private partnerships. These ventures dovetailed the upfront 'financing' and downstream 'operation' functions into the design and construction package.

However, these arrangements are not without their disadvantages, and so cannot be deployed on all projects. Furthermore, the hasty assembly of temporary joint ventures for Design & Build or for special purpose consortia to handle BOT projects does not contribute significantly to long-term institutional development or 'knowledge' assimilation. It has also been alleged that clients may see these methods as mere opportunities for 'risk-dumping' (Hemlin, 1999), for example through single-source combined services. It is therefore argued that meaningful and effective re-integration has yet to be achieved. Gaps and shortfalls arise, for example, from rigid mind-sets and perpetuated perceptions on 'pre-ordained' roles of designers, supervisors and constructors in conventional systems.

Apart from the foregoing moves towards functional integration in the construction supply chain and corresponding adjustments in contractual frameworks; fresh non-

contractual approaches towards team integration have been initiated. 'Partnering' is perhaps the most prominent of such recent initiatives, having been extensively adopted in countries ranging from USA and UK to Hong Kong and Australia. While partnering has met with varying degrees of success, it is generally accepted as a valuable approach to re-integrating polarised project participants. However, potential benefits will not be realised unless it involves the entire supply chain, including sub-contractors. Partnering shortfalls in this context are cited in a case-study by Dissanayaka and Kumaraswamy (1999), while a case-study of good partnering practice in selecting and mobilising sub-contractors is described by Kumaraswamy and Matthews (in print). Such an extended partnering philosophy is a corner stone of an ongoing Hong Kong Housing Authority initiative to revamp its entire procurement system following scandalous quality and supervision shortfalls on a few recent projects. The 'establishment of a partnership culture' is one of 'six main issues' in the first phase of a two-phase implementation of a 50-point plan announced in April 2000.

INTEGRATING INNOVATIVE PROCUREMENT WITH OTHER SYSTEMS

Integrating Procurement and Operational Systems

It should be noted that procurement systems are conceptualised in a broader sense, as 'the framework within which construction is brought about, acquired or obtained' according to the general definition of the CIB (Conseil International du Batiment) W92 Working Commission on 'Procurement Systems'. In particular, Kumaraswamy (1999): (a) modelled procurement systems as incorporating five principal sub-systems of Work Packaging, 'Functional Groupings' (e.g. between design, construct, supervision and project management functions), 'Payment Modalities' (e.g. whether lump-sum, re-measure etc.), Contract Conditions and Selection Methodologies (of selecting the various project groups); and (b) reported recent research confirming that the judicious selection of an appropriate procurement system for a given new project (from the choice and assembly of appropriate options within each sub-system) is not enough by itself to ensure project success. While necessary, it is insufficient.

Appropriate procurement protocols must be synergised with suitable operational systems for planning, co-ordination and control. The operational systems themselves must be integrated with each other, to avoid failures witnessed with attempts to 'bolt-on' separate safety or quality sub-systems to existing operational systems, in knee-jerk responses to sudden demands for improved safety or quality (including ISO 9000 certification). Innovations in procurement and operational frameworks must necessarily 're-engineer' the whole system, targeting improved productivity and quality, while reducing claims, disputes and health, safety and environmental hazards.

Integrating Innovations through IT

Exploding IT capabilities facilitate such integration that may have appeared a formidable undertaking just a few years ago. The development of knowledge-bases of available procurement options and their performance potential has been shown to assist in more rationalised selection (Kumaraswamy, 1999), while similar assistance is advocated for integrating suitable operational systems. Instantaneous electronic data interchange; multi-media aids, real time project information management systems and virtual reality tools have opened up a multitude of integration opportunities through innovative knowledge management (INCITE, 2000).

Integrating Innovative Initiatives

Significant performance gains, while considered possible, have long eluded the construction industry (Kumaraswamy, 1998). It is postulated that the drawing together of the threads traced in this paper produces a 'roadmap' for reaching this long targeted bottom line as in Figure 3. Innovative initiatives in procurement systems, operational systems and construction technologies are insufficient by themselves. They need to be developed synergistically, while being incorporated in 'bottom-up' educational and training programmes. The latter are important in transforming ingrained 'cultures'/mind-sets. Well-established linkages of R&D to production in manufacturing industries

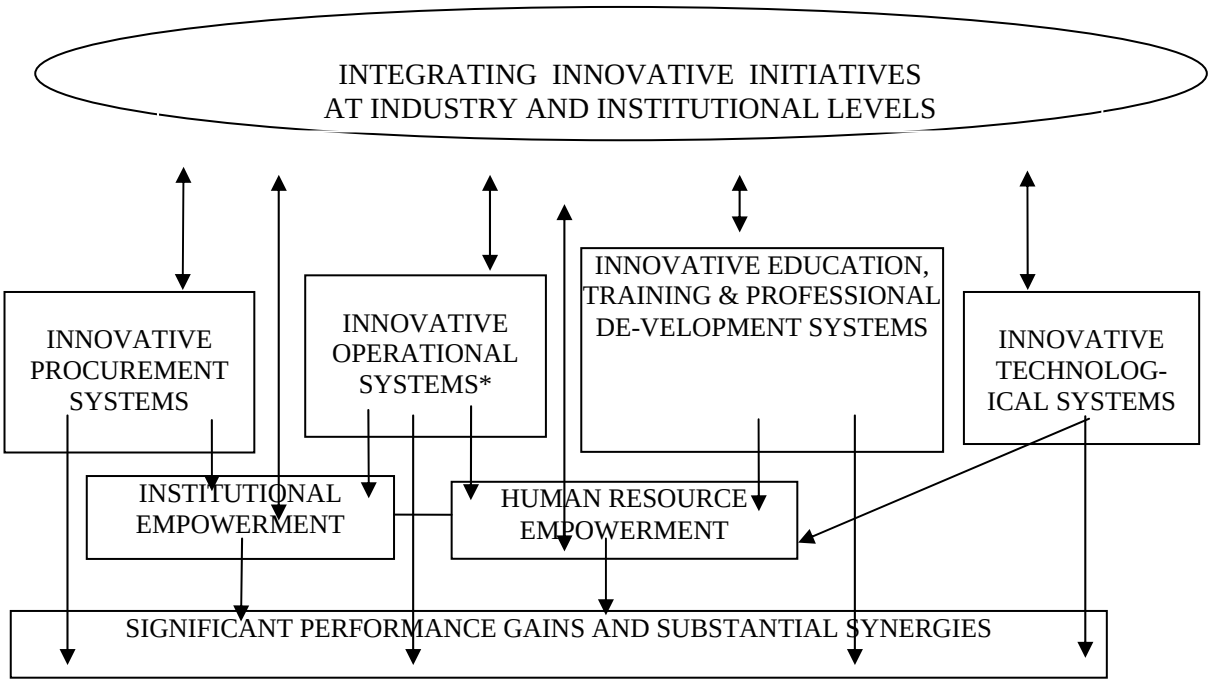

Figure 3: A basic Model for integrating innovations in institutional and industry development

Operational Systems such as for: Planning and Control, Information management, Quality management, Safety management, Environmental management, Dispute reduction

provide excellent parallels that may be adapted for construction scenarios. Furthermore, it is postulated that innovative procurement itself would provide the foundation for the model shown in Figure 3, given its significance in initiating and therefore determining the contours of the entire project system. Institutional and human resource empowerment is envisaged through the interactive innovative initiatives, leading synergistically to the long awaited leaps in industry performance levels.

DISCUSSION AND CONCLUSION

Business organisations face increasing pressures to be more effective and efficient in order to survive. The need for such organisations to enable their employees to be more creative and innovative has propelled the shift towards knowledge creation and knowledge sharing. Significant differences were noted between the innovation model in a manufacturing setting and that of traditional construction procurement. Figure 2 showed that the generation of a new "idea" and the development of a new product in manufacturing can create a centrifugal force that pulls together the different

organisations, groups and disciplines that work and function under differing and competing paradigms. The main driving force, hence, is the common goal created by the need to ensure the success of this innovation. However, such success cannot be realised until this collaborative network of alliances can deliver a final product that is marketable in attracting customers.

The construction industry has seen process innovative product development restricted mostly to the early stages of the construction process. The approval of the design by the "captured" customer is paramount. This seems to reduce the ability of the "idea" itself to influence the development process. Instead it creates a vacuum that would be filled by the most politically powerful individual/party, which may lead to an unhealthy domination of one paradigm over the others. For example this may lead to over-emphasis on rigorously defined risk allocations via rigid contract documents. However, to over-emphasise one aspect alone is futile. Integrated development is needed - synergising innovative procurement, operational, education-training and technological systems. The integration of sub-systems and functions within procurement itself (such as of design, construction, financing and operation functions), is seen to be sorely in need of fresh inputs. Such inputs are in turn seen to be forthcoming from the integrative impetus of innovative ideas in manufacturing scenarios, as exemplified in the smooth transition and close interactions between R&D, production and marketing.

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