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**Learning and Local Knowledge Institutions  
in African Industry**

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# LEARNING AND LOCAL KNOWLEDGE INSTITUTIONS IN AFRICAN INDUSTRY

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## Abstract

Drawing insights from firm-level survey, this paper addresses three broad issues relating to the role of learning and knowledge in African industry. First, we examined modes of learning proxied by training in small and medium firms. We found that elementary learning mechanisms such as apprenticeship, resulting in the creation of tacit knowledge, are the dominant forms of learning. While knowledge externalities tend to benefit larger firms, small enterprises with little absorptive capacity are locked into repetitive routines of learning-by-doing and disconnected from both local and global knowledge pools. Second, we looked at the types and nature of the mix of formal knowledge and human skills possessed by firms and how these impact on the learning process. Management and technical training are mostly conducted in-house and are correlated with firm output and export performance. The level of resources devoted to training also correlates with performance. Thirdly, we examine the effect of interaction of local knowledge institutions and small and medium producers to generate autonomous technical dynamism. While small firms collaborate with suppliers and industrial associations, interaction with 'knowledge creators' such as universities is insignificant. We suggest that economic policy has a role to play in stimulating dynamic learning in firms.

*Keywords: knowledge, tacit, codified, small firms, and institutions, Africa.*

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## 1.0. INTRODUCTION

This paper examines the links between different forms of technological knowledge and the learning processes by which they are created in African industry. The growth of knowledge is related to historically generated learning institutions as well as the depth of available stock of local knowledge.<sup>2</sup> This stock of knowledge could come from outside the national system or be developed through domestic efforts. There are also the so-called 'non-formal' local learning institutions upon which the growth of small firms rely, but which are either overlooked in conventional analysis, or in the extreme, regarded as inferior to formal learning. In this regard, a substantial part of knowledge in modern economies is attributed to measurable codified knowledge while non-formal learning, which is largely tacit in nature but far more difficult to measure, is unaccounted for. For instance, Africa's small firms, rooted in crafts apprenticeship are likely to learn through this kind of knowledge system, and enterprise performance may therefore signal how well such institutions of knowledge are serving the firm. Learning based predominantly on information and knowledge is regarded as the defining concept in a world that is increasingly characterised by rapid changes in the modern sectors.

Forms of knowledge and the relevance of skills transfer processes have been altered significantly by advances in digital technologies as well as by changes in the economic contexts, particularly the liberal regimes of trade and production (Lundvall and Johnson 1994; Johnson, Lorenz and Lundvall 2002; Ducatel 1998). However, debates about the most appropriate mix of skills and the most important sources of knowledge accumulation are likely to continue in the foreseeable future. For instance, discussions on how to assign the relative weights of formal and experiential or non-formal knowledge in firms, underline the conceptual dichotomy of tacit and codified knowledge. Despite the increasing propensity to codify technical functions, tacit knowledge remains an important component not only in the context of traditional sectors and small firms, but a necessary cognitive basis for interpreting codified knowledge including digital and mathematical functions.

We have two motivations for this paper. The first is that all societies no matter their level of development need to process and use knowledge of one kind or another. As Metcalfe (2003)

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<sup>2</sup> However as Lundvall and Johnson (2003) observe, what is important is the process of learning rather than the stock of knowledge. They offered the notion of the 'learning economy', "as an economy where the ability to learn is crucial for the economic success of individuals, firms, regions and national economies...the learning economy is not necessarily a hi-tech economy. Learning is an activity which takes place in all parts of the economy, including so-called low-tech and traditional sectors".

observes, “every economy, always and everywhere, is a knowledge economy; for social systems and economies as social systems, could not be arranged otherwise”. Developing countries are as such not insulated from, and indeed have much more to lose, if they do not engage in the debate and find ways to survive in the new environment. The second motivation stems from the well-debated notion that knowledge growth, validation and transfer is a socially distributed process, mediated by institutions, (Lundvall and Johnson 1994; Metcalfe 2003, Ducatel 1998). Our concern is that African countries have embryonic, or poorly functioning science and technology institutions and in a number of important areas, none at all. Indigenous knowledge systems such as apprenticeship in medicine and manufacturing crafts, that once served societies well, have atrophied from neglect or have been swept away by modern techniques. Central to this inquiry is the difficult process of transforming what individual scientists, engineers, and craftsmen know into what one may call an *organised knowledge system*. Mokyr (2002) expresses it succinctly: “In the end what each individual knows is less important than what society knows and can do.” Institutions exist precisely for this role, to store, validate, and distribute knowledge. In this paper we concentrate on technological knowledge, its acquisition and the institutions for diffusing it.

The above issues thus beg the following questions: What are the sources of industrial knowledge and skill formation in African manufacturing? What formal and informal systems create industrial human capital? What are the modes of training in firms, and how systemic is human capital creation in manufacturing? How well does the formal educational system prepare the individual for workplace efficiency and is the skill composition of enterprises adequate? This paper is organised as follows: the next two sections present a methodology, define institutions and discuss the types of knowledge and varieties of institutions. Section three provides some evidence of knowledge generation processes in African industry. In section four we employ recent firm-level data to draw a profile of the impact of formal qualification and human skills on the rate of learning and levels of technological capability acquired. The last section concludes and suggests directions for policy.

## **Methodology and Data**

The paper draws from the findings of empirical firm-level studies carried out in the following countries involving over 300 manufacturing firms distributed as follows: Nigeria (129), Kenya (47), Zimbabwe (30). We supplemented our analysis with data collected on a separate study on the nature and learning processes of small firms in the process of adopting information and



communications technologies (ICTs) in Ghana and Kenya. The sectors covered include metalworking, food processing, automotive components and repairs. Response rates to questionnaires vary from 60 to 80 percent. Our primary aim was to understand the nature of small and medium enterprise (SME) learning and performance within a network of other economic actors that support firm-level innovation. The studies were carried out in the different countries in 2001 and 2002.



## 2.0 INSTITUTIONS AND TYPES OF KNOWLEDGE

### **Institutions as Carriers of Knowledge**

The concept of "institution" is often used interchangeably with that of "organisation." While the normative and cognitive aspects of institutions are stressed, greater emphasis is laid on the structural dimension of organisation. Institutions are defined as the 'rules of the game' - they imply routinised behaviour and actions and consist of the "...cognitive, normative, and regulative structures and activities that provide stability, coherence and meaning to social behaviour. Institutions are transferred by various carriers-cultures, structures and routines", Scott (1995).<sup>3</sup> However, technological institutions may be conceptualised either narrowly or broadly. According to Lundvall (1992, p.12), "The narrow definition of institution would include organisations and institutions involved in searching and exploring- such as R&D departments, technological institutions and universities. The broad definition ...includes all parts and aspects of the economic structure and the institutional set-up affecting learning as well as searching and exploring- the production system, the marketing system and the system of finance present themselves as subsystems in which learning takes place."

In both contexts institutions take on the functions of the management of uncertainty, the provision of information, the management of conflicts, and the promotion of trust among groups (Edquist 1997; North 1989).<sup>4</sup> For these reasons, institutions are necessary for innovation for two reasons. First, due to the uncertainty that characterises innovative activities, institutions act to provide stability and secondly, to regulate the actions of agents, and to enforce contractual obligations.

Organisations may be set up to perform technical functions but being embedded in a social context, they take on "value-impregnated status", and in the process of time, their goals or procedures become institutionalised (Selznick, 1949:256-257, quoted in Scott, 2001, p23). Over the past four decades, several organisations for science and technology research and policy have been established in Africa but their objectives remain largely unfulfilled. One explanation for

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<sup>3</sup> Scott (1995) defines organisations as entities set up around definite processes that result in the attainment of particular goals. To this end the structure of an organisation will be shaped by the different functions, roles, and rules that promote good performance.

<sup>4</sup> Coriat and Dosi (1998) refer to the broad meaning of institutions as having three components which are: (a) formal organisations (ranging from firms to technical societies, trade unions, universities, and state agencies); (b) patterns of behaviour that are collectively shared (from routines to social conventions to ethical codes); and (c) negative norms and constraints (from moral prescriptions to formal laws).

the poor performance of these organisations may well be the mechanistic conception that guided their establishment with little consideration for path-dependent parameters defining their evolution.<sup>5</sup> Organisations find their meaning and legitimacy through this process and ultimately support and resources for their existence. As Selznick (1948: pp16-17, emphasis in original) observed organisations are the "structured expressions of rational action" but they are also organic social systems and to that extent, they are transformed over time.

"Institutionalisation is a process. It is something that happens to an organisation over time, regarding the organisation's own distinctive history, the people who have been in it, the groups it embodies and the vested interests they have created, and the way it has adapted to its environment.... In what perhaps its most significant meaning, 'to institutionalise' is to *infuse with value* beyond the technical requirements of the task at hand" (quoted in Scott, 2001: p24).

## **Types of Knowledge**

We follow after the taxonomy proposed by Johnson, Lorenz and Lundvall (2002) (hereafter JLL) that views knowledge in terms of what, who, why and how we know things. In this treatment we focus narrowly on what Kuznets (1965) termed "useful knowledge", by which he meant technological knowledge as the source of modern economic growth<sup>6</sup>. JLL identified four forms of knowledge namely, 'know-what', 'know-why', 'know-how', and 'know-who'. At the organisational level these categories of knowledge translate into 'shared information databases', 'shared models of interpretation', 'shared routines' and 'shared networks'. Know-what refers to knowledge about facts, which is largely codified, while know-why is the knowledge of principles, rules, and ideas of science and technology (S&T). This form is in the main codified but relies considerably on tacit knowledge for interpretation particularly at the level of individual understanding. Know-how is the skill and knowledge of doing things reflected in such activities as industrial production and due to the process of acquiring it, has a significant tacit component. Lastly, know-who is the knowledge of individuals gained through shared social interactions and networking. Mokyr (2002) confines his analysis to 'know-what' which he defined as *propositional* knowledge<sup>7</sup> which can be used to create 'know-why' or instructional

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<sup>5</sup> According to Parson(1956), organisations are differentiated vertically into three broad but distinct levels, namely, the technical that does production; the managerial, that is concerned with control, co-ordination and resources and product procurement; and lastly, the institutional. The last function relates the activities of the organisation to the norms and convention of the community and society in which it is located.

<sup>6</sup> See Mokyr (2002), *The Gifts of Athena: Historical Origins of the Knowledge Economy* for a seminal treatment

<sup>7</sup> Know-what according to Mokyr (2002) takes two forms: "one is the observation, classification, measurement, and cataloguing of natural phenomena. The other is the

or *prescriptive* knowledge, otherwise called, techniques. What this means is that know-what (*episteme*) provides the basis for know-how (technique)<sup>8</sup>; for instance to translate a model or invention into practical instructional manual. One knowledge form would feed on the other. Table 1 presents the taxonomy.

Table 1: Learning Processes and Types of Knowledge

	<b>Know-What</b>	<b>Know-Why</b>	<b>Know-How</b>	<b>Know-Who</b>
Knowledge Type	Codified	Codified	Tacit	Tacit
Sources	Facts & Information	Scientific principles and laws	Skills acquired through experience	Developed and maintained through personal contacts in research groups and production networks
Transfer Processes	Formal joint venture patents	Formal Books, journals	Non-Formal Formal Learning – by practising/production design Reverse engineering Apprenticeship	Non-Formal Networking, face-to-face contacts, joint research/production; exchange of personnel; professional association, Apprenticeship
Learning context	Digital libraries Formal Institutions (schools)	Digital libraries Formal Institutions	Workplace Research and Training Centres	Workplace Research/Training Centres

This way of looking at knowledge has several implications for transfer mechanisms, and for the development of institutional forms (formal education, the role of firms, and training). Ducatel (1998) talks of the learning triangle consisting of theoretical, vocational and experimental forms, which translated to institutional terms suggests a closer interaction between formal schooling and workplace training. For African countries there are four broad implications. First, a large part of knowledge in these societies is tacit in nature; African societies thrived on oral history and most techniques are passed on from master craftsman to the apprentice. Even if it is hardly acknowledged in official documentation, a significant amount of learning takes place through this institution of apprenticeship and for much of history, knowledge of nature is regarded as a set of secrets to be passed on to the ‘chosen’, mostly

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establishment of regularities, principles, and ‘natural laws’ that govern these phenomena and allows us to make sense of them. Such a definition includes mathematics insofar as mathematics is used to describe and analyse the regularities and orderliness of nature.

<sup>8</sup> “Techniques are the fundamental unit of the technological knowledge set. They are essentially sets of executable instructions or recipes on how to manipulate nature, much like Nelson and Winter’s ‘routines’. When these instructions are carried out in practice, we speak of production

offspring. Second, there is a dearth of institutions dealing with the codification of traditional knowledge. . Third, orthodox measurements of knowledge generation and flows concentrate largely on measurable data such as patents, scientific publications, and R&D statistics. These practices, having been adopted by developing countries policy making and scholars, tend to underrate institutions of apprenticeship with a vast knowledge base that is largely tacit. Attention is focused on formal schooling such as universities to the exclusion of enterprise level skills and traditional crafts. Fourth, while scholars and multilateral organisations call for increased investment in knowledge of the type that is rewarded with certificates, the precise mix of such skills, while admittedly important, is not specified and the tendency is to assume that formal training is all that developing countries require. On the contrary, the skills required for building modern economies are far more complex and cannot all be acquired through formal schooling. Ducatel (1998) identified seven sets of skills namely: (1) the capacity to manage models mentally; 2) the workings and interactions of machines; (3) the capacity to make inferences from statistics; (4) willingness to take responsibility for work process and products; (5) oral and visual communication capacity; (6) combining technical and business skills; (7) ability to make good judgements. These skills cannot be acquired through formal schooling alone, but they are extremely important for industry.

### **Varieties of Learning and Local Knowledge Institutions**

Non-formal learning, which often takes the form of learning-by-doing is an important component of human capital, but this is particularly so in economic contexts where traditional craftsmanship, often acquired from apprenticeship, predominates. Knowledge of production, which is largely tacit, relies largely on the skills (know-how) of workers although skill itself draws on know-why to find reasons for particular procedures or routines.<sup>9</sup> In this paper we will examine in some depth, the nature, prevalence, and role of apprenticeship, and the links with tacit knowledge in promoting learning in firms.

Tacit knowledge is built up from considerable practice and accumulated experience in narrow tasks, for instance by an apprentice learning from the master. For this reason it is idiosyncratic but not necessarily inapplicable to other situations. For instance a great many people use the computer to perform quite complex operations yet cannot define what an operating system

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and they are no longer knowledge but action. It is comparable to DNA instructions 'being expressed' Mokyr (2002).

<sup>9</sup> A metallurgical technician could mix iron ore, coal and other materials under the right kind of temperature and obtain molten iron without a knowledge of why this reaction had taken place. Yet skill is not the domain only of technicians; an accomplished mathematician requires

means, neither is it necessary for individuals to be able do so. There are many dimensions to tacit knowledge<sup>10</sup> but much of the tacit knowledge in firms is transformed into organisational routines<sup>11</sup> (Nelson and Winter 1982). Routines are regularities and predictable patterns of behaviour. In small firms, the owner/manager tends to define and exemplify the nature of routines. In apprenticeship institutions, the master personifies the routines, and determines the culture, and rates of transferring, these largely "hard to pin down skills" to learners.

The nature of tacit and codified knowledge brings us to the issue of formal and non-formal institutions. As Stiglitz (1999) argued, developing countries need to formulate effective ways to promote *local knowledge institutions* because clearly "the overwhelming variety and complexity of human societies requires the localisation of knowledge. Practical know-how is largely tacit knowledge that needs to be learned by horizontal methods of twinning, apprenticeship, and seconding". There is a clear distinction between global public goods and local knowledge and for this reason, every society should be active in strengthening local knowledge institutions to drive the local learning process. In transforming codified global knowledge to local use, only a proportion can be transferred by formal methods, while the rest would often require a long heuristic process of imitation, reverse engineering, learning-by-doing and apprenticeship. Stiglitz termed these processes of learning "horizontal methods of knowledge transfer" and referred to the formal codified storable mode as "vertical transfer".<sup>12</sup> Formal learning is characterised by five distinct characteristics, namely: (1) it has a prescribed framework; (2) an organised learning package or events; (3) the presence of a designated teacher or trainer; (4) the award of a qualification or credit, and (5) the external specification of outcomes, Eraut (2000).

Formal institutions and learning provided the seedbed for much of the innovation in the past but non-formal learning in factories led to equally momentous technical improvements (Rosenberg 1976; Landes 1999). Each served and continues to serve different evolutionary goals. For

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elements of both know-why and know-how to be effective in solving complex problems. To master calculus, one requires consistent practice, the domain of skills and tacit knowledge.

<sup>10</sup> Lubit (2001) identifies four categories of tacit knowledge, namely, (a) hard to pin down skills-"know-how", (b) mental models, which show us how the world is constructed, (c) ways of approaching problems, and (d) organisational routines. "The word skill implies tacit knowledge which range from the ability to swing golf balls to the dexterity of handling cells in a biology lab, all which are hard to explain in words.

<sup>11</sup> According to Lubit (2001), p.167 "Routines solidify as standard operating procedures and roles are developed and enforced. Routines include ways of producing things, ways of hiring and firing personnel, ways of handling inventory, decision-making procedures, advertising policy, and R&D procedures".

<sup>12</sup> Among these are: study tours to other countries; cross-training, which is a form of "learning-by-observing" - an implicit knowledge acquisition process that is different from explicit training on how to do things; twinning or seconding, which pairs together institutions in a horizontal knowledge exchange process, (Stiglitz 1999).

instance the French system of polytechnics<sup>13</sup>, with its emphasis on the abstract and theoretical succeeded in graduating bright individuals who led in building railways, assimilated the best of British metallurgy and formed the cream of French engineering and technocracy. However, there was a lacuna, and private based institutions for on-the-job training were established by employers to build on theoretical knowledge and to replace the apprenticeship system of old. In other words, the establishment of theory-based scientific institutions was not a sufficient condition for industrial progress particularly given the example of Britain's industrial revolution, driven largely by learning-by-doing. The lesson from these historical developments is that institutions serve particular ends but they are highly conditioned by the social and economic contexts as well as by national absorptive capacities.

Apprenticeship, a process of skill formation, is one type of local knowledge institution. It often lasts for periods of about six months to three years and tends to be organised by, but not limited to, small firms (Velenchik 1995). It is a form of learning in which the learner, in addition to learning a skill from the firm, provides labour services to the firm or the owner of a business unit. This institution is highly widespread in Africa, but has long historical roots in Europe and elsewhere.<sup>14</sup> The practice takes different forms from highly structured training in large firms, as is the case in Germany, to the more loosely organised “learning-observing own work mates”. Training is the object and the mode of instruction takes on a variety of forms - from the use of specific instructional manuals (codified) to unspecified and randomly assigned oral tasks (tacit basis) that the supervisor may give - each feeding on the other. The written and unwritten contract is the agreement to teach, and to learn, for a fixed period of time.

Within the African context, apprentices tend to emerge from the young, low ability range with no more than secondary education but more likely with less (Velenchik 1995). Training is of a generalised type that takes place on the job. Findings concerning the types of skill differ. While some findings confirm the generalised nature of training, others found it to be idiosyncratic with little possibility of skill transfer to other firms. The alternative is for an apprentice to establish own firm and replicate the routines learned (Frazer 2002). Frazer found that educated workers in Africa tend to be more productive apprentices, so are apprentices who remained where they trained although he cautions this may have no general applicability.

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<sup>13</sup> These were the Ecole Polytechnique (originally named the Ecole Central des Travaux Publics) founded in 1794, Landes (1999).

<sup>14</sup> Smits and Stromback (2001) trace the practice to the reign of Tiberius Augustus in AD 36.



## **The Role of formal and experiential knowledge: the limiting value of learning-by-doing**

An important point for theory and policy supporting small producers in Africa is why the tacit knowledge base in industry has not been sufficiently externalised and why, despite considerable investments, the process of internalisation has yielded so few dividends. Why have institutions of apprenticeship succeeded in the community of medical practice and the legal profession for instance and yet been far less successful in creating an industrial and technological knowledge base in underdeveloped areas? Why has the system of innovation that has been so successful elsewhere not been embedded in Africa? The treatment of apprenticeship and other modes of tacit knowledge learning as a historical anachronism does not fit the facts. Lave and Wenger (1991) cite diverse historical practices from Feudal Europe to West Africa and the United States where the bulk of learning, including in highly skill-intensive disciplines such as medicine and the arts, takes the form of apprenticeship. They come to the conclusion that apprenticeship learning diverges significantly from popular stereotypes. They call into question, for instance, the conventional wisdom of apprenticeship as an informal activity. "It is typically assumed, for example, that apprenticeship has had an exclusive existence in association with feudal craft production; that master-apprenticeship relationships are diagnostic of apprenticeship; and that learning in apprenticeship offers opportunities for nothing more complex than reproducing task performance in routinised ways".

We suggest four main reasons for this anomaly. First, due to the small size nature of firms with little capacity for institutional memory, dispersal of persons with the requisite human skills - a rather common occurrence in firms with high labour turnover - lead to the destruction of such skills. Second, the atomistic behaviour of firms, with their aversion to sharing tacit knowledge, forecloses optimal socialisation of such knowledge, and in turn diminishes the value of knowledge and information. As Fleck (1996) observes, tacit knowledge constrains the social distribution of knowledge and is responsible for the limited circulation of scientific and technological knowledge. The need to maintain asymmetrical power relations within organisations might in fact encourage knowledge hoarding, which might in turn undermine the organisation itself. Again, tacit knowledge transfer involves devoting considerable energy and personal time in a mentoring arrangement such as apprenticeship. There are evident disincentives in doing this especially in competitive environments where individual knowledge is a source of power.

Third, there is a limit to the knowledge accumulated through learning-by-doing. According to Johannessen and Olaisen (2001), tacit knowledge is bounded by negative feedback, because, while it promotes continuous improvements, it hardly leads to innovation. "Thus tacit knowledge promotes continuous improvements only to a certain level, and then declines". The

limiting value of tacit knowledge creation in the absence of innovation is captured in Young's (1993) formulation of 'bounded learning by doing'. He suggests that learning in the course of producing certain goods is finite and in the end will approach a limiting value and stop altogether 'in the absence of the introduction of new technical processes' (our emphasis). In other words, an industry, system of production or firm cannot hope to rely indefinitely and exclusively on particular knowledge of production without injecting new knowledge through innovation. This assertion follows the well-known asymptotic behaviour of growth of systems represented in a simple mathematical formulation (Von Bertalanffy 1968). We could use this to describe the growth of human knowledge<sup>15</sup> assuming as some scholars have noted that knowledge growth takes on an exponential character (Cowan, David and Foray 2000).

Consider a simple representation where the growth of knowledge in the system is directly proportional to the number of elements (information, data etc in a variety of forms) present<sup>16</sup>. When the growth is developed into a Taylor series and solved, it becomes,

$$Q = Q_0 e^{At} \dots\dots\dots 1)$$

The growth of the system is positive or negative depending on the value of the constant  $A_1$  and the system increases or decreases accordingly on the sign assumed by  $A$ . When we retain only the first term of the series, the simplest solution emerges as equation (1) above.  $Q_0$  signifies the number of elements at  $t = 0$ . This is the well-known exponential law, called the "law of natural growth".

When we retain the second term, the solution takes a different form with important implications. The second solution takes on a sigmoid shape with a limiting value while the first simple solution shows an indefinite growth. Young's formulation, albeit much more complex, echoes the generalised systems solution to which Von Bertalanffy had suggested this simple but powerful equation of growth a quarter of a century earlier. Speculatively applied to our small firm situation, with limiting internal resources in the absence of little or no external innovating inputs, knowledge growth tapers off eventually assuming the logistic curve shown in diagram 1. We suggest that the stagnation of African industry may well not be unconnected with the low

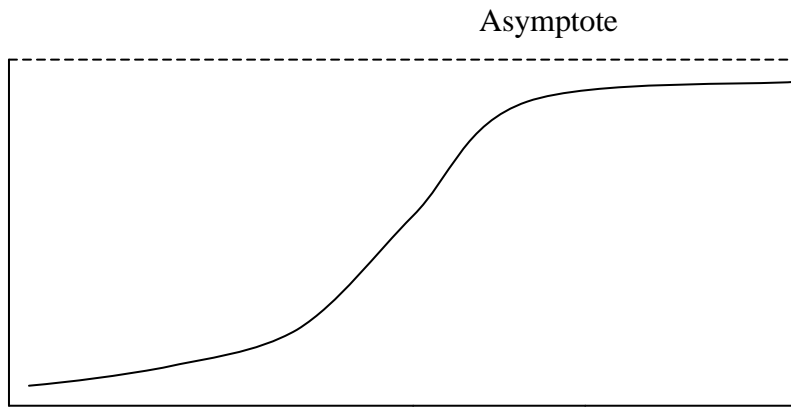
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<sup>15</sup> This is measured by all kind of accumulated information and data. Where ( $a < 0$ ) the exponential law would apply as much to radioactive decay as it will the decline of unutilised human knowledge.

<sup>16</sup> This is the well-known equation of growth and for knowledge may vary from the volume of books, journals or in the current context, digital materials.  $\frac{dQ}{dt} = f(Q)$

innovative dynamism of the predominantly small firms that populate manufacturing and services. The solution to the sigmoid or logistic curve is shown in diagram 1.

Diagram 1: Logistic curve representing the growth of human tacit knowledge





### 3.0 LEARNING AND KNOWLEDGE IN AFRICAN INDUSTRY

#### An Analytical framework

Local technological knowledge institutions (LKI) carry out the generation, recreation and diffusion of knowledge available from the local and global domains. LKI can be normatively defined as a set of agents that act as the repository of creative assets, and evolving in a milieu of dynamic interaction with other agents. To be effective, they would have the following three properties: (i) an optimum organisational size (firm size, capacity of a R&D laboratory etc), which can be specified only in a given context; (ii) a right mix of formal and experiential knowledge and skills base; (iii) and an environment with a positive systems dynamics.

*i) Optimum Size structure* is a well-discussed factor in the literature. Both the dynamic capabilities as well as the resource-based literature emphasise the importance of firms' internal assets (Penrose 1959); Nelson and Winter 1982; Freeman and Soete 1997). The weight of empirical evidence suggests that for the small firm, growth is negatively correlated with firm size and age, while this may not necessarily hold in medium and large firms Audretsch (2002). There is a threshold of human and non-human resources required for firm-level effectiveness. African firms are largely small enterprises while universities and public research institutions (PRIs) often lack the basic infrastructure and facilities. However, comparative training data for other low-income countries show the close relationship of size and mode of training. For instance, it would appear from Table 2 that all the countries exhibit a strong propensity for informal learning with relatively advanced countries like Malaysia showing higher incidence (Biggs, Shah and Srivastava 1995). Their report confirms that advanced industrial countries do more formal training while larger firms in developing countries, particularly multinationals conduct much more formal training for their workers compared with small firms.<sup>17</sup>

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<sup>17</sup> Large multinational firms in Africa and Asia have well-developed systems of apprenticeship for young engineering and science graduates often referred to as *trainee engineers or scientists*. Some have formal vocational schools and highly structured curricula lasting between three to nine months. Even then this is not the end of training. A trainee is attached to a senior colleague, much like the master craftsman, who is responsible for the progress of the apprentice and makes recommendations on future promotion.

Table 2: Incidence of Informal Training by Firm Size across Countries

Firm Size	Colombia (1992)	Indonesia (1992)	Malaysia (1994)	Mexico (1992)
<15	67.6	N.A	56.6	7.4
21-100	77.8	15.7	80.5	36.1
101-250	88.6	32.6	88.8	44.7
>250	87.2	16.1	92.4	30.4

Source: Biggs, Shah and Srivastava (1995)

We therefore hypothesise that size correlates with the nature and type of learning (formal or non-formal training) and could be a significant predictor of firm domestic and export performance.

(ii) *The Role of Formal and Experiential Knowledge*: From Table 3 we observe that the relative proportion of graduates in firms display considerable variation across countries, while the arithmetic means for primary and secondary leavers is relatively low and shows no significant difference across countries. It is clear from Table 3 that the proportion of employees with formal university education differs significantly between Nigeria and Zimbabwe.

Table 3: Test for Equality of Mean Values of Educational Qualifications

Variable	All	Nigeria	Zimbabwe	df	T-value	F statistic	Level of significance
<b>Education</b>	8.69	10.32	6.08	63	0.924	0.854	0.359
No formal education							
Elementary School	44.96	46.47	38.74	131	1.189	1.416	0.236
High school	51.98	51.28	54.87	136	0.565	0.319	0.573
University	12.93	17.73	2.60	83	4.222	17.826	0.0001
Employees (size)	37.01	38.85	28.56	149	0.843	0.710	0.401

*Note*: Percentage of workers has been computed using individual sample of each category. Hence they are not expected to add up to 100%.

While formal education acquired in higher education institutions is important, it is only one source of knowledge. Non-formal sources of skills are equally important and represent an important continuation of the human capital build-up. One of such form of skills upgrading is adjustment through training in basic and general skills by firms. However, small firms are normally prone to under-invest in training, while the widespread institutional failure in developing countries to attenuate the skills market failure is well known Lall (2000). At the basic level, general skills such as literacy and numeracy are necessary for basic production processes, however, firm-level technological learning and capability acquisition is the primary focus for enterprises. According to Enos (1991), p20:

“To operate modern equipment requires the least training and experience; to improve upon operation requires more; to specify and procure individual pieces of equipment, still more; and to design entire plants and processing schemes the most of all.”

In other words, technical skills upgrading is an evolutionary, time-consuming process. In addition to the need for progressive addition of skills as society becomes more industrialised, a country needs to maintain an industrial momentum that fosters continuous learning. To this end, time is not the only factor as the opportunity to foster skills upgrading from the lower to higher levels is important for consistent industrial progress. Appendix 1 shows the technological learning and skills formation trajectory of progressing from the simple to complex industrial production. Considerable explicit investment in learning and technological capability building is required on a consistent and sustained basis.

In dynamic economies, a combination of incentives and threats that both induce and provide the scope for productive technological learning and innovation, arise from a variety of sources. These include possibilities for market expansion, investments in new machinery and equipment, in which the skills of engineers are utilised and competitive pressures that bring new entrants in the domestic and external markets. For most developing countries, the opportunity for industrial learning has been limited, but not totally absent. According to Freeman and Lindauer (1999), “...With the majority of the region’s labour force still engaged in agriculture, the lack of productive enhancing effects might explain why the accumulation of human capital has done little for economic growth.”

We therefore hypothesise that human capital, comprising formal education and human skills acquired in firms is positively related to firm performance.

(iii) *Positive Systemic Dynamics*: this is the operative environment that promotes, and supports creative capability building and innovation. It depends to a considerable degree on the maturity of institutions of finance, banking, regulation, property rights in addition to those supporting technical advance. In normative terms, a positive systemic dynamic is said to exist where we have the following: (i) a variety and large numbers of linkages involving suppliers, producers, and service providers; (ii) a high propensity for competitive cooperation and collaboration; (iii) a large number of agents creating and disseminating information and knowledge useful to production of goods and services; (iv) a propensity to foster private initiatives in complementary association with intelligent public service provision; (v) a strong global-local institution networking at the formal and informal institution levels.

Systems interaction, defined as the organisational competence to generate linkages, is made up of the knowledge, skills and experience to engage other firms and institutions in the process of

production and innovation (Ernst, Ganiatsos and Mytelka 1998). It is an important firm asset that has not been fully explored in the literature of underdeveloped economies. In addition to internal firm capabilities, a firm succeeds on the strength of its ability to gain access to, and process a whole range of, knowledge outside of itself. Organisations benefit from external agents by internalising such knowledge, and by continually engaging in networking with sources of knowledge within the national system and outside of it. In this way, organisations develop process paths to transform knowledge into firm capabilities for production and innovation.

Networking could be conceptualised as information flows and knowledge interactions, which may take several forms. They include inter-firm flows of knowledge and skills in a user-producer type relationship, through the movement of skilled staff from one firm to another; sub-contracting (manufacturing and trade types), joint ventures, franchise, and supplier-customer relations (Pavitt 1984; Hippel 1988; OECD 1999). Secondly, there are firm-institution interactions in which public agencies such as technology development centres (of different varieties across countries), and public R&D laboratories are among the most prominent in Africa. Their mandate, in broad terms, is to assist firms in process and product adaptations, and in gaining comparative advantage through utilising natural resources (Oyelaran-Oyeyinka 1997a; Biggs, Shah and Srivastava 1995); Romijn 2001).

Universities tend to be central to innovation and knowledge creation but in developing areas, their mandate is primarily to train scientists, and engineers. As a subset of regional, national and sectoral innovation system studies, considerable attention has been paid to university-industry interaction (Hicks, Breitzman, Olivastro and Hamilton 2001); Salter and Martin 2001).

Given the theoretical and empirical evidence from the literature, we hypothesise that collaboration in a given systemic context promotes firm-level performance.



## 4.0 LEARNING AND KNOWLEDGE IN AFRICAN FIRMS: EVIDENCE AND EXPLANATION

### Optimum Size Structure and the Role of Formal and Experiential Learning

We consider the first two hypotheses together as they are intractably connected. Based on our own findings, Table 4 shows the average firm size in African countries, which is only a fraction of the average enterprise size in East Asia and the advanced industrial countries.<sup>18</sup> Size is imperative for knowledge creation and storage, that is, the building of institutional memory, but this is the precise problem that Africa's small firms face. Moreover, the death rate of enterprises is high, and exit into non-related activity wipes away the tacit knowledge that has been painstakingly acquired over time. The reason crafts knowledge tends to have stagnated at a non-competitive level might relate to its tacit nature. Knowledge that is codified (in texts, pictures, and symbols) is easily transferred and adapted and improved upon by others in the *community of practice* (Lave and Wenger 1991). Tacit knowledge, embodied in human skills, is said to undergo "internalisation of knowledge", and vice versa for the transformation of codified to tacit, transformed through the "externalisation of knowledge", Nonaka and Takeuchi (1995). Theirs is a framework in which knowledge creation and re-creation spiral in a ring.<sup>19</sup> According to Nonaka (1994) there is a perpetual dialogue between tacit and explicit knowledge. In the absence of this sort of dynamic dialogue, or where the dialogue is a repetitive exchange of old ideas among horizontal actors, very little learning takes place, and in the extreme, none at all.

Firms are severely constrained by limited knowledge, human skills and experience as well as poor techno-managerial capability of top management - and in the case of the small firms - that of the owner/entrepreneur. This finding applies to almost all African SMEs. We considered two components of human capital - of firm owners or managers - that tend to affect the growth and dynamism of firms. These are certificated or diploma-awarding qualifications obtained from formal institutions and non-formal learning. The level of human capital shapes the ways in

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<sup>18</sup> For instance the Small Business Administration (SBA) in the United States defines a small firm as one employing no more than 500 employees, a figure ten times the mean enterprise size in Africa.

<sup>19</sup> The model presents four modes including *socialisation*, a process in which tacit is converted to tacit such as happens in apprenticeship (observation, imitation and practice); *externalisation* converts tacit to explicit using metaphors, analogies and models; this is followed by *combination*, the conversion of explicit to explicit through techniques such as reasoning, programming, data mining, and information exchange; and lastly, *internalisation*, a process of transforming explicit into tacit routine day-to-day work.

which a firm is managed<sup>20</sup>, and tacit knowledge, a vital but non-quantifiable component of human skills could indeed be a decisive factor of firm performance. Compared with their counterparts in other developing countries, and indeed the management of larger firms within the same countries, owners/managers of SMEs tend to score relatively low in formal education and experience. We observed a fairly consistent pattern of relatively low qualification and poor managerial competence among the workforce in most cases with a few exceptions. This is particularly so for the smaller enterprises (with less than fifty employees). While firm owners may in fact possess intrinsic entrepreneurial abilities, this attribute does not prove sufficient in the face of the complex demands of modern economies. As firms face both domestic and external competition, the need for new sets of technical and managerial competencies arises.<sup>21</sup>

Conceivably, the considerable gap in management and skills levels between Africa's SMEs and their counterparts in the more industrialised developing countries is understandable given the relatively recent history of industrialisation in Africa. Managing a firm with a limited number of qualified and experienced personnel (the perennial resource allocation constraint) leaves firm owners with little or no time for training. For this reason, non-formal training seems to be the preponderant mode of learning. In the second survey cited in this paper, we sought to know from firm managing directors how they train staff and how they themselves learn to use various forms of information and telecommunications technologies (ICTs).

Table 4 shows that technical apprenticeship is the most common type of training in both small and medium firms (S and M respectively).

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<sup>20</sup> In an econometric study of Ghanaian firms, export dynamism was found to be positively associated with the experience of the workforce. Comparative evidence was found for human capital in a number of other African countries, Soderborn (2000), "What drives manufacturing exports in Africa? Evidence from Ghana, Kenya and Zimbabwe." Mimeo, Centre for the Study of African Economies, University of Oxford, presented at the Annual Conference on Development Economies Europe, Paris, June 26-28, 2000.

<sup>21</sup> This is what Lundvall and Johnson (1994), p33 referred to as learning and forgetting. "The enormous power of habits of thoughts in the economy constitutes a permanent risk for blocking potentially fertile learning processes. It may be argued that some kind of creative destruction of knowledge is necessary in order to make it possible for radical innovation to diffuse throughout the economy.... Forgetting is an essential and integrated part of learning..."

Table 4: Learning ICT Skills by Firm Owners and Firm Size

Learning Mode	Uganda		Nigeria		Kenya		Ghana
	S	M	S	M	S	M	All
Formal Training	21 (28.4)	8 (80.0)		47 (66.2)	29 (20.1)	10 (27.8)	13 (14.4)
Apprenticeship	49 (66.2)	7 (70.0)	2 (5.9)	47 (66.2)	82 (56.9)	24 (66.7)	76 (84.4)
Searching the Internet	18 (24.3)	2 (20.0)		5 (7.1)			
Learning from Technical Partners	18 (24.3)	1 (10.0)	1 (2.9)	21 (29.6)			1 (1.1)
Overseas Training	18 (24.3)	1 (10.0)		4 (5.6)			
Firm size		25		38.9		44.7	
Total Firms	74	10	34	71	144	36	90

Source: Author's field survey (2002)

Note: Numbers in parentheses are column percentage; Percentage will not add to 100 as this is a multiple response variable.

In all the countries, the percentage of owners with formal training is higher in medium sized firms. For instance 80% of the MDs of medium sized firms in Uganda have formal training compared to only 28.4% of small firm managers. The situation is reversed when it comes to informal training modes, such as learning from technical partners.

Tables 5 and 6 illustrate the correlation of training and different measures of performance namely, increased firm output, perceived improvement in technical capability and actual increased export performance as a result of training. These are perceptive responses of firm managing directors and the question was framed as: "By how much has your firm increased technical capability as a result of training"? or "By how much has staff quality improved as a result of training". The questionnaire provided for choices on different training types such as "in-house technical apprenticeship" and "in-house management apprenticeship". The responses on ICTs show a general pattern to technical training, as follows. Local consultants or employees of state agencies provide much of the training in small firms, in form of apprenticeship. Small firms are not able to pay for overseas training and it is not surprising therefore that a sizeable proportion attributes improved technical improvements, production output and export growth to learning through apprenticeship training. Firms that devote a greater proportion of their budget to training tend to record higher output, increased technical capability and better export performance.

Table 5 : Correlation of Firm output and Type of Training

	<b>Nigeria</b>		<b>Zimbabwe</b>		<b>Kenya</b>	
Training Item	Increase d output (%)	Improved Technical capability	Increased output (%)	Improved Technical capability	Increased output (%)	Improved Technical capability
In-house Technical Apprenticeship Training	61.7	70.3	64.7	75.0	71.0	66.0
In-house Management Apprenticeship Training	33.3	29.2	-	50.0	45.0	31.0
Overseas Training			50.0			
Local Training	53.8	53.8	40.0		50.0	52.0
Budget on Training (1-5%)	52.3		60.0		57.0	
Budget on Training (6-10%)	64.0		-		60.0	
Budget on Training (> 10%)	71.4		-		70.0	
Better Quality Product From training	57.7		57.1		55.0	58.0
More Efficient Workforce	60.9	47.7		57.1		56.0

Source: Author's survey (2002)

Table 5 shows that in-house technical apprenticeship training mode contributed significantly to increasing output as well as to improvement in technical capability. The percentages vary from 61.7 % in Uganda to 71% in Kenya. Similarly improvements in technological capability vary between 66% in Kenya to 75% in Zimbabwe. Another evident inference from the table is that firms that spent more on training have experienced greater production outputs.

Table 6: Correlation of Capability, Export Performance and Training

	<b>Nigeria</b>	<b>Kenya</b>	<b>Zimbabwe</b>
Training Items	Increased Export Capability (%)	Increased Export Capability (%)	Increased Export Capability (%)
Management Training	46.2	46.0	50.0
Improved Job Quality	24.1	22.3	21.4
<i>Type of Training</i>			
In-house Technical (apprenticeship)	34.1	38.5	50.0
Local Training	35.3	37.2	40.0
Budget on Training (1-5%)	25.0	30.1	35.3
Budget on Training (6-10%)	53.3	54.2	n.a.
Budget on Training (>10%)	42.9	47.2	50.0
Training Improvement Producing better quality jobs	21.1	23.0	
Higher quality products	50.0	47.2	29.2
Improved Productivity	66.7	65.2	57.3

Source: Author's survey (2001)

Table 6 shows that the impact of training mode on export performance followed a similar pattern to that of output and technical capability in all the countries. For instance in-house technical training contributes an increase of 50% of export capability while local training (outside of firm) contributes 40% increase in Zimbabwe. The impact of differentiated training expenditure on export performance follows the pattern on output and technical capability while improved productivity in firms has the highest impact on export capability in all the countries. Firms indicate that competitive pressures in some way induced greater expenditure and efforts on training and subsequent increases in productivity.

### **Positive Systemic Dynamics**

If we accept the premise that the innovative impulse, with the exception of continuous small improvements, comes from outside the small firm, the logical next question is: where from? In order to put this question in perspective in the African case, we need to analyse how well firms collaborate with local and global knowledge institutions. Table 7 provides some partial answers, which show that little or no collaboration takes place between small firms in Africa and knowledge institutions such as universities (row five), with no significant difference between

the countries. The normalised scores are rated on a scale of one to five, with five indicating strong collaboration and one rated as extremely low or no collaboration.

Although the incidence and importance of knowledge spillover is not in dispute, not much of it is associated with university-industry collaboration in the context of Africa small firms. There seems to be greater collaboration with suppliers and subcontractors at this size level and in this technological regime, for three broad reasons. First, in positive systemic environments, where knowledge externalities are present, there are three broad sources of knowledge for firms, namely, industry R&D, university R&D (both broadly defined), and skilled labour. The role each plays is self-evident while in particular, new economic knowledge in form of tacit skills and knowledge generally leads to the propensity to innovate. The absence of graduate skilled labour in small firms will therefore deprive them of this impulse to innovate. Second, small firms lack the internal capacity to absorb new knowledge. A firm with little or no experience in innovative activity will lack the skills to identify, and adopt the necessary external inputs. Third, acquisition of external knowledge depends on both geographic and knowledge proximity. There is a wide cognitive disparity between small firms and university knowledge bases in African countries particularly the latter. Where firms are situated near universities, their activity domains are worlds apart as a result of the kinds of markets small firms serve and the publication niche market those university scientists respond to. The mobility of labour is a key source of knowledge transfer but this kind of exchange hardly takes place except with large, often multinational firms, Oyelaran-Oyeyinka and Barclay (2003).

Table 7: Equality of Means of modes of Inter-firm collaboration

Variable	Mean			Df	T-value	F-statistic	Significance level
	1. Small	2. Medium	All				
Horizontal cooperation	1.473	1.212	1.426	182	1.539	2.370	0.1254
Subcontracting	1.285	1.368	1.301	196	0.496	0.246	0.6206
Linkage with Industrial Association	1.641	1.192	1.559	142	2.376	5.646	0.0188
Cooperation with Input Suppliers	0.768	0.795	0.772	196	0.1886	0.0356	0.8506
Collaboration with universities and Technology Institutions	0.781	0.809	0.787	201	0.397	0.157	0.6921

Source: Author's survey, 2001

It can be seen from the table that the type of technological collaboration does not differ significantly between the two sizes of firms. The only exception is in the case of linkages with industrial associations. The results are not surprising because small firms are more dependent on industry associations for various types of interactions with government and other local agencies. They also depend substantially on industry associations with respect to information on the latest product specifications, market trend, and developments in production technologies.

### **Learning Strategies in African SMEs: an illustrative case study**

In this final section, we cite a case from a study carried out in four major Nigerian towns: Lagos, Benin City, Ibadan and Nnewi.<sup>22</sup> The sample stratification of firms was based on information collected from trade and manufacturing directories. Three engineering subgroups were examined in this study covering forty-seven firms. The subgroups are basic metal and fabricated metal; electrical and electronics; and automotive components and miscellaneous assembly. About 80 per cent of the firms imported between 61-100 per cent of machinery from abroad. Almost all the Nnewi firms imported machinery and equipment from Taiwan. Technical services, both for initial investment and subsequently for production, were supplied by foreign firms. The initial investments were largely necessitated by the need to exploit perceived market opportunities. For Nnewi entrepreneurs, the origin of manufacturing investment is, without exception, found in trading. All started as traders and once they had accumulated sufficient capital they sought a technical partnership with a Taiwanese partner. None except one had previous manufacturing experience.

The Nnewi firms present a particularly interesting phenomenon. Most of the enterprises were started just before or during the implementation of a tough structural economic programme and they are all fully owned by Nigerians. The owners constitute a distinct category of previous traders with a common ethnic background (all are of Igbo extraction); the firms are spread over a geographic space that has been transformed into a prosperous economic enclave similar to an industrial district. The study examined issues of clustering or networking in a systematic manner and found a large measure of communalism that is culturally and ethnically determined. Whether or not this potential of proximity has been usefully explored to enhance local efficiency through the use of available knowledge, skills and information remains to be seen. We do know however that Nnewi has explored the external linkages profitably through trading and later investment in manufacturing with Taiwan.

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<sup>22</sup> Details of the study can be found in Oyeyinka (1997b). A journal version was published as "Technological Learning in African industry: a study of engineering firms in Nigeria". *Science and Public Policy*, Volume 24, No. 5, October 1997.

Investment capability, which includes searching, sourcing, negotiating, scheduling of investment as well as erection and civil construction seems to have been well mastered by the firms. Since the technology involved in the civil and structural aspects of construction is relatively uncomplicated and has had a long history in Nigeria, it did not pose many problems for Nigerian engineers. Again, it would seem that the entrepreneurs made extra efforts to acquaint themselves with details of the systems either locally or by attachment to suppliers' factories abroad before finalising transfer agreements. In what follows we summarise the implications for our three hypotheses.

### **Optimum Size structure and the Role of Formal and Experiential Learning**

Again we bunch up the first two hypotheses in examining learning mechanisms as they relate to size. Technological learning is the way in which firms acquire and build up technical knowledge and competencies and it represents the dynamic component of the process of capability acquisition. We identified the following channels for learning: (a) The apprenticeship system of training; (b) on-site training at suppliers factory;(c) on-the-job training in Nigeria; (d) expert contracting; (e) support mechanisms provided by public institutions; (f) learning through transaction with local and external agents; and (g) learning -by -doing production and maintenance.

During the early stages, most firms rely on the technical expertise of machinery suppliers and as such set great store on on-site training at the suppliers' factories abroad. The period of training ranges between three to nine months and essentially emphasises learning to produce and maintain machinery and equipment. Product technology is often quickly mastered while process technology learning, the skill and knowledge for plant design, to modify plant layout, quality control, maintenance and industrial engineering takes a relatively longer time.

The knowledge and skills acquisition process continues with on-the-job training whereby those who had foreign exposure become trainers to others, while they continue to master the process technology. Expert contracting is a common learning channel with firms at Nnewi. The contracts last for varying periods, depending on the complexity of the tasks involved.

Sometimes these transactional exchanges between Nnewi and supplier factories in Taiwan develop into long term relationships, thus creating loose networks for indefinite period. Services are paid for as rendered - a sort of "cash and carry" consulting service because Nnewi firms lack access to financing sources, apart from own savings; (in spite of their relatively excellent performance Nnewi firms have had very little success accessing financing from commercial banks, except for a handful within the medium size range). The firms' dependence on their foreign partners is also related to low education levels and the related lack of formal



technical or engineering training among the owners and workers. This makes the initial technical instructions provided by the supplier factories extremely important. For this reason, entrepreneurs tend to favour their immediate kith and kin for fear of losing a worker who may not be committed to the long-term goals of the firm. "Close marking" of foreign experts becomes an important technique since the foreigner has a finite time to spend at the factory.

The decision to train always proves difficult for firm owners as small firms encounter difficulties in retaining competent staff. A strong disincentive is the incidence of high labour turnover among small firms, a situation that results in one of two distinct choices for firms – to remain small, or to invest in training and skills upgrading in order to achieve growth. The tendency is for firms to maintain their small size, which locks them into a low productivity growth path. In taking this route a firm effectively avoids investments in higher skills but forecloses transition to higher technological growth path.<sup>23</sup> In this and other case studies, other skill-related reasons identified by firms as constraints to growth and innovation include: (a) Lack of skilled personnel to initiate and sustain growth-inducing activities; (b) Fear of losing competent staff once trained; (c) Lack of time outside the production routines, this relates particularly to the owner/manager who tends to be over committed while carrying out multidimensional functions; (d) Lack of in-house technical skills with enough experience to understand the combined technical and market imperatives of growing competitive economies.

Drawing from this case study a number of lessons can be learned regarding the role of formal and experiential learning. We found firm-specific apprenticeship training to be the dominant mode of learning, the main reason being that it confers considerable competitive advantage to the enterprise in three ways. First, firms are in a position to identify their specific skill deficiencies as well as the relevant source for bridging the skills gap. Second, firm managers are familiar with the techno-managerial profile of the industry and are best positioned to take advantage of this to improve firm-level capability. While formal education raises general-purpose technical skill - important prerequisites for industrial level capacity - it is not sufficient for specific routines of firms such as production, basic and detailed design of products and processes. Third, the process of capability building is cumulative, realised through learning, and consolidated by learning (learning-by-doing) the latter, an important source of experience.

Most of the small firms in Africa, do no more than “operate modern equipment” (Enos 1992) for the move to higher levels of technological activities requires a deliberate and radical change of capability stock. As the Nnewi case illustrates it is mostly medium and large firms that can afford to pay for such upgrading. In addition, labour cost per employee is inversely related to

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<sup>23</sup> Some firms retain the choice to remain small in order to benefit from subsidies and other forms of tax protection where these are available.

firm size. These higher costs per employee could act as a disincentive to growth. For these reasons, small firms are less able to attract quality staff.

There is a positive correlation between capital intensity and the level of technical and skill structure of the firm. Small firms tend to be associated with lower quality management and skills. This would no doubt affect the firm's ability to adopt, adapt and assimilate technical innovation. Placed in a more dynamic context, the temporary lack of skilled manpower tends to be manifested in the long-term accommodation of limiting technological and quality goals. In other words, when constrained by skills, small firms tend to "accept" low-level production/technological regimes and they may be stuck with these for a long time.

Small firms also undertake less training and spend less per worker. When it is undertaken, training is usually of a general-purpose type. There are two implications to this, which was confirmed during our interviews. First, the predominance of general training in the sector suggests lack of specialisation and workers are left with general-purpose-type technology knowledge. Firms that undertake specific training and impart skills to workers are less likely to hold on to such staff. The returns from general training tends to be less than for specialised training, but this does not seem to affect the types of training that small firms invest in.

### **Positive Systemic Dynamics**

Collaborations with local knowledge institutions is practically non-existent in this rural enclave. For this reason, firms seem to rely on, and have acquired technical knowledge from, visits to suppliers' factories and by exchange with local supplier firms, but these tend to be secondary channels of learning. A few benefited from technical advice and information from external support services but again this tends to be on a limited scale. The kinds of horizontal linkages and subcontracting relationships that made the Taiwan model a source of inspiration for entrepreneurs at Nnewi has not fully emerged. Firms rely to a considerable extent on internal human and machinery assets and as such tend to be vertically integrated. Some acquired special machinery services such as foundries and heat treatment facilities in order to take advantage of economy of scope and to acquire capabilities for minor modifications and maintenance.

Some semblance of routine factory floor R & D is taking place but not in the formal sense. This is particularly so in the area of adaptation of local raw materials where a lot of "experiments" (according to firm owners) are being undertaken. For instance, one of the Nnewi firms producing rubber-based products has in time undertaken diversification of its product mix through internal as well as external efforts. The firm has achieved 95 per cent by weight in local content and won the Nigerian Industrial Standard awards in the process. Although the company sends samples to Taiwan for quality assurance tests, much of *compositing* of inputs is done

locally. This type of activity is not uncommon and is generally considered an important avenue for gaining competitive edge over domestic and foreign rivals.



## 5.0 CONCLUSIONS

In conclusion, we advance some tentative explanations as to the nature, mode and implications of the type of learning and knowledge accumulation in African industry. We suggest three broad but inter-linked trends that draw from our empirical work on firm-level performance. The first is the inability of local knowledge institutions to interact with all but few productive agents in order to generate sufficient autonomous technical dynamism. The second trend is the continuing neglect of local knowledge, bundled up in the main in firm-level tacit knowledge of small firms that have failed to meet the challenges of high quality product requirements in a new competitive environment. Third, is the lock-in into repetitive learning-by-doing routines among the predominantly small firms with little opportunities for fresh ideas in industries that rely on institutions of apprenticeship. Knowledge externalities tend to benefit larger firms but small enterprises with little absorptive capacity and limited human skills and knowledge, are disconnected from both local and global knowledge pools. Imported technologies are of little benefit unless they are properly mastered and replicated in new processes and products. Institutions that act as the repository of indigenous knowledge have either completely ossified in repetitive techniques or have turned modern methods, which in turn have not taken root in the local practices. The inability to exploit global knowledge by local economic agents and institutions further limits the competitive scope of local firms. This vicious cycle accounts in part for the lack of dynamism of historically derived learning mechanisms such as apprenticeship institutions, which are so highly prevalent in Africa.

The role of learning institutions is important but local autonomously generated knowledge is even more critical if transplanted institutions and the knowledge they are expected to transfer will be successfully embedded in the local milieu. Economic and innovation policies need to support small and medium firms with the right kinds of incentives and the environment to develop their capability through continuous training. An important implication of our study is that stocks of knowledge need to creatively change through re-training and that age old habits and routines might benefit from transformation through institutional innovation. The apprenticeship institution is a case a point. Government policy should provide firms with the incentives to develop workers and to upgrade skills and technologies by linking up with universities and other knowledge centres, while continuing to promote inter-firm linkages.

Appendix Table 1: Typology of Manufacturing Skills and Technological Capabilities

Type of Skill	Elementary Technical	Basic Technical	Basic Production	Advanced Production
Type of Technological Capability	Simple knowledge of machining, operation and maintenance	Knowledge of production processes	Knowledge and experience of production	Knowledge and experience of production, design and minor innovation
Sources of Skills and Experience	Technical and vocational schools	University, science and engineering schools	University plus firm-level experience	University firm-level experience, additional theoretical training in production and design
Approximate cumulative number of years of training and experience	3-4 years	4 years	7 years	9-10 years

Note: The approximate years of skills training is derived from the Korean experience in chemicals and steel sector (Enos, 1991)

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