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Links in the Knowledge Journey of an Idea to Innovation: A Study in the Context of Development of Customized Cartons

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Abstract

This paper identifies and analyses the links in the knowledge journey of an idea to innovation. It tracks the links in the development of customized cartons for packaging tomatoes. The trigger points for the innovation, the milestones crossed by the innovator, the interaction with agencies and actors in the environment, the interests and responses of the agencies and the actors, and the final outcomes were identified. Based on analysis, it conceptualises a model of knowledge journey and develops suggestions for innovators and innovation associates. The suggestions are in the areas of responding to innovation triggering points, learning and leveraging on what is possible and happening, adapting to the constraints of the innovation associates and building flexible systems and structures.

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1. Introduction

As an idea fructifies into innovation, various knowledge bases complete their own journey as they link themselves with one another and contribute to the progress of the idea from one stage to the next. Nonaka (1994) has distinguished between tacit and explicit knowledge and studied the knowledge conversion processes. Tacit knowledge is the bundle of insights, intuitions, dos and don'ts, ideas and heuristics an individual holds. This is developed as the consequence of an 'accumulated experience or exposure' of the individual over time. Tacit knowledge of each individual is unique. The individual himself/herself may not know what he/she has in store till an opportunity is created to reveal the same. As opposed to this, explicit knowledge is codified and available to all in the same format. Individuals access it differently and internalize it in their own way, depending upon the support provided by their tacit and other dependent explicit knowledge bases. He has defined processes like socialization (tacit to tacit), externalization (tacit to explicit), combination (explicit to explicit) and internalization (explicit to tacit) to investigate the conversion process. These categories could also be looked at knowledge junctions where one type of knowledge is linked to the other for carrying the knowledge journey forward. One can also distinguish between specialized knowledge held by specialists in a discipline of study and generic knowledge that is commonly held by the society. Further distinction can be made between field based grass root knowledge and theory based academic knowledge. Innovators need to establish the link between what needed and what is available to complete the innovation journey. They even have to generate the needed knowledge through experiments and observations. Many a time, ideas do not travel to become innovations, because the needed knowledge is not available at the time it is needed and in the form it is needed or is available at an unaffordable price. Phene, Linduist and Marsh (2006) have shown how accessing external knowledge can facilitate innovation. Innovators, in their case the innovating firms, may be limited by their abilities in guaranteeing success in innovating. Hansen and Birkinshaw (2007) argue for 'taking an end to end view' of their innovation efforts. To be successful they need to look at the entire 'innovation value chain'. They discuss ways and means of strengthening the three parts of the chain – idea generation, conversion and diffusion. Each phase requires knowledge resources from within and outside the organization.

The key questions in the above context are:

What types of knowledge bases interact with each other to facilitate the completion of innovation generating activities? How does the innovator identify the demand for knowledge inputs and how does he/she ensure their supply? What are the supply sources and how are they identified? How are they tapped? What are the facilitators of the desired match between demand and supply? What are the consequences of delayed match or inappropriate match for the progress of the innovation journey? How does this support come by? How does the innovator establish the rapport and get support of those who are

needed to proceed further. We develop responses to these questions by analyzing in detail the knowledge links in the journey of an innovation - customized cartons. The cartons were innovated to transport perishable fruits over longer distance. Based on the analysis, we develop guidelines for innovators and facilitating institutions and innovation associates.

2. Methodology and Data

We followed the following steps in tracing the links in the knowledge journey of customized cartons

- Idntification: We identified the trigger for engaging in an innovation generating activity or activities and the embedded knowledge basis of the innovator and his environment
- Mapping: We mapped the entire set of actitivities engaged in by the innovator in his movement from idea to innovation. We looked at a given activity as a both user and generator of knowledge.
- Clubbing: We clubbed the activities into distinct phases, if there existed identifiable phases.
- Study: We identified the innovation associates of the various activities, the roles played by them, knowledge supplied, created and demanded by them in the progress of the innovation journey.
- Search: We searched for the facilitators and the constraints in above
- Insights: Based on above we developed insights into the knowledge journey of the innovation

Data for the study was collected from the narration of the innovator, documents published from him in various academic journals and popular press. The narration was in response to a series of structured and unstructured questions over four sittings. In the last sitting, the document of the journey was shown to the innovator, and he was also asked to reflect on the entire journey all over again and identify the missing steps and linkages that could have increased the efficiency effectiveness of the innovation.

We have traced the knowledge journey over two spans, one primary – where the innovator studies the problem and develops a workable solution – and a secondary one where the innovator responds to an opportunity to improvise the innovation in a related context. The key processes used by the innovator were informal consultations, visits, and formal experiments, structured and random reflections.

3. The Innovator and the Innovation

Girja Sharan is the innovator who developed three different corrugated boxes named ‘Vastrapur Cartons.’ He has masters and doctoral degree in agricultural engineering. As a doctoral student in Cornell University, he had taken courses in applied statistics for engineers. He was aware of the statistical tools and techniques. Girja Sharan is involved in research on the problems of agriculture in arid areas. He offers courses in Systems Analysis in Agriculture. Prior to the development of this innovation he was involved in the development of an ‘Earth Tube Heat Exchanger’ that has application in cooling greenhouses and livestock buildings. The innovator is a faculty member at the Indian

Institute of Management Ahmedabad, India and is associated with its Centre for Management in Agriculture. He is a fellow of Indian Society of Agricultural Engineers and Institution of Engineers (India). Details of his profile are in exhibit 1. The Centre receives grants from the Ministry of Agriculture, Delhi for research on problems of agriculture.

'Vastrapur Cartons' were developed as a substitute for the wooden boxes that damaged the contents, handicapped the growers in sending the produce to distant, more lucrative markets and spoilt the economics of the crop. The cartons were commercially launched in the regional market in 1999. Later, on request from the tomato growers of Himachal Pradesh, the boxes were modified to suit their needs and launched in that region's market in 2000 under the name 'Himachal (Kisan Bandhu) cartons'. From the innovation triggering event to the commercialization phase, it took sixteen months. The total expenses involved were Rs 60,000. The cost included the materials, travel and design and testing charges. It excluded the time cost of the innovator himself. It also excluded, incidental costs incurred by the host institute where the innovator carried out his activities. The innovation associates were farmers, traders, post-harvest research engineers, horticulture scientists, packaging units, a packaging company, and academic and research institutions in packaging and in management education. The knowledge links were from diverse fields of knowledge like physics, mechanical engineering, crop science, mathematics, material science, paper technology, material handling and management. The links were achieved through people to people interaction, interfaces of the associates with, existing practices, routines, processes and products that embodied knowledge. The interactions and interfaces were facilitated through serendipity, deliberate search and voluntarism. Rest of the paper is organized as follows: In section four we present the primary journey of the carton, in section five we present the secondary journey, section six analyses the experience and develops a model of the Knowledge Journey of an idea to Innovation, Section six develops guidelines for innovators and the innovation associates. The last section concludes the study.

4. The Primary Journey

4.1 Triggering Point

In the tomato growing season of 1998 in Gujarat, the slump in prices of produce was so drastic and precipitate that growers preferred to let the crop rot in the fields, instead of sending it to market. It was not possible for them to even recover the cost of packing and transport. Local media highlighted the difficulty faced by a very large number of impoverished small growers. The innovator watched the news and decided to go out to the farms to see what the problem was and whether there could be ways in which one could help. The questions here were: which fields to visit? Which farmers to interact with? What kind of additional information to seek? How does one access the farm and interact with the farmer?

4. 2 The Institutional Link

The innovator called up the office of the Chairman of APMC Market Jamalpur, Ahmedabad, District, Gujarat State in December 1998 seeking help in establishing contact with the growers. All commercial growers send their produce to this Market daily for auction. The managers of the Market have close links with the trade and the growers and are very knowledgeable about their problems. The call was answered by Mr.

Chhasatia, the Secretary of the Market who invited the innovator to meet him. The innovator met him and explained the purpose of his visit - to know the areas where farmers have problems related to tomatoes. He also told him that he was an agricultural engineer and that he would like to explore if there was some way he could help to solve the farmer's problems. The innovator impressed upon them that he meant to work on the problems to find some real practical solution - and not just an academic study. Mr. Chhasatia introduced the innovator to Mr. Pathak, the Statistical Officer of the Market. They responded readily and because APMC was mandated to help improve marketing of agricultural produce (exhibit 2 provides a snapshot of the functions and objectives of APMC). Mr. Pathak gave the innovator addresses of the farmers to visit and also called-up some farmers to encourage them to meet him on the visit.

While this telephone call may have appeared to be a routine call to the APMC authorities, it was special for the innovator. The innovator was aware of the institutions that worked for the farmer community but did not have the addresses of the farmers to visit. The response of APMC linked the innovator to the knowledge base of APMC authorities. A link between who –knows- who and who- knows- what was established. This link was facilitated by the earlier work of the Innovator in studying the congestion of vehicles in another APMC market at Vasna, in Ahmedabad, itself and the reputation of Centre for Management in Agriculture, in taking up studies on Agriculture

4.3 The First Field Link

The innovator visited the growers of Sanand area, located close to Ahmedabad alone. Visit to the farms confirmed that the problem was real and acute and affected the growers in large number in the area. Tomato could be seen on the vines or scattered in the fields. The growers stated that there were in all about 50,000 growers in the area and in Dholka and Bodeli areas near Baroda, Gujarat State. The innovator tapped the ready knowledge of the growers. The growers responded as he had gone there with a reference from the APMC. The innovator had often made such field visits in the course of his research work. His previous experience had shown that it was very important to be understood by the farmers i.e. they should be told of the real purpose of interaction and visit clearly in the manner they can appreciate. That helped get real response from them. The knowledge gathered could be summed as follows:

> Tomato growers of Gujarat usually sold their produce in the wholesale or bulk market of Ahmedabad. The transport distance from farms to this market was within 200 km. Tomato from Gujarat growers begins to reach the market early October, initially in small quantity that peaks in December. Prices were high in the beginning reaching a low in December. It is a normal thing and trade is used to it. The slump is drastic in most years.

He asked the growers - if prices in Ahmedabad were so low, why didn't people go to other markets like Jaipur, Bombay, Delhi. Jaipur was a large market 600 km away, Delhi even bigger 900 km, Bombay 600 km and Bangalore 2000 km from Ahmedabad. The growers said that they were aware of this possibility but that there were difficulties in pursuing this. One of the difficulties was packaging. The growers apprehended that the 'peti' (boxes made of recycled wood) would not be suited for a much longer road journey. Lack of information on current prices, and arrangement with the Commission Agents

were the other difficulties. These latter could be more easily solved. But problems of the existing peti and possible alternatives needed closer examination.

In the first field visit the academic knowledge of the innovator was linked to the grass root knowledge of the farmers. The links was established through face to face interactions with farmers. This is a kind of tacit-tacit linkage in the socialization mode. The establishment of this link required resources like transportation facility – IIMA provided the vehicle- and, time of the farmers and the innovator.

4.4 The Market Link

The site for building the next knowledge link shifted from the field to the market. The innovator soon after visited the market in Ahmedabad where the tomatoes arrived in 'Petis'. A sample of ten petis were emptied out and each fruit was examined visually for mechanical damages- bruises, cuts and dents. The innovator paid for the boxes from the research funds of the Centre for Management in Agriculture, IIMA. The flexibility in the CMA functioning enabled the Innovator to get an ad hoc payment made for buying the tomatoes. The innovator was making these investigations for the first time. It required knowledge about how to identify mechanical damages, some of which were visible some not**.** A list of what and how to observe was made first by consulting technical literature (for example – Physical Properties of plant and animal materials written by Mohesin (1970) on the subject. The innovator internalized the explicit specialist knowledge available in the books. This internalization was facilitated by the academic background of the Innovator.

The Inspection showed that in petis that came from farms about 100 km away, the proportion of fruits with mechanical damage incurred in transit was 55%. Petis that came from a longer distance about 250 km , had a slightly higher proportion of damaged fruits(65%). This suggested that the fear of the growers about the peti being unsuited for longer road journey was correct. Inspection of packaging also showed that a large number of growers made use of discarded cardboard boxes previously used for transport of biscuits, compressors and a variety of other industrial goods. It was noted that once used, such boxes lost the cushioning property as the flutes were flattened. In each subsequent use their ability to protect the contents reduced. It began to be apparent that an alternative would be needed. In this process the Innovator generated new knowledge about the extent of damage. Organizing the information from the investigation and developing interpretation was again facilitated by the innovators academic training. While the innovator became aware of the need from alternative packaging solutions, he debated whether he should take initiatives to do something about this. His anxieties were as follows: He had not worked on packaging solutions for any crop and was unfamiliar with what was (or was not) available by way of an alternative. The anxiety was also caused by the fact that the innovator was picking up a real problem to solve and the farmers would expect him to deliver an implementable solution before the next season. They would be very disappointed if it did not happen. The new situation in which the researcher found himself in called for link with a new knowledge base.

4.5 Institutional links

4.5.1 Indian Institute of Packaging Management

Despite the anxieties he decided to proceed further. Better packaging was a widely-felt need of large number of growers, and there wasn't any on-going initiative in Gujarat region to fulfill it. The innovator felt that with his past experience of working on other problems of engineering nature and the skills of securing cooperation from other resource persons he would be able to make progress. The innovator visited The Indian Institute of Packaging, Bombay, and a leading R&D institution mandated to improve packaging in the country, to find out if they had a packaging that would meet the needs of tomato growers. They said they were aware of their problem but had not been approached by the growers or any one else on their behalf to work on it. They also mentioned that some time back the Ford Foundation had commissioned a research project to study the tomato packaging problem. The study was carried out, some concept designs of boxes were visualized but no prototypes were made or trials conducted. The product had not been developed, as the requirements of the Institutions were not fulfilled. The institution had the knowledge, but had not used that to convert it into a product. It however helped the Innovator to get going. Here the innovator linked attempted to bridge the knowledge gap by tapping a specialized institution.

The search for links was facilitated by the letter written by the innovator to the director of IIP stating that he intended to visit the institute to know the facilities for design and to see whether they had investigated the tomato packing problem. While the interaction with the specialist institution provided the knowledge on work done, it did not carry the link forward for its own institutional reasons. The search of the innovator continued.

4.5.2 Agricultural Universities in the Region

The innovator visited the Agricultural Universities of this region – Anand, Junagadh and Dantiwada - which undertook work on post-harvest technology for the produce in the area. None of the universities had projects aimed at developing packaging for tomato or for that matter any other commodity. The study of processing technologies - the seed processing, ready-to-cook lentils and mango processing- dominated their research agenda etc. Packaging and transportation of fruits and vegetables did not find a place in the research programs. The visit to the agricultural university was not fruitful to solve the problem. Innovator's demand for knowledge was not met by the stock of knowledge in the University. No link could be established. The search continued.

4.6 Industry Link

As there was wide use of cardboard boxes for packaging industrial goods, the innovator decided to visit some of the manufacturers to see if boxes for tomatoes were available. He looked at the yellow pages for addresses of box manufacturers in the city and nearby. He selected to visit Core Emballage, as its office was very near the educational institution where the innovator was working. The company was one of the largest box makers. Core Emballage manufactured boxes for a variety of products – oil, liquor, TV, fridges etc- but had not manufactured for any fresh fruits or vegetables. It was promoted by Sunil Handa,

one of the alumni of IIM Ahmedabad. The innovator used this link to call up Mr. Handa for an appointment.

The innovator explained to Mr. Handa that in Gujarat itself nearly 50,000 tons of tomatoes were grown each year. Given that a peti carried 20 kg, each season 2,500,000 petis were fabricated and sold. Development of a box to replace it offered a huge business potential. As tomatoes were grown in other parts of the country as well, the potential was in fact even greater. Box makers had failed to notice the vast business potential. Mr. Handa appreciated the points of the innovator made and stated that the company would readily extend its cooperation and make its design facilities available to the innovator whenever he wished to undertake the development of boxes. The company had a well equipped design studio, testing facilities and good paper technologists. We need to note here that the innovator provided the link between the knowledge base about the opportunity and the specialized knowledge base of the company. The knowledge link was established through face to face interaction. The yellow pages that provided the address and the association of the promoter with IIM Ahmedabad facilitated the build up of the link. This link provided the impetus for the forthcoming links that made the solution possible.

4.7. Host Institution Link and Evaluation

The innovator formulated a R&D proposal and submitted it to the Centre for Management in Agriculture of IIMA for financial support. The aim and schedule of the project was as follows.

- Collect a sample of various types of packaging containers used for tomatoes in Gujarat.
- Perform compression, drop and vibration test in laboratory on the peti which was clearly the dominant mode of packaging. Identify its positive and negative aspects.
- Design new packaging containers with a view to reduce transit losses in Gujarat conditions.
- Test new systems in laboratory and then in the field.
- Introduce these in the industry.

The project was to commence in March 1998 and end in April 1999. The implementation of the project involved the generation of new knowledge and utilizing it to solve the problem. The requirement of developing the proposal enabled the Innovator to externalize the knowledge gathered so far and articulate the new knowledge required. The proposal was subjected to evaluation by the colleagues at CMA. It met with opposition from colleagues who said that the work of product development was beyond the scope of CMA's mandate. They said that the innovator should restrict himself to highlighting the need for better packaging and leave it to the industry to develop it. The innovator narrated that his survey of literature had shown that such recommendations had been made several times by horticultural scientists and others. He also narrated his disappointing experience of visit to IIP Bombay - the most likely place where such work would be expected to be done- and the visit to a large box makers in the region. Some other colleagues saw merit in the proposal. He got the approval and a support of Rs 60,000. Here the knowledge base of the Innovator enabled him to argue his case fill the

knowledge gap of the evaluators. This exercise facilitated the progress of the innovation. There was a link between the accumulated knowledge base of the reviewers and that of the Innovator.

Evaluation of a proposal brings in opportunities for externalization and facilitates bridging the knowledge gap between the innovator and the evaluators. The proposal of the innovator was evaluated from the perspective of both the objectives and scope of the cenre, and the personal interests of the innovator. The evaluators were flexible in their recommendations. This points to the role of the institution in facilitating innovation. The evaluation and feedback brought to light the challenges the innovator would face in pursuing his idea in a project oriented management school. It meant that the innovator would have to work alone and develop his own mechanisms and processes to build the subsequent knowledge links.

4.8 The Outside Academic Link

The innovator realized that the task was a complex one involving knowledge and experience from more than one discipline and therefore looked for partners. The innovator requested Dr Siripurapu, **a** professor of post harvest engineering from Gujarat Agricultural University, Anand to join him in development of the product. The innovator sought to link the post harvest specialist knowledge with his and industry's engineering knowledge to develop the product. Dr. Siripurapu said he would be interested, but would need his Vice Chancellor (VC)'s permission to join. He asked the innovator to write to his VC seeking permission for him to work with him. The innovator wrote to the VC and got him the permission. But the arrangement did not work because despite the official permission, Dr Siripurapu could not use university facilities for the work. He was required to seek clearance for each step which threatened to slow the progress considerably. Here was an opportunity to link the knowledge of the Agricultural scientist with that of the innovator. Here was also an opportunity to create new knowledge. The opportunity was missed owing to the internal structure and processes of one of the organizations. Staying on would have checked the speed of developing the solution. The innovator decided to go on his own and met this need by referring to published work in the field. The published work was easily accessible. The innovator internalized the knowledge by going through documents the build technical and contextual knowledge. Exhibit 2 provides an illustrative list of references. Going through the publications and assimilating the contents for use in taking the idea journey forward was possible owing to the innovators academic background.

4.9 Next Industry Link

The innovator approached Core Emballage Limited, Ahmedabad, to become a partner in this effort. Sunil Handa, the Managing Director of Core, saw the potential. He entered into an agreement with the Innovator that enabled the innovator to use the design studio and work with Umang Dave, the designer. Part of the costs of development was to be shared by the company and the product would be manufactured and marketed by it when ready. Here was an opportunity to link the specialist's design knowledge with the field and engineering knowledge possessed by the innovator. Mr. Dave had designed boxes for industrial applications. It was his first opportunity to get involved in boxes for agricultural applications. Together they could link their respective knowledge bases and take the idea

forward. The effectiveness in harnessing the opportunity depended on the way the collaboration worked.

4.10 Next APMC Link

The innovator sought the cooperation of the APMC market offices for tests and feedback from traders operating there. The innovator requested the Chairman of APMC for it and he readily extended the necessary cooperation and named Mr. I B Pathak, their Statistical Officer, to interface with us and help when needed. Mr. Pathak also arranged for a group of growers led by Mr. Ghanshyam Patel to interact with and test the prototypes in the field. The growers cooperated because they saw that the effort was directly related to the solution of the problem they had articulated to the innovator only a few weeks earlier. One of the growers also said that when the boxes were ready for market he would be interested to become a distributor. The activity of prototype testing and receiving feedback would link several knowledge bases. The success depended on how the multiple parties involved worked together.

4.11 Harnessing the Knowledge Links

Mr. S. M. Srivastava, an agricultural engineer specializing in post harvest engineering was recruited as a member of the project team. Mr. Srivastava brought to the project the knowledge of field conditions and skills of laboratory work. Umang, Srivastava and Innovator formed the team to take the innovation forward. They evolved the following plan of action.

- Interact with growers again to understand the needs clearly. This involved linkages with grass root knowledge again and get deeper insights into the positive and negative aspects of the petis, the currently used boxes.
- Interact with the market and understand the economics of packaging and other environmental factors. This was to lead to the generation of new knowledge.
- Set the requirements of the new packaging and develop of concept designs and options. This would lead to combination of knowledge.
- Choose the best option after discussion in the team and with the group of Growers and traders, for further development, build prototypes, test in the Laboratory and then in the field. This would lead to the utilization of knowledge.
- Test market, modify if needed based on feedback of users. This would externalize the implicit knowledge of the users and enable the utilization of the new knowledge.
- Develop a marketing plan, launch the product: This would lead to the utilization of knowledge and completion of the journey from idea to innovation.

4.12 Knowledge Consolidation and Generation of New Knowledge

The interaction with the growers and in the market led to the consolidation of old knowledge and generation of new knowledge about Petis and their economics. Petis were of three different sizes, the most common had the outer dimensions of 42x30x28 cm, and held about 20 kg of tomatoes. The other two held about 25 kg. Growers purchased petis close to the time of use. There were sellers in Ahmedabad city and some also near the farms in villages. The prices varied between Rs. 8 to 15 / peti. Petis were fabricated at the Box Market in Behrampura, Ahmedabad, with wood slats from timber processors

usually of neem, mango, deodar, nilgiri, etc. Slats had coarse finish. Box making was a hammer-and–nail job done by families at home or at select locations near farms. There was wide variation in dimension, tare weight, firmness of joints, and mechanical strength. Petis in transit underwent handling abuse (drops and shocks), were compressed when stacked, and encountered vibration and shocks induced by unevenness of roads. During transport, petis were stacked in columns of four to six. Thus, the bottom peti would have on it a static load of about 125 kg. On occasions there could be some extra load, such as person sitting atop. Peti should be capable of resisting a static load of 250 kg without excessive deformation. Under a load of 250 kg, deformation did not exceed 6 mm. This was quite satisfactory.

As was required by test protocols of boxes - drop, compression, and vibration tests were done on the peti in the laboratory of Core. A sample of petis was dropped sixteen times and damages were noted. It was observed that the best petis could not retain structural integrity beyond 10 to 12 drops. The content (tomato) incurred damages - burst, skin discontinuity, bruises - of around 5 per cent. This suggested that the petis were strong but did not cushion the shocks to protect the produce. Based on its study, the team inferred that the scope of improvement in the peti was limited, given that these were produced with low-skills , simple tools and raw material of varying quality. An alternative to peti that could go a longer distance on roads without excessive damage to produce was considered desirable. The results of tests carried out on petis were published. The innovator continued to document the progress and publish them. Exhibit 3 provides an illustrative list of the publications. Here was an attempt to establish links with a professional community and get them involved in the innovation directly or indirectly.

4.13 Utilization of New Knowledge

Following was the process of utilizing the new knowledge and developing an alternative packing solution. Two options were considered in detail for developing a viable alternative solution - plastic crates and corrugated fiber board (CFB) cartons. Crates were already available in various sizes in all parts of the country and met the requirements of stacking strength, withstanding use and abuse, absorb shock and be economical. The problem with these was that they were very expensive. These could be used only if a system of retrieval was in place – that is the empties were returned to the grower for reuse. That was not feasible in tomatoes. Therefore the CFB was selected for development. The details of the criteria are listed in Exhibit 4.

As the design work started the team was faced with a knowledge gap. There was dearth of data related to tomato grown in Gujarat- bulk density of tomato, size of fruits, shape, Rheological properties - firmness, bio-yield point, respiration rates under regional ambience etc. The gap was bridged with the team's own study. The data was obtained using farm fresh tomato of the growers group at Khanderaopura. Rheological properties were measured at the facilities of the Gujarat Agricultural University, Anand. Again a link with specialist knowledge was established. Three different boxes VC-20, VC-10 and VC-10 were designed. These were produced in quantity (3000 each) for trial at Core Emballage. The team established a link with the accumulated production knowledge of the company. Field trials included road journey of about 250 km from farm to market. In the trial, one-half of the truck was loaded with tomato packed in petis and the other half with produce packed in VC-15 and VC-20. Overall damage in petis was found to be higher (4.6 per cent) than that on Vastrapur cartons (2.8 per cent). The boxes appeared to

be satisfactory in performance and an improvement over the petis. The test results of the boxes were also published (Sharan et al. 1999). The new cartons were introduced in the Gujarat market in October 1999. Cartons were launched from Sanand area - where the problem was first identified. A public event was organized in the village Khanderaopura, growers attended in large numbers. Cartons were put on displayed and question and answer sessions organized. A network of local dealers was also arranged to distribute and market the cartons. The farmers who had been with the innovator since the beginning were the ones involved at this stage also. The village Khanderaopura was the one from where the innovator had started his innovation journey. The knowledge cycle was thus complete.

The team members decided to keep track of the progress of adoption of the boxes in the field for at least one year. They also chalked out plans to collect feedback of users and traders some time into the season. In December 1999, there was a meeting of the CMA faculty with the officials of the Ministry of Agriculture. A presentation of the project outcome was made. The officials commented that it was 'one of the most useful work' done under their grant. The CMA research coordinator also sent the project report to reviewers outside gave positive reactions and recommended that it be published. That was done.

5. The Secondary Journey

Soon after the launch of Vastrapur cartons, the innovator was approached by the International Development Enterprises (IDE, India), an NGO working with small tomato growers in the hills in Himachal. IDE noticed that growers used wooden boxes called `***peti***' to pack and transport their produce. But the Himachal government had just passed a law banning felling trees to make the petis. Pine trees were mostly used. IDE perceived that an alternative would need to be developed urgently. A systematic search by IDE brought CFB boxes that the innovator had developed for growers of Gujarat, to their notice. Subsequently a group from IDE visited IIMA, took a sample of boxes checked with the growers in Solan area and selected VC-15 for trial. Two thousand and five hundred boxes were manufactured and taken to Solan. The approach was repeated here. The knowledge base of the innovator was stronger. He linked it with the knowledge in the field. It was easy to reuse the knowledge. Reuse was possible as the innovator had documented the various stages of the journey.

The innovator visited the area in Himachal to observe the conditions and discuss with the growers their requirements. The post harvest phase of tomato handling and movement was observed and documented. Mr. Kishor Rawale had by then joined the team and Mr. Srivastava had left. Almost all aspects were similar here except one – the harvest season here got some rains and therefore the cartons will need protection not needed in Gujarat. A positive aspect was that the tomato here was off-season and attracted much better prices making it easier to spend some more for packaging.

Pine wood was commonly used to make peti. There was a well developed and efficient network through which growers get their supplies of kits from which to assemble petis when needed. Kits consisted of sets of wood strips cut to measure. Suppliers delivered the kits at a convenient pick-up point on the road side near the farms. Growers needed only to use hammer and nails to assemble the peti from the kits. It takes about four minutes to assemble one. Peti had provision for aeration, and smooth inner finish, though nails might

some time be protruding. Tare weight of freshly made peti was 2.7 kg. Tare was less if the wood used was relatively drier. Petis were usually available for Rs.18-20 per piece. The growers indicated that they liked the VC-15 box. But before finalizing the choice they required that a transport trial be organized from their area to Delhi. They set the aims of trial as follows.

- To see whether VC-15s withstand the rigors of road journey from Solan to Delhi and to see how well these protect the produce.
- To obtain feedback from growers, traders and others on various features of the boxes- ease of filling, handling, price etc.
- To develop second generation boxes suitable for Solan area taking into accounts the results of the trial and feedback.

Overall damage to the produce was 1.5% in VC, nearly half of that in the (2.1 %) in the petis. The growers who witnessed the trial also suggested modifications relating to the capacity of the box, placement of ventilation holes, side grip, moisture resistance and competitiveness in pricing. The modifications were carried out and the new box - Himachal Tomato Kisan bandhu- was made available in the market in Delhi and Simla area. As a part of the feedback session with the farmer, the Innovator and his associate were asked by the farmer how strong was the box. The answers were given in terms compressive strength of the box. The farmer did not understand. There was a knowledge gap. The innovators lacked the vocabulary to express their technical terms in a way that the farmer would understand. They expressed in the way that came naturally to them. The farmer posed the question again and tried to find the answer himself by putting a plank on top of the box and standing on it. The innovators photographed this and used it as a means to communicate the strength of the box to other potential users. In a way the photograph embodied the answer to the question of the users.

6. Analysis and Discussion

6.1 Triggering Point

We use the term ‘triggering point’ to mark the event that triggers the idea of developing a solution to an imbalance noticed by the innovator. Noticing could be conscious and coincidental. The triggering point has an explicit knowledge content that links with the tacit and accumulated knowledge of the innovator. An innovator recognizes an imbalance between what is happening and what should happen and develops solutions that eliminate or reduce the imbalance. In this case the innovator saw an imbalance between the aspirations of the growers and their realization, between the potential to supply and the actual supply. There was demand supply imbalance - the demand for tomatoes in one region and the inability to respond to the demand despite adequate production owing to difficulties in transporting over long distances. The innovator himself did not have answers to the various questions that got generated when he thought of responding to the innovation trigger. He was not capable of generating the answers either. He had to seek support from others. He engaged in both related and unrelated activities to get the knowledge links in place and develop the product. In the process he generates new knowledge and links with the old. The success of the innovator in developing the links is not dependent on the innovator alone. He needs support from the community. The

community's response provides him an opportunity to access the accumulated tacit and explicit knowledge prevalent in the community.

6.2 Multiple Knowledge Bases

The insight obtained from both primary and secondary journeys is that for an idea to fructify into innovation, the innovator needs to link himself with multiple knowledge bases. In this case he needed the knowledge of sciences like physics and mathematics, post harvest technology, farmers' knowledge on tomato growing, transportation and selling, paper technology and mechanical engineering. The need for different knowledge bases arises as the journey progresses in the format of questions, answers and new questions. The innovator needs to build a network of innovation associates to make the knowledge available and link them. The innovator did not have an idea of paper technology. He was familiar with metals and other common engineering materials. He filled this gap by referring to the existing base in the library and linking himself with the design engineers at Core. Dialogue takes the innovator from the familiar to the unfamiliar.

6.3 Innovator's Background and Involvement

The experience narrated here points to the persistent role of the innovator in making the links happen. His academic and researching background enabled him to accomplish the journey. Called up APMC and made the initial contact. He made the field visit, he investigated the damages, he studied the technical literature and supplied the post harvest knowledge needed, he worked with the designer at Core Emballage, and he explicitised the knowledge through conference papers and shared it with colleagues. All this may not have been possible if the innovator did not have the background discussed in the case. In that case he may have had to rely on linkages among the associates. This could have worked for or against the speed of progress depending on the time taken to link and provide or generate new knowledge. Innovators need to engage in both exploration and exploitation. (March, 1991). The benefit that the innovators may derive from the knowledge links is limited by their absorption capacity. This capacity of the firm is the ability to "recognize, assimilate, and utilize external knowledge". (Phene et al, 2006, p 373). The research orientation of the innovator and his academic back ground endowed the innovator with a high absorption capacity. He was able to assimilate knowledge from a wide range of disciplines and speed up.

6.4 Innovation Associates and the Knowledge Links

We use the term innovation associates to include all those who get associated with the with the journey of the idea to innovation either at the instance of the innovator or on their own. Each associate participates in a knowledge exchange with the innovator. They also participate in new knowledge creation and utilization. The links in the knowledge journey could be between the associate and the innovator or among the associates themselves. The innovation associates in the Vastrapur Cartons were: colleagues at CMA in IIMA, Chairman and Managing Director of APMC, Pathak, Researchers at the Indian Institute of Packaging, Agricultural Universities, Sunil Handa and Dave of Core Emballage, Farmers, Channel Members, and conference delegates. Each of the associates had a useful knowledge component to contribute and take the journey forward. Associates

from Core Emballage contributed their knowledge based from industrial applications, design and testing, and building new products. The farmers contributed their knowledge of farming and transportation difficulties. In way the innovation associates contribute the knowledge of the external community to the innovation process. The associates also participated in new knowledge creation and absorption when they participated in various trials and experiments of the innovator.

Establishing a knowledge link between the holders and the seekers of knowledge, requires that there is a mutually of interest between the two and the incentives are sufficient to facilitate the transfer. While some of those whom the innovator approached for support, appreciated the problem but did not contribute for want of sufficient incentives. There were also constraints in terms of institutional processes. Therefore the ease with which the link is established is dependent on the mutulity of interests and institutional processes. The link with researchers at the Agricultural University was more difficult to come forth than with Core Emballage.

6.5 Conceptualizing the Knowledge Journey

Based on the above narration, we can conceptualize the knowledge journey as follows:
To begin with, the innovator uses ***readily available*** knowledge residing with him or with the innovation associates identified by him to state the problem and outline the solution possibilities. Innovator experiences the gap between ***knowledge needed*** for accomplishing innovation related activities and ***knowledge that is readily available***. He/she and proceeds to search for other associates who might have ready to use knowledge and/or creates the needed knowledge through experiments, field visits and observations. The activities the innovator engages in have the following effect. They bring the associates – invited by the innovators and volunteers- together and provide them an opportunity to reveal their knowledge. They generate new knowledge and link the revealed knowledge with the new knowledge. The knowledge links get established as the innovator moves from one activity to the other. The links were seen among Tacit Knowledge with individuals, Knowledge embodied in products and processes and Documented Knowledge through Interactions with innovation associates, Interfaces with institutions and self absorptions. The link facilitators have been correspondences, visits, partnerships, library search, outsourcing, experimentation, conferences and brainstorming. Knowledge is embodied in end products, prototypes, practices- way of doing one activity, processes: way of doing several activities in an order and routines - repetitive activities

We can distinguish between two types of linkages. The innovator links the activities with diverse knowledge bases he himself has or has created. This is dependent on the profile of the innovator. The innovator could leverage on his knowledge accumulated from his research as an agricultural engineer and the resolution of problems like cooling systems based on deep soil temperature. He could also build on the theoretical knowledge gathered from graduate studies. We call this ‘self link’. The innovator links his knowledge with outside knowledge; we call this ‘outward link’. We can also distinguish between knowledge and existing knowledge; we call this ‘extant link’ and links between new knowledge generator by the innovator or other associates for the purpose of facilitating innovation developing activities. We call this ‘novel link’. The nature of links could be ‘transaction specific’ or ‘repetitive’. The latter links are those that get used again and again in the innovation journey.

7. Guidelines for Innovators and Innovation Associates

Based on the above we can develop the following guidelines for innovators and innovation associates.

7.1 Responding to Triggering Points

Triggering points for ideas for innovation occur whenever there is an imbalance between supply and demand. Either there is excess supply as in case of tomatoes or there is excess demand. Drucker (1991) points to triggers arising from 'unexpected occurrences, incongruities, process needs, industry and market changes, demographic changes, changes in perception and new knowledge'. The innovator needs to recognize this and link it with his accumulated knowledge base. This link would throw up new questions or provide answers to the questions of the triggering point. The unanswered questions point to the knowledge gap and the need for search and linking. The links could be in the familiar or unfamiliar environment of the innovator. There is a need for sustaining the search for links and building the response. The innovator may not succeed in establishing the links at one go. Three would be cold responses and inappropriate search. The knowledge journey conceptualized by us would enable the innovators to prepare themselves adequately to respond to the trigger points.

7.2 Learning, Leveraging on What is Available and Whatever is Happening

The experience analysed here also points to the need for continuous learning and updating on the part of the innovator. The focus is on establishing the self link forcefully. In this process he/she not only taps into his/her tacit knowledge and explicitises for use of self and others, but also adds new knowledge to his existing stock by reading, field visit and interaction with specialists.

Instead of waiting for all links to fall in place at one go, the innovator could leverage on what is available for the following: Reassessment of the knowledge gap, building new bases of knowledge and utilization for building a concrete product or service. The innovator could create documents and share the knowledge gained explicitly and seek support from new and old associates. Once the knowledge is explicitised or a concrete product is made available it generates spin offs and opportunities for new ideas or further refinements. The innovator needs to be sensitive to this and build the next trigger point. Pursuing the spin offs provide new knowledge links and take the network of innovation associates further.

7.3 Adapting to the Constraints of Innovation Associates

The innovator needs to recognize that the innovation associates operate with their own interests and constraints. The innovator needs to adapt to the constraints instead of giving up. At times there is tendency on the part of the innovator to do everything himself or herself and deny the benefit of specialized knowledge. This makes the journey inefficient and at times ineffective. He or she could also see whether the constraints could be worked around. The task here is to get the knowledge flowing, however small the contribution may be. The agencies and actors in the environment can become an innovation associate and facilitate to augment the speed of innovation. They would also get access to the

problems, technologies and solutions in other domain that could be of help to them. Working with a new set of innovation associates expands the knowledge net. The flexibility of the host institution can play a role in enabling the Innovator to adapt to the constraints of the innovation associates.

7.4 Keeping Systems and Structures Flexible

Institutional environment – shaped by its structure, systems and processes- plays a crucial role in encouraging or constraining idea generation and follow through to innovations (Rosenfeld and Servo, 1991). Institutions with flexible systems and structures can support building and strengthening knowledge links. Flexibility is required in permitting exploration and exploitation of new linkages. They can provide incentives like seed grants, free allowances or free time to experiment and play with ideas and experiments. The experience of 3M is the most quoted in this context (Mitchell, 1991). The institutions can be supportive evaluators. We have seen that supportive evaluation is essential for the externalizing the tacit knowledge of the innovator and setting up alert signals. Evaluation helps clarify the ideas and approaches of the innovator. We should also recognize here that they could play a dysfunctional role by discouraging the innovators from traveling further. By virtue of its reputation and image it could also act as a facilitator in accessing external knowledge.

Rigidity in the institution prevents the innovator and the innovation associates from taking the knowledge journey forward and enabling the idea to fructify into innovation. There is the risk of the idea being dropped prematurely.

8. Conclusion

In this paper we presented the links in the knowledge journey of an idea to innovation. We tracked the links in the development of customized cartons for packaging tomatoes. We identified different types of links in the journey. The trigger points for the innovation, the milestones crossed by the innovator, the interaction with agencies and actors in the environment, the interests and responses of the agencies and the actors, and the final outcomes were identified. Based on analysis we conceptualized a model of knowledge journey and developed suggestions for innovators and innovation associates.

Exhibit 1
Profile of the Innovator: Girja Sharan

Education

Ph.D. (Cornell, USA)
Agricultural Engineering (*Farm Machinery and Power)*
M.Sc. (Guelph, Canada)
Agricultural Engineering (*Farm Machinery and Power)*
B.Sc. (Allahabad, Agricultural Institute, India) Agricultural Engineering

Dr Sharan teaches two courses - Systems Analysis; and Analogs in Engineering and Management.

Products Developed by Dr Sharan

- **Dew harvest systems** - now commercialized. These devices enable Families and communities living in arid coastal areas of Gujarat to condense Dew water and use it for drinking
- **Corrugated Fiber Board Cartons** for transport of tomatoes available commercially
- **Earth-tube-heat-exchanger** based cooling systems for agricultural and rural application - greenhouse, livestock buildings
- **Arid Area Greenhouse** specially suited for hot arid areas
- **Sol-café** solar eateries for schools and other small community Places in sun-abundant Kutch

Awards and honors

- India Country Level Development Marketplace Award 2004 for dew harvest systems
- Global Development Marketplace Award 2005 for Arid Area Greenhouse
- PLASTINDIA Foundation's award for New Product Development in 2005 For new use of polymers to make dew condensers
- A citation and a trophy Indian Society for Agricultural Engineering Gold Medal 2007

(Medal is the highest honor given by the Indian Society of Agricultural Engineers (ISAE) to its members for outstanding contribution to technology development)

Exhibit 2
An Indicative List of Technical Literature Studied by the Innovator

Building Technical Knowledge

- Technical Association of the Pulp and Paper Industry (1993): "Standard Test Methods for Drop, Vibration, and Compression Test," **Annual Book, 15:09** (Atlanta Technical Association of Pulp and Paper Industry).
- U.S. Department of Agriculture (1991): **United States Standards for Grades of Fresh Tomatoes** (Washington D.C.: United States Department of Agriculture).
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Building Contextual Knowledge

- Patel, V.M. (1995). **Emerging Problems of Agricultural Marketing: A Case Study of Tomato in Gujarat** (Vallabh Vidyanagar: Agro-Economic Research Centre).
- National Horticultural Board (1997): **National Horticultural Board Production Year Book** (New Delhi: National Horticulture Board).
- Bose, E.D. and Som M.C. (1986): **Vegetable Crops in India** (Calcutta: Naya Prakashan).

Exhibit 3

Externalizing the Accumulating Knowledge: Illustrative Publications of the Innovator on the Innovation

- Siripurapu S.C.B., Gabani S.H. and Sharan Girja (1998). "Quality Aspects of Tomato Arriving for Auction at APMC, Ahmedabad," W.P. No.98-06-02 (Ahmedabad: Centre for Management in Agriculture, Indian Institute of Management).
- Sharan Girja; Srivastava S.M., and Monika Khandelwal (1999): "Mechanical Properties of Wood Carton used for Long Distance Transport of Tomatoes," *Packaging India*, 31 (5), December 1998-January 1999.
- Sharan Girja and Srivastava S.M. (1999): "Temperature Distribution in a Tomato Carton," W.P.No. 99-04–03, (Ahmedabad: Centre for Management in Agriculture, Indian Institute of Management).
- Sharan G., Umang D., Srivastava S.M., and Sreenivas P (1999). Performance of Vastrapur Cartons in Laboratory. *Packaging India*, 32:2, June-July 1999.
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Exhibit 4
Criteria for developing the Carton

(a) Stacking Strength
Carton should be capable of resisting a static load of 250 kg without excessive sagging, to permit stacking height of about 2 m common in Indian trucks.

(b) Should Withstand Handling Abuse
Carton should be able to retain its structural integrity through a sequence of at least 15 drops of height 46 cm. These many drops are expected to occur in a single journey from farm to retailer shop.

c) Should Withstand Vibration Shocks
Carton should maintain its structural integrity during transport under Indian road-vehicle condition. Transport distance is 2000 km. Some workers have reported that accelerations as high as 20 g are encountered.

(d) Ventilation
8 holes of 20 mm diameter

(e) Capacity
20 to 25 kg

(f) Material and Environmental Factor
Material used should not create disposal problem.

(g) Cost
About Rs.15 per piece.

(h) Ease of Handling
Provision of grip for handling.

(i) Produce Identification
Graphics printable

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