Survey on
Artificial Intelligence Technology in Thailand

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1. Outline of AI in Thailand

Since the first paper on Artificial Intelligence (AI) was published by Walter Pitts and Warren McCulloch in 1943[1], AI has received much attention and has been researched and applied in various areas such as problem solving, planning, learning, natural language processing, speech processing, robotic etc. It can be seen that there has been a rapid growth in AI technology in America, Europe, Japan.

In Thailand, the research and application of AI technology receives comparatively less attention than in America, Europe or Japan. This may be because the technology is still new to Thailand, and most of Thailand private companies use systems from overseas but do not develop their own systems. AI is fairly known in university sector where there are researchers who were graduated from overseas and familiar to the technology.

This report surveys AI technology in Thailand at present (in 1999). The objectives of the survey were to investigate AI technology in Thailand from both university and business sectors. The survey focuses on:

1. AI in Thai government policy
2. the status of AI research and development in institutes and universities in Thailand,
3. the status of AI application in companies in Thailand,
4. the problems of using, researching and developing AI technology in Thailand,

The survey was partly done by questionnaires. We sampled a set of universities, research institutes and companies. This sample includes the most active institutes, universities and the large or medium sized companies in various areas such as computer companies, telecommunication companies, electric companies, financial business, etc. Then they were requested to answer the questionnaire. The data received by the questionnaire was collected during August to October 1999. The questionnaire was designed to answer the question 2 - 4 above.

To compare the AI technology at present (1999) and that in the past, we summarize the main results of a previous survey on AI technology in 1992 which was reported by Computer System Consulting Co.,Ltd[2]. This enables us to see the growth of the technology between this period.

1.1 The Status of AI Technology in Thailand Surveyed in 1992

In 1992, Computer System Consulting Co.,Ltd., had done a survey entitled "A Project of Study for Determining Plan of Research, Development on AI technology and AI Industry"[2]. The survey was reported to National Electronics and Computer Technology Center (NECTEC). In the report, the status of AI technology in Thailand in 1992 was described. This was based on the data that was collected from questionnaire answered by both government and private sectors. The survey emphasized on (1) the need of AI, (2) the use of AI, (3) the knowledge or

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[1] McCulloch, W. S., and Pitts, W. 1943. A Logical Calculus of the Ideas Immanent in Nervous Activity. *Bulletin of Mathematics and Biophysics* 5:115.

[2] Computer System Consulting Co.Ltd, 1992. A Project of Study for Determining Plan of Research, Development on AI Technology and AI Industry. National Electronics and Computer Technology Center (in Thai).

understanding of these sectors about AI technology, (4) the research on AI, and (5) the fields of AI in Thailand. The main results of the survey are summarized below.

♦ The need of AI technology

The applications of AI technology that were needed in 1992 are as follows.
  - Finance Data Analysis
  - Diagnosis System
  - Energy Conservation
  - Planning and Scheduling
  - High Risk Work
  - Hard Laborious Routine-Work
  - Traffic Arrangement

♦ The use of AI technology

The use of AI technology in private and government (university and institute) sectors is shown in Figure 1.1.
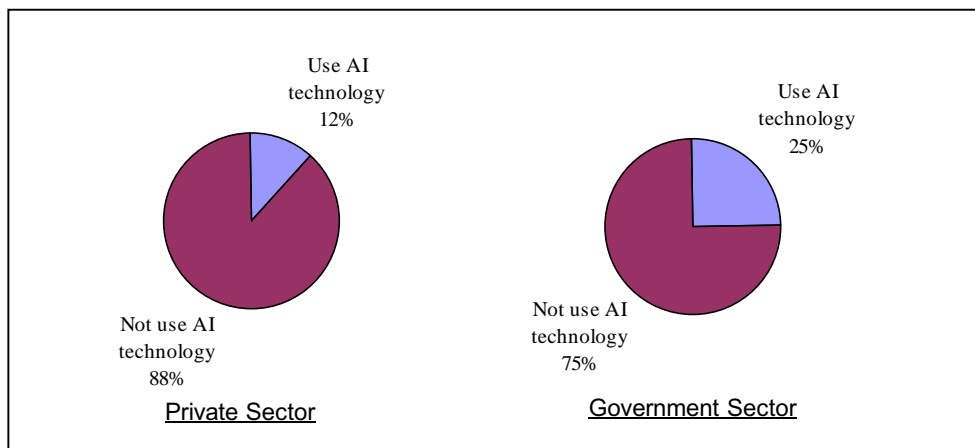
Figure 1.1 The use of AI technology

♦ Knowledge or understanding in this technology

Figure 1.2 shows the percentage of persons, both in private and government sectors, who have knowledge or understanding in AI technology.
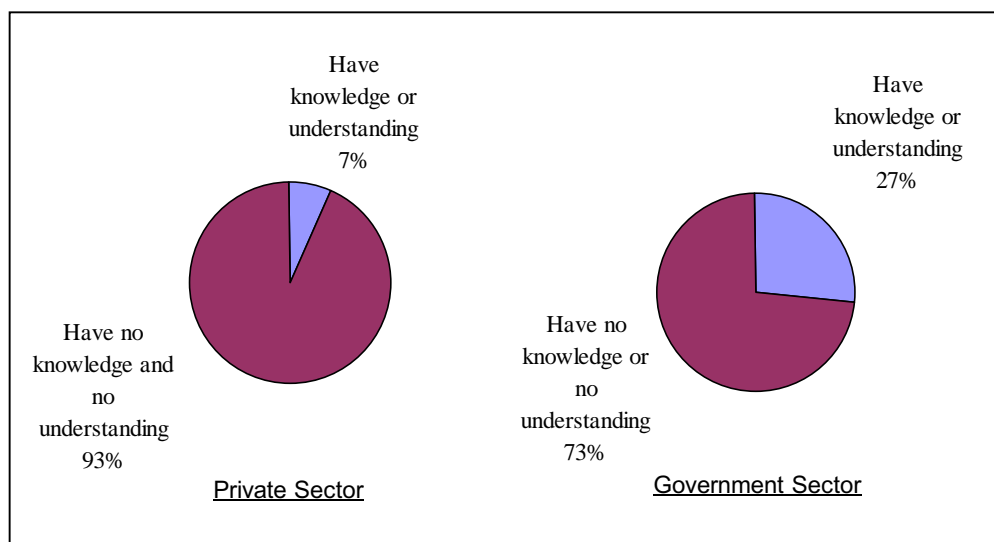
Figure 1.2 Knowledge or understanding in AI technology

♦ Research

Figure 1.3 shows the status of AI research in private and government sectors.

have research
on AI
0%

have no
research on AI
100%

Private Sector

have research
on AI
37%

have no
research on AI
63%

Government Sector
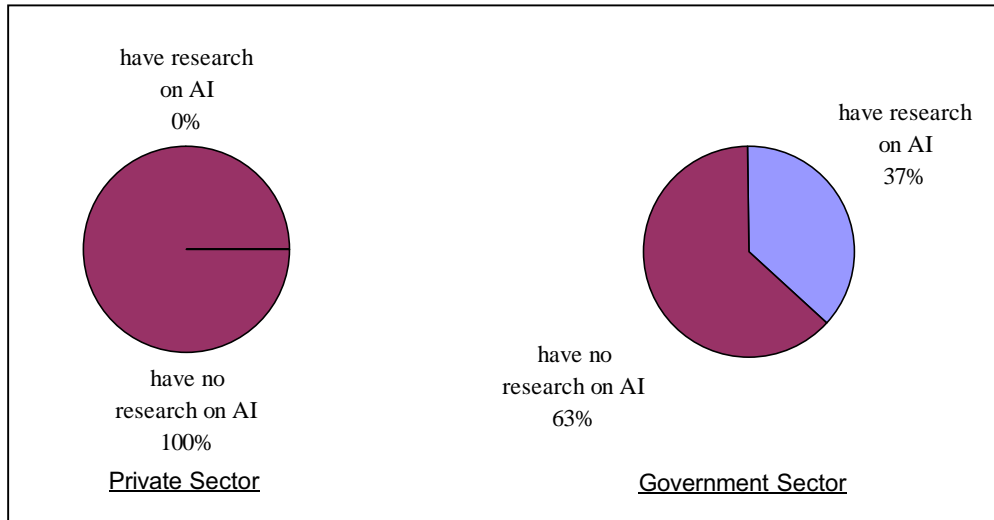
Figure 1.3 The status of AI research

The universities doing research on AI were:
(1) faculty of engineering, Chulalongkorn University
(2) faculty of art, Chulalongkorn University
(3) faculty of science, Mahidol university
(4) Asian Institute of Technology
(5) King Mongkut's Institute of Technology at Ladkrabang and at Thonburi
(6) National Institute of Development Administration
(7) faculty of engineering, Kasetsart University.
Most of research topics were (1) expert system, (2) natural language processing, (3) energy conservation, and (4) planning and scheduling.

♦ The fields of AI

The fields of AI were divided into three groups: (1) the field that received much attention, (2) the field that received attention, and (3) the field that received less attention in Thailand. These three groups are shown below.
- The fields that received much attention
  (1) Natural Language Processing
  (2) Expert Systems
  (3) Planning and Scheduling
  (4) Knowledge Engineering
  (5) Human Interface
- The fields that received attention
  (6) Robotics
- The fields that received less attention
  (7) Visions
  (8) Theorem Proving
  (9) Reasoning
  (10) Machine Learning
  (11) Machine Architecture and Software for AI

1.2 The Status of AI Technology in 1999

The survey on AI technology in Thailand in 1999 is explored by the way of questionnaires and interviewing. This report summarized the results from the survey during August - October 1999. The report is organized as follows. Section 2 describes AI in Thai Government IT Policy. Section 3 summarizes the results of the survey on AI in universities and institutes. Section 4 shows the results of the survey on business sector. The conclusions and suggestions of this survey are provided in Section 5.

For reference, we also include (1) the list of government organizations and universities that are surveyed, (2) the summary of the Eight National Economic and Social Development Plan, and (3) National Science and Technology Development Plan, in the appendix of this report.

2. AI in Thai Government IT Policy

In the country-level policy, there was no specific issue about the development policy of AI including the Eighth National Economic and Social Development Plan (1997-2001)[3] which was written in a way of general policy. However, the Ministry of Science, Technology and Environment (MOSTE)[4] has set a policy about the research and development (R&D) of science and technology (S&T)[5]. The following are the problems and the objectives that are described in the policy.

2.1 The Problem

1. Production of manpower, particularly in the S&T area, does not respond to the country's needs, in terms of both quantity and quality. The existing measure to expand production without increasing teaching and research personnel is simply a short-term solution which cannot alleviate the situation in the long run. Moreover, it results in the transfer of already scarce personnel in universities from the R&D field.
2. There are no linkages between public and private sectors to support R&D in the industrial sector.
3. The technological capabilities of the private sector are still very low, particularly small and medium enterprises although technological capabilities constitute a major factor of survival and progress of the private sector in today's opened economic system.
4. Market mechanisms do not stimulate the private sector to develop their technology.
5. R&D results do not respond to users' needs and are not aimed at improving the well-being of the public, public use, commercialization, and sustainable development.
6. There is no assessment of technologies, particularly those with strong economic and social impacts. Technology transfer systems and the development of potential technologies are also lacking.

2.2 Objective Settings

To cope with this problem, the following objectives are set.

1. To increase the number of researchers by 15 percent per annum with a view to raising the number of researchers from 12,000 to approximately 24,100 in the last year of the Eighth Development Plan by placing the strongest emphasis on the private sector and technologies important to the economy and society.
2. To enhance the linkages between the R&D system geared towards users' needs and high-level personnel production.
3. To develop the research profession as an attractive career choice that offers growth opportunities.

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[3] The summary of the Eight National Economic and Social Development Plan is given in Appendix B in this report.

[4] http://www.moste.go.th/ : The Ministry of Science, Technology and Environment's web site

[5] The summary of National Science and Technology Development plan is given in Appendix C in this report.

4. To increase the efficiency of services provided by the government as well as production and services by the private sector by further developing infrastructure to support the linkages among the R&D, technology transfer, and personnel production systems.
5. To create more concrete and extensive tax, financial, and technical support measures to encourage technological development in the private sector.
6. To stimulate R&D cooperation in the form of a consortium.
7. To set the target for R&D expenditures at a minimum of 0.75 percent of GNP, that is, 0.5 percent of GNP or 2.0 percent of the annual government expenditures for public research and 0.25 percent of GNP for private research, by maintaining basic research at not less than 10 percent of the total.
8. To determine R&D targets in 5 major areas, namely biotechnology; metal and materials technology; electronic and computer technology; information technology; and environment and energy technology in accordance with the technology transfer targets of each sub-sector in agriculture, manufacturing, and services, and to maintain the expenditures on R&D for environment and public use at a minimum of 30 percent of the total R&D expenditures, and to extensively utilize and publicize these R&D results.
9. To create or improve organizations or mechanisms to be in charge of analyzing and formulating a master plan and action plans on R&D in sectors important to economic and social development, and managing future technology assessment as well as technology prioritization.

2.3 Policy on Artificial Intelligence (AI) Research and Development

For the R&D policy on AI, the National Electronics and Computer Technology Center (NECTEC) under the National Science and Technology Development Agency (NSTDA)[6] of the Ministry of Science, Technology and Environment (MOSTE), has included issues about AI research and development in its policy and plan. This includes the research and development of some AI fields such as natural language processing, expert system, intelligent image processing and so on.

Research Fund for Artificial Intelligence (AI) Research

There are some funding agencies for research in Thailand. The most important ones are the Thailand Research Fund (TRF), National Research Council of Thailand (NCRT), National Science and Technology Development Agency (NSTDA). Among these, TRF supports for developing new researchers for various fields, including AI field, through the project named the Royal Golden Jubilee Ph.D. Program (RGJ Program). Table 2.1 shows the number of current grants in this program.

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[6] http://www.nstda.or.th/ : The National Science and Technology Development Agency's web site

Table 2.1 The number of RGJ grants awarded by Thailand Research Fund

COMPARISON OF RGJ. GRANTS AWARDED IN FIRST AND SECOND YEARS. (I: 1998, II: 1999)																
Disciplines	Eng.		Techno.		Phy.Sci.		Biol.Sci.		Health		Agri.		Soc.Sci & Hum		Total	
Awards	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II
No. of PH.D. Programs.	16	12	16	15	15	17	21	18	11	13	11	9	9	9	99	93
No. of Grants	32	19	35	39	44	40	69	46	36	33	25	16	21	17	262	210
No. or Advisors	27	16	31	30	35	33	62	45	32	31	23	16	20	17	230	188
% of Applicants Awarded	32	34	42	57	57	73	51	67	34	65	35	47	42	74	42	59

Source: Thailand Research Fund (1999)[7]

The table shows that there is trend to increase the researchers in various fields in Thailand, including engineering and technologies where AI is included. TRF also supports for developing research communities in Thailand by giving funds for universities or private sectors to develop their own research communities to be stronger. It also gives individual researchers to develop new technologies.

While NSTDA has its own research institutes, (i.e., the National Electronics and Computer Technology Center (NECTEC), the National Metal and Materials Technology Centre (MTEC) and the National Centre for Genetic Engineering and Biotechnology (BIOTEC)), it provides a potential source for research funds. Among these, NECTEC has a laboratory on some fields of AI, including natural language processing (NLP), speech recognition, optical character recognition and image processing. NSTDA gives research supports under the concept called 'Tri-Partite' where government research affairs, universities and private sectors make researches together. Table 2.2 shows the research and development projects that Tri-Partite has supported more than ten years since 1988.

From the table, AI field was supported very well during the 1988-1991. Focusing on these years, we found that the projects were almost related with the cooperative project between the Center of the International Cooperation for Computerization of Japan (CICC), NECTEC and some Thai universities to develop a multilingual machine translation system. CICC and NECTEC are very important cores in developing NLP technology, which is a subfield of AI, in Thailand. Not

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[7] http://www.trf.or.th/ : The Thailand Research Fund's web site for the Royal Golden Jubilee Ph.D. Program and some research funds

limited to NLP, AI is a field that is recognized among a lot of researchers. From recent years, the budget fund for the AI field has been calculated including into the computer software field. Even the number of supported projects decreases, the amount of support fund rarely changes. The fund per a project is increasing. That means there is trend that big projects are taken into account this day. Because of the economic crisis in 1998, support funds for research decreased for these couple years. However, recently NECTEC encourages researchers in Thailand again to generate projects for this Tri-Partite fund.

Table 2.2 The number of R&D projects supported by Tri-Partite

unit: projects

Field	1988	1989	1990	1991	1992	1993	1994	1995	1996	Total
Artificial Intelligence	6	11	7	6	4	1	0	0	1	36
Computer Networking	13	12	13	3	12	10	5	2	1	71
VLSI Design	6	6	5	7	0	1	0	0	3	28
Computer for Medical	2	4	2	5	9	8	2	2	2	30
Electronics and Computer Technology Transfer	2	2	2	3	1	0	0	2	0	12
Electronics Material and Part Development	5	3	2	6	5	6	2	3	3	35
Electronics Circuit Development for Industries	8	4	6	8	0	9	3	3	5	46
Computer Software Development	5	10	9	13	2	8	11	4	6	67
Computer System Technology	3	4	5	6	2	1	0	2	1	24
Telecommunication Device Development	5	4	8	7	1	6	2	1	2	36
Computer Software Development for Industries	0	0	1	1	0	0	0	0	0	2
Electronic Measurement Tool Development for Agriculture	0	0	0	0	0	0	6	1	3	10
Total	55	60	60	65	30	50	31	20	26	397

Source: Tri-Partite, NECTEC, 1999[8]

The trend of AI research fund support is not bad. The AI field is acknowledged very widely among researchers in Thailand. However, because AI supports various fields, such as medical information systems, expert systems for industries and computer-aided instruction, the fund for AI research is also provided as the development of intelligent applications and computer software.

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[8] http://tpt.nectec.or.th/ : The Tri-partite Research Fund's web site

3 AI R&D in Thailand (R&D Institutes and Universities)

3.1 Overview

Currently AI has become a popular research area in Thai universities. This can be recognized by the large number of researches on AI in both R&D institutes and universities. Many universities, including Chulalongkorn University (CU), Thammasat University (TU), King Mongkut's Institute of Technology Ladkrabang (KMITL), King Mongkut's Institute of Technology North Bangkok (KMITNB) and King Mongkut's University of Technology Thonburi (KMUTT). The most active institute that researches on AI is National Electronics and Computer Technology Center (NECTEC). They have their own research laboratories and supports research fund for other research institutes.

For real applications, however, the existence of AI is sometimes not recognized by the end users who directly use such applications such as Thai companies in private sector. In Thailand where most technologies and applications are mainly imported from overseas, the awareness of AI is still low in private sector. Mostly done in universities and government research institutes, AI research is rarely applied in private sector and other government sectors. This section describes the current situation of AI research and development in Thailand institutes and universities. The detail situation of private sector will be described in Section 4.
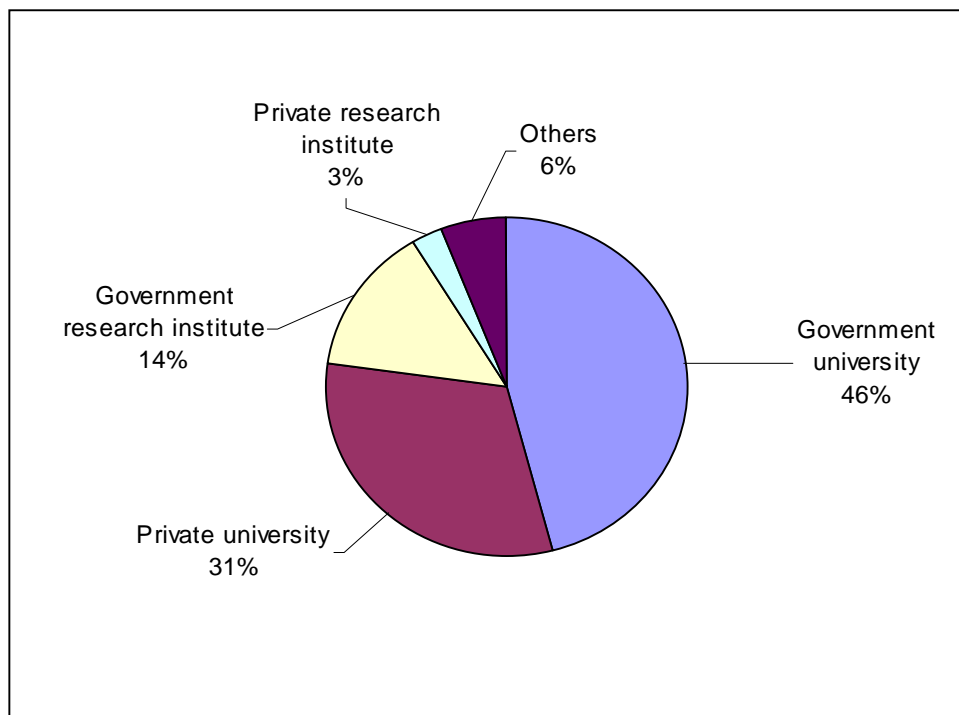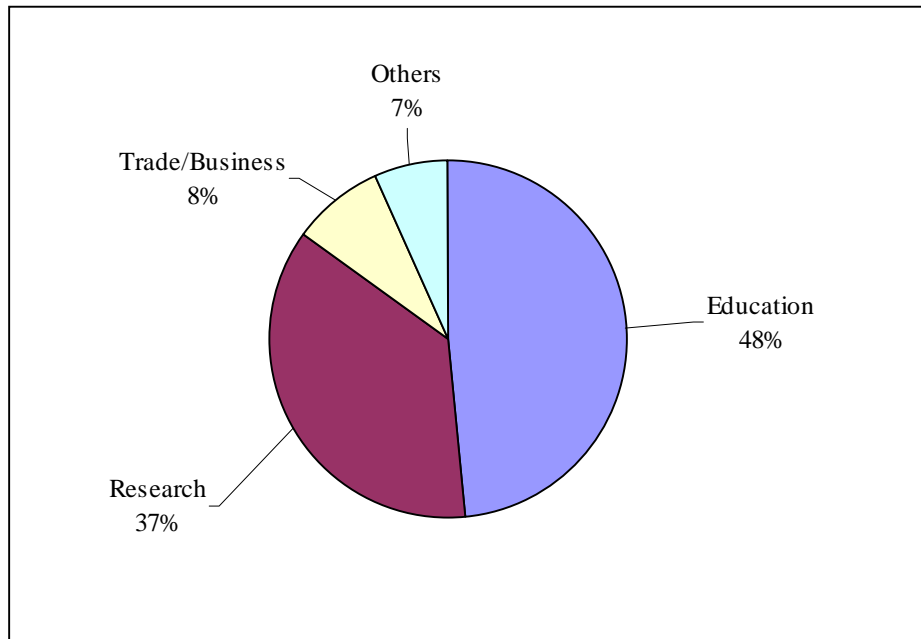

Figure 3.1 The ratio of types of surveyed institutes

3.2 Sampling

To explore the current status of AI research and development in Thailand, we sampled a set of universities, research institutes and companies, and sent them questionnaires.

35 out of 50 (70%) universities/research institutes returned the questionnaires to us. This sample includes the most active institutes such as Chulalongkorn University, KMIT, Thammasat University, Asian Institute of Technology (AIT) and NECTEC (for detail, also see Appendix A). The institutes are not limited to those related with computer science or engineering but other related fields are also explored. The surveyed institutes can be classified into a number of types. The ratio of the types is shown in Figure 3.1. The institutes we surveyed are mostly universities rather than research institutes. Among the surveyed institutes, their objectives are mainly research and education as shown in Figure 3.2.

Figure 3.2 The ratio of purposes of surveyed institutes

3.3 Existence of AI in Thailand R&D Institutes and Universities

In this subsection, we investigate how much AI research and application exist in Thailand. Table 3.3 shows the numbers of institutes that do research and/or apply such research to real applications.

Table 3.3 the numbers of institutes that do research and/or apply to real applications

Research	Application		
	Yes (+A)	No (-A)	Total
Yes (+R)	16 (46%)	11 (31%)	27 (77%)
No (-R)	4 (11.5%)	4 (11.5%)	8 (23%)
Total	20 (57%)	15 (43%)	35 (100%)

From the table, we found that 77% of institutes (+R) do research on AI while the rest 23% (-R) do not research on this field. 57% of institutes (+A) apply or use some AI applications while the rest 43% (-A) do not apply or use any AI applications. These numbers indicate that AI research and AI applications get a lot of interest in

R&D institutes and universities in Thailand. Among the total institutes, 46% (+R+A) do research on AI, and apply or use some applications while 31% (+R-A) do research on AI but do not apply or use any AI application. 11.5% use some AI application but do not research on AI. By this view, we can classify the institutes in the table into four groups as follow.

(1) Institutes that do research on AI, and apply or use some AI applications(+R+A)
(2) Institutes that do research on AI but do not apply or use any AI application(+R-A)
(3) Institutes that do not research on AI but use some AI applications(-R+A)
(4) Institutes that do not research on AI and do not use any AI application(-R-A)

To examine the status of AI research and development (R&D) in Thai R&D institutes and universities, we first investigate the areas of AI researches in the institutes as shown in Section 3.4. Next, we explore the characteristics of each group in Section 3.5.

3.4 Research Areas

The areas of research in AI are plentiful and varied. Concepts in AI can be introduced to a large number of applications to make them act more intelligently than the traditional ones do. In Thailand, the research and development areas include:

- Speech Processing
- Natural Language Processing (NLP)
- Expert System
- Image Processing
- Machine Learning
- Robotics and Other Mechanical Instruments
- Intelligent Computer-Aided Instruction (Intelligent CAI)
- Intelligent Information Retrieval, Information Extraction and Summarization
- Database, Data Mining and Knowledge Engineering
- Intelligent Control System
- Forecasting System
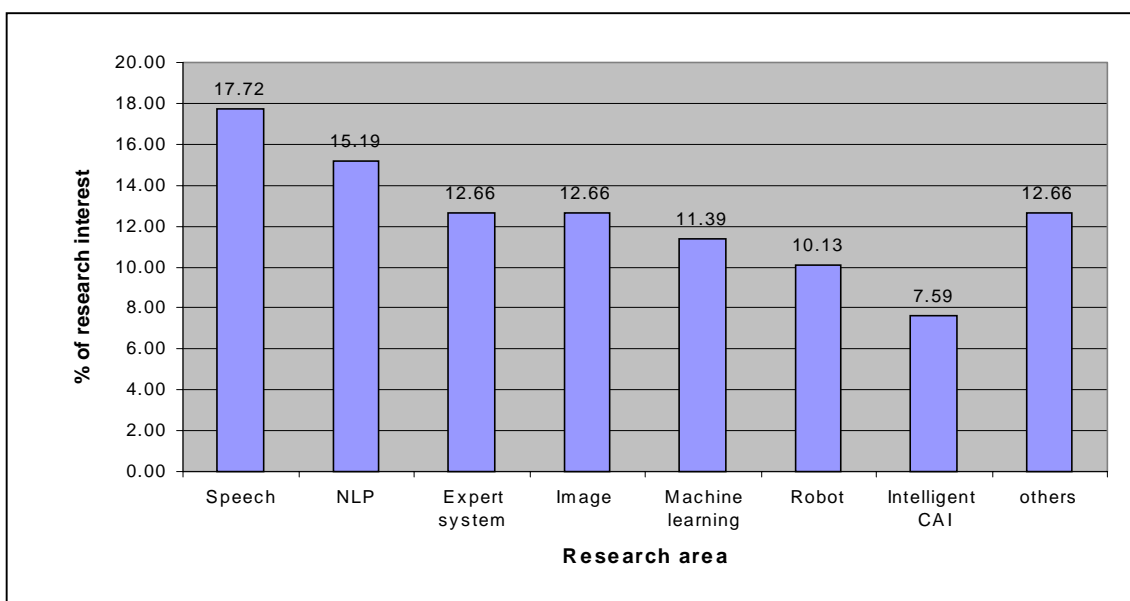
Figure 3.4 The ratio of R&D areas in R&D institutes and universities

Figure 3.4 shows the ratio of R&D areas in R&D institutes and universities. Among these areas, speech processing and natural language processing are the most popular research areas in Thailand. Research on Thai language can be made more easily by Thai native researchers than by the non-natives. Expert system and image processing are the next popular areas for research. Instead of basic research, the study of AI is concerned more in the application research.

Besides this, the areas of applications used in Thailand are shown in Figure 3.5. We found that the speech processing is the most popular application developed in Thai R&D institutes and universities. Image processing is the second-rank application. The detail of each research area is provided in the following.
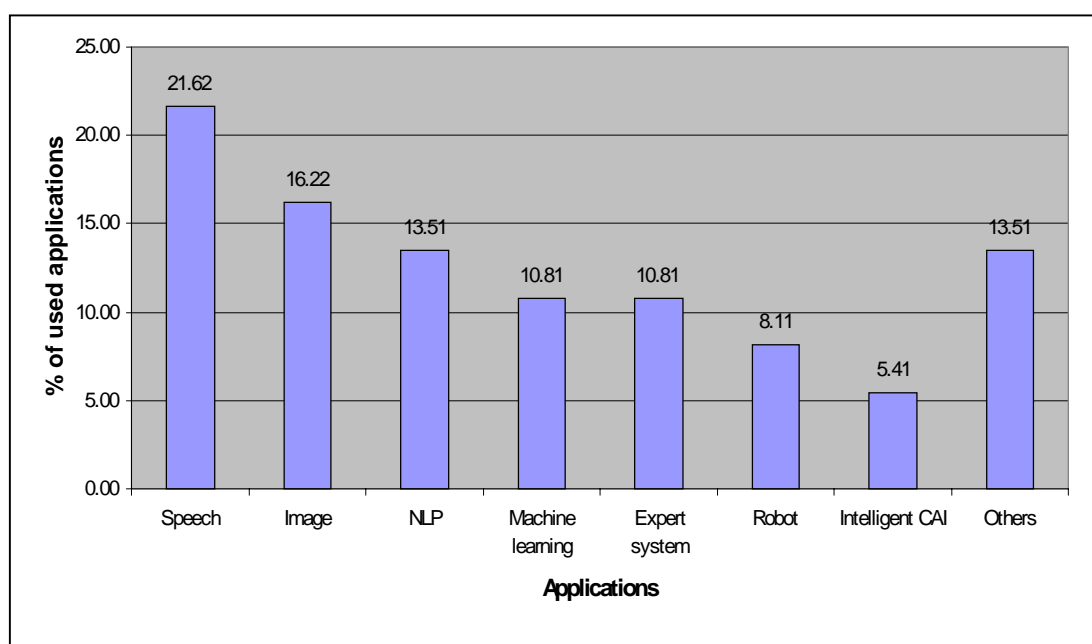
Figure 3.5 The ratio of application areas in R&D institutes and universities

3.4.1 Natural Language Processing and Speech Processing

Natural language processing is one of the dominant AI fields in Thailand. Thai language has its unique characteristics, such as no word boundaries, no sentence boundaries and less case makers. These features make the language difficult to be analyzed. This AI area is a strong area in Thai because Thai language is usually used by Thai native speakers rather than foreigners. In this area, the following topics are made.

- Machine Translation
- Word Segmentation
- Error Correction in Natural Language
- Speech Recognition
- Speech Synthesis, including Text-to-Speech Synthesis
- Speaker Identification

Machine translation is a direct application of natural language processing. From 1987-1995, an international cooperation project, namely, CICC-NECTEC Multilingual Machine Translation Project had been launched to develop a machine translation system which can translate among five languages of Thai, Chinese,

Malaysian, Indonesian and Japanese through a designated intermediate representation called "Interlingua". Supported by CICC, this project started with anxiety about the research background of Thai language and the infrastructure of Thai researchers in the field. While NECTEC was the center of the project in Thailand, a lot of research institutes and universities actively conducted the research on natural language processing, such as King Mongkut's University of Technology Thonburi (KMUTT, previously KMITT), King Mongkut's Institute of Technology Ladkrabang (KMITL) and Chulalongkorn Univerity (CU). The CICC-NECTEC project succeeded in some extents. Thanks to this project, there have later been a lot of researches on natural language processing up to present.

Because Thai language does not have a space between words in a sentence, word segmentation is an important process for segmenting a continuous string into words. At the present time, Thai language word segmentation is successfully performed better than 95 % of accuracy. However, word segmentation is still a challenging problem until now. In the 2000 international symposium of natural language processing (SNLP-2000), NECTEC and Kasetsart University will arrange a contest on word segmentation.

Besides text processing of natural language, speech processing, both speech recognition and speech synthesis, are other popular research areas in Thailand. Most Thai universities and institutes including Chulalongkorn University, NECTEC, King Mongkut's institute of Technology, Kasetsart University, have their own laboratories on speech processing. Research on speech synthesis includes text-to-speech processing and Thai-typing-to-speech processing. For speech recognition, NECTEC, KMITN, KMUTT, Chulalongkorn University and Kasetsart University are developing their own systems. Chulalongkorn University has a research on speech encoding and decoding. There is also research on analyzing Pali/Thai language of the Buddha's teachings, to build an electronic version of the teachings at Mahidol University. Some research attempts to apply machine learning algorithms to deal with ill-formedness in natural language.

3.4.2 Expert System

Research on expert systems is very various. This technology can be applied in many fields, such as mechanics, electronics, environment science, energy science, and so on. This area is also very popular in Thailand. The following are the topics done in this area in Thailand.

- Agricultural Expert System
- Student Consulting System for Registration Process
- Environmental Expert System
- Energy Saving Expert System
- Medical Expert System
- Expert System Shell

Kasetsart University develops an expert system for analyzing soil stability and its problem. Systems for aiding registration process are developed in some private universities, including Bangkok University, for consulting their students to register efficiently their study courses. A system for waste water and garbage management is developed at King Mongkut's Institute of Technology North Bangkok (KMITNB). This system intelligently analyzes pollution status for the Pollution Control Section in Thailand. Research on an expert system for energy saving control is done by using

neural network approach by KMUTT. Bayesian networks and Fuzzy logic are applied in medical diagnosis system which is developed at Assumption University. Rangsit University develops an expert system shell.

3.4.3 Image Processing

The second popular application in Thailand institutes and universities is image processing as shown in Figure 3.5.

- Thai Optical Character Recognition
- Hand Written Thai Character Recognition
- Texture Analysis
- Medical Photograph (X-Ray) Recognition
- Image Processing for Agriculture Product/Plant Classification
- Geographical Information Systems (GIS)

Research on image processing for medical purposes is made at Chulalongkorn University, Naresuan University and so on. Many researches are made on optical character recognition at several universities, including Chulalongkorn University, KMITL, Rangsit University and Mahanakorn University. Image processing applications on agriculture product and plant are made at KMUTT for recognizing quality of fruits and rubber. Some universities also study about shape recognition and digital signal encoder/decoder. Mahanakorn University has a research on face recognition. Texture analysis using image processing is done at Mahidol University. Applications of pattern recognition to hand written Thai character recognition is done at Mahidol University. A GIS system combined with NLP technology is developed at Kasetsart University.

3.4.4 Intelligent Computer-Aided Instruction

Intelligent computer-aided instruction is also an interesting area but still gets very little attention from Thai researchers. The following are the topics done in some Thai institutes.

- CAI for Teaching Computer Usage
- Typewriting Teaching Systems for Blinds
- Teaching Aiding Systems for Lecturers
- Instructing Digital Filter Design

Research on intelligent computer-aided instruction is done at Chulalongkorn University, Kasetsart University and South-East Asia University. Bayesian network tutoring shell is developed at Assumption University for teaching medical diagnosis.

3.4.5 Robotics and other mechanical instruments

The following are the research interest in this area.

- Electric Chairs for a Cripple
- Robot Contest

There are a lot of universities that develop their robots for robot contest, including Chulalongkorn University, KMITL, KMUTT, KMITNB, Kasetsart University, Mahanakorn University and Bangkok University. Besides this, these universities and also Naresuan University develop robots for other purposes, including for industries. Bangkok University is developing an electric chair for a cripple where AI is introduced. Robot learning research is made at Chulalongkorn University.

3.4.6 Information Retrieval, Extraction and Summarization

Apart from natural language processing, some topics on information retrieval are done as follows.

  - Full Text Search
  - Index Search
  - Text and Document Retrieval

Text and document retrieval researches are made in several institutes including NECTEC, Kasetsart University and Sirindhorn International Institute of Technology (SIIT -Thammasat University).

3.4.7 Database, Data Mining and Knowledge Engineering

Some research applies AI on database, data mining and knowledge engineering as below.

  - Deductive Object-Oriented Database
  - Data Mining
  - Intelligent Database

Research on deductive object-oriented database and intelligent database is made at some universities including Chulalongkorn University, AIT, Sirindhorn International Institute of Technology (SIIT -Thammasat University). Data mining is also made at SIIT. Fuzzy temporal knowledge management and rough set application is researched at Mahanakorn University.

3.4.8 Forecasting Systems and Decision Support Systems

Forecasting is one of interesting applications of AI. In Thailand, the following topic is done in R&D institutes and universities.

  - Flood Prediction

Introduction of AI to predict phenomena, such as flood prediction, is done by some universities and institutes, such as NECTEC, Chulalongkorn University and Assumption University. NECTEC has its own supercomputer for processing a very large scaled data. Assumption University has a research on decision-theoretic planning and probabilistic reasoning.

3.4.9 Intelligent Control Systems

Some universities and institutes research on intelligent control systems. These include NECTEC, KMITNB, Naresuan University and Mahanakorn University. The following are the topics in this area.

  - Temperature Controlling System by Fuzzy Logic
  - Intelligent Instrument and Control System in Industries

3.4.10 Games

A lot of universities have research on game theory. Bangkok University develops a Thai chess program.

  - Thai Chess Game

3.5 Four Types of the R&D Institutes and Universities

In Section 3.3, the surveyed institutes are classified into four groups:

(1) +R+A: Institutes that do research on AI, and apply or use some AI applications
(2) +R-A : Institutes that do research on AI but do not apply or use any AI application
(3) –R+A: Institutes that do not research on AI but use some AI applications
(4) –R-A : Institutes that do not research on AI and do not use any AI application

Based on this result, this subsection provides an analysis on the survey. The percentages of the number of institutes in the groups are 46%, 31%, 11.5% and 11.5%, respectively. To find the difference between +R+A and +R-A groups, we plot the ratio of research interest as shown in Figure 3.6 and 3.7. From the graphs, the most popular fields for both research and application are speech recognition. Natural language processing research can be applied in any applications while image processing research seems to get less attention in its application. Expert system is a moderately dominant field in both groups.
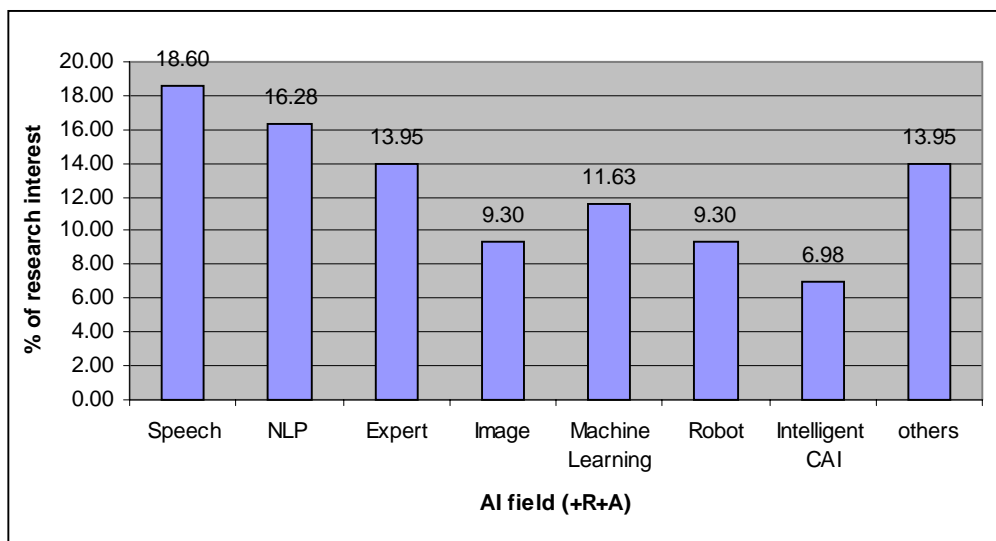
Figure 3.6 The ratio of research interests of the +R+A group
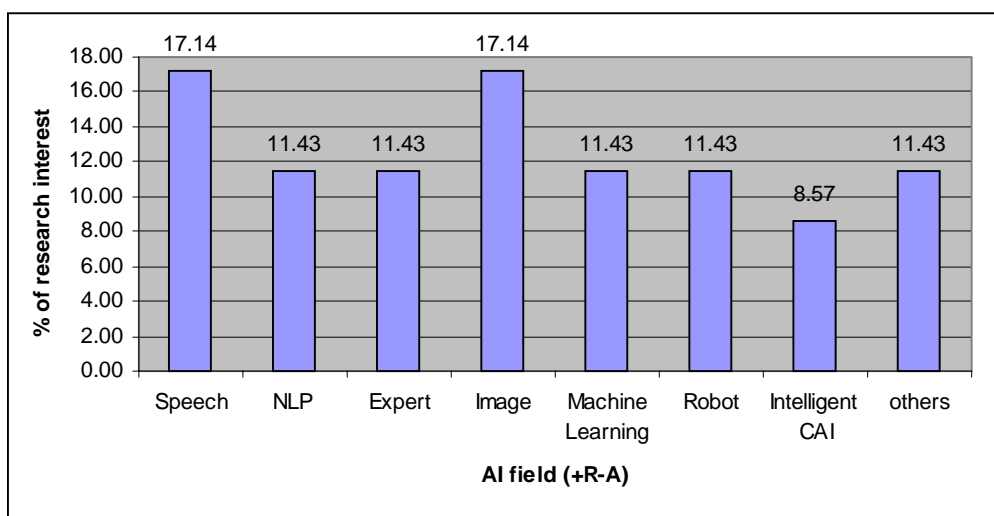
Figure 3.7 The ratio of research interests of the +R-A group

The third and fourth groups (-R+A and –R-A) are very small. They are the institutes that do research on other fields. However, the members in the third group use or apply AI technologies partly in their works, especially the field of image processing and speech recognition. The members in the first group (the most active group) tend to buy tools and develop the system based on those tools or to develop the whole system from scratch by themselves.

3.6 Problems and Solutions in AI Research

This subsection analyzes the problems during research in Thailand. Figure 3.8 shows the problems that the first group (+R+A) has in doing their research in Thailand. It asserts that the lack of experts is the main bottleneck. The lack of instruments and budget are the next problems. The problem of lacking cooperation is less important.
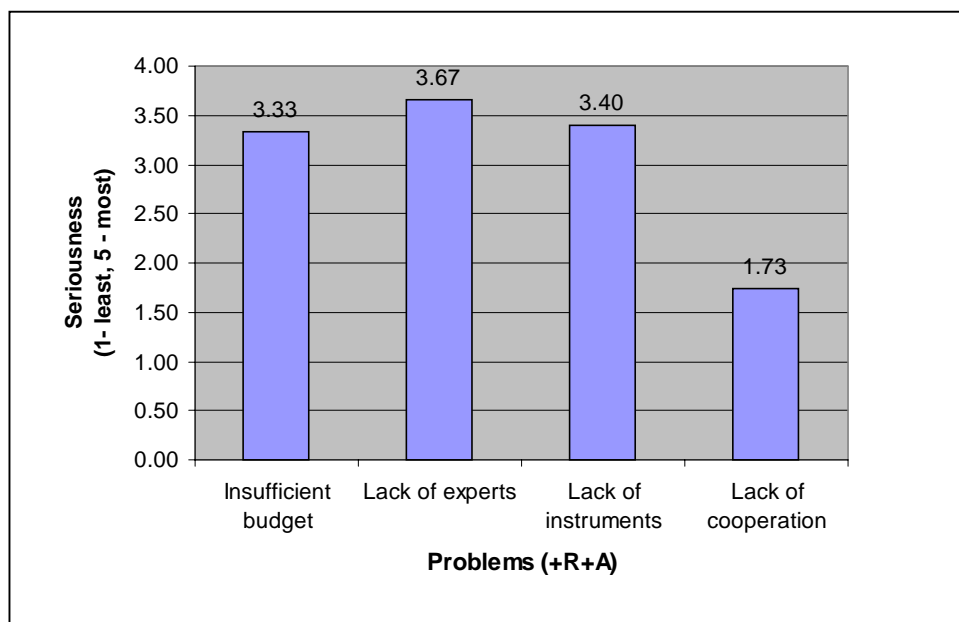
Figure 3.8 The problems of doing research of the first group (+R+A)
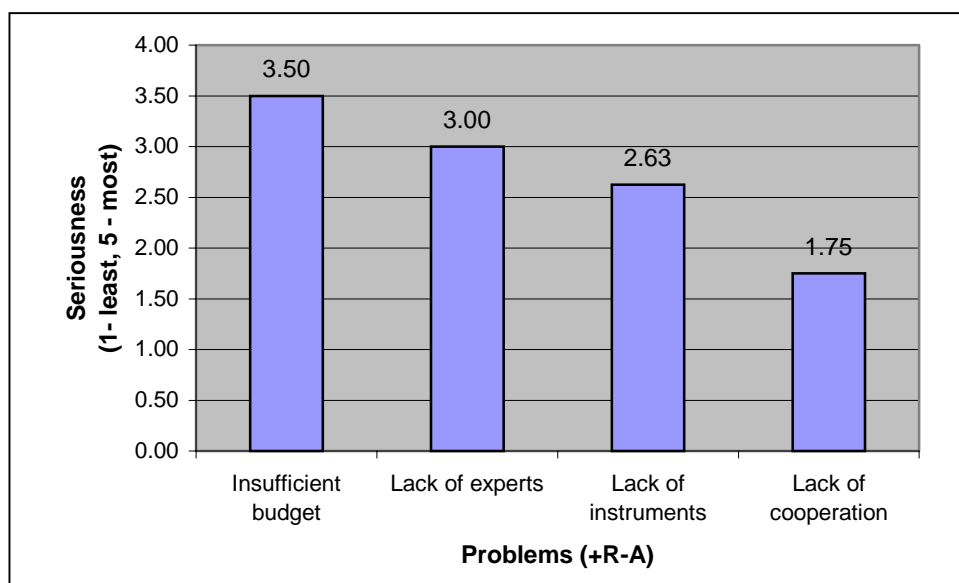
Figure 3.9 The problems of doing research of the second group (+R-A)

Moreover, the problems of the second group (+R-A) are also explored. Figure 3.9 shows the problems they have in doing their research. Unlike the first group the main problem of the second group is insufficient budget. Lacking of experts and lacking of instruments are the second and third problems. Related with the problem of insufficient budget, the research fund in Thailand mostly comes from the source inside the country more than that outside the country. The graph in Figure 3.10 tells us that only 6% come from overseas fund while the rest 94% come from national sources. The fact that sources of research fund are mainly national organization, is one of the reasons of lacking budget in the research community.
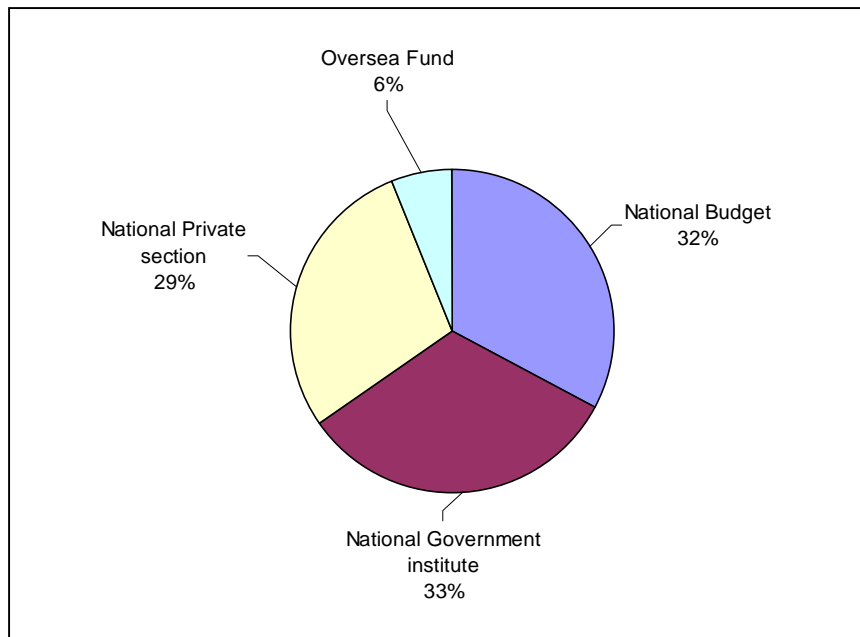
Figure 3.10 The ratio of sources of research fund
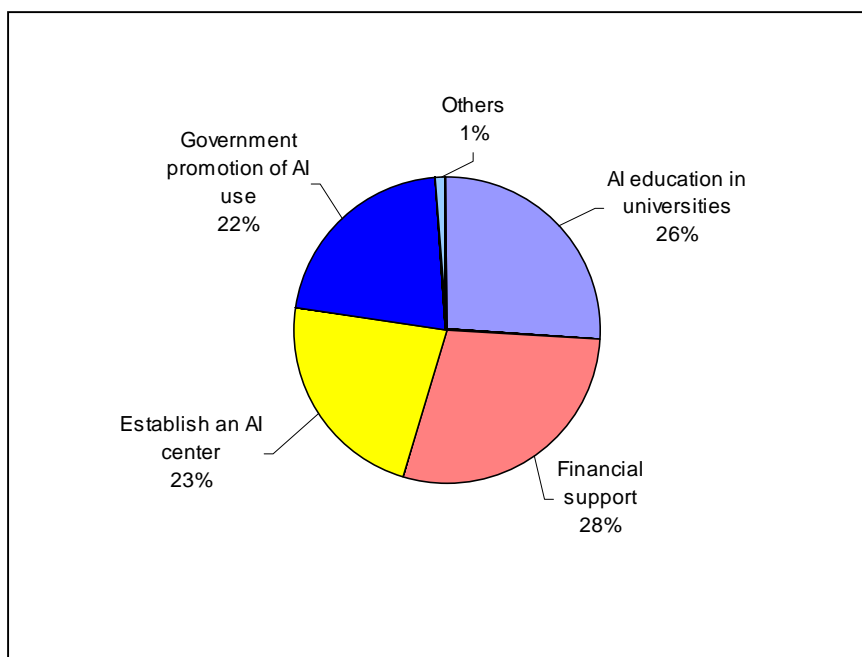
Figure 3.11 The ratio of alternatives to promote AI research

As one possible side effect, the R&D institutes and universities mainly develop their own systems from scratch or buy some tools (43%) and then develop a system using such tools (50%). Rarely, complete packages from overseas are purchased for research. To promote AI research in Thailand, some methods can be applied, such as supporting budget, promoting AI education in universities, supporting the use of AI technology by government and establishing an AI center. Figure 3.11 shows the ratio of solutions that Thai researchers hope to take. Although financial support is the most required one but the gaps from others are not dominant.

3.7 Observation for R&D Institutes and Universities

Recently, research on AI in Thailand R&D institutes or universities has become popular. The previous AI survey done in 1992 reported that 37% of universities did research on AI. Compared with this number, at present AI research occupies up to 77% and applications of AI are used in the level of 57%, comparing with 25% in 1992. Almost universities have their own program on artificial intelligence. Artificial intelligence becomes a general course in a number of universities. The most popular AI areas in Thailand are speech recognition, natural language processing and expert systems. Lacking of financial support and lacking of experts in AI field are dominant. Especially, for pure research without application, financial support for such AI research is rare and it becomes a more serious issue than lacking experts. For application research, the lack of experts becomes more important issue than financial support. In Thailand, there are very few oversea support funds for AI research. Most of research funds come from the sources inside Thailand. Because of lacking budgets for AI, there is a trend that R&D institutes and universities develop their own systems from scratch or using freeware tools, and rarely purchase any package from overseas.

4. AI Applications in Thailand

The section describes the results of the survey on AI application in Thailand private sector.

4.1 Introduction

As the need for intelligent computer is increasing, AI technology will play an important role in computer systems. Here we want to find out the need of this technology in Thailand private sector. This survey will clarify the current status of AI technology, the problems of using AI and the future trend of AI in Thailand companies.

To investigate the current status of AI application in Thailand, we chose some companies and sent them questionnaires. The companies chosen were based on the following criteria: (1) we chose companies that are well known or do business more than three years; (2) companies chosen are not limited to computer companies, but are on various types of business: i.e., telecommunication companies, electric companies, finance companies, food companies, oil companies, insurance companies, hotels, hospitals, automobile companies, newspaper companies, chain stores, cement companies, construction companies, others; (3) For each type of business, more than three companies were selected to be representatives of that type of business. 101 out of 195 (52%) companies returned the questionnaires to us. Figure 4.1 shows the number of companies according to the types of business. "Others" in Figure 4.1 are the companies that cannot be grouped into the pre-determined types (computer, telecommunication, …, construction companies) and the number of representatives returned the questionnaires are less than three. The questionnaire consists of four parts:

1. the information of company, such as the name, the number of staffs, etc.,
2. the current status of AI research and development,
3. the current status of applying AI in business, and
4. the problems of researching or using AI technology.

The results of the survey are given in the following subsections.

4.2 The Current Status of AI in Thailand Companies

The result of the survey are summarized in Table 4.1.

Table 4.1 Summary of AI in Thailand companies

Status	Ratio
1. Research	7/101
2. Use	20/101
3. Do not use at present, but will use in the future	40/101
4. Do not use at present, and will not use in the future	23/101

Note: the others 11/101 are not available.

Table 4.1 divides the companies into four groups.
1. The first group: companies which do research on AI technology
2. The second group: companies which use AI technology
3. The third group: companies which currently do not use AI technology, but will use in the future
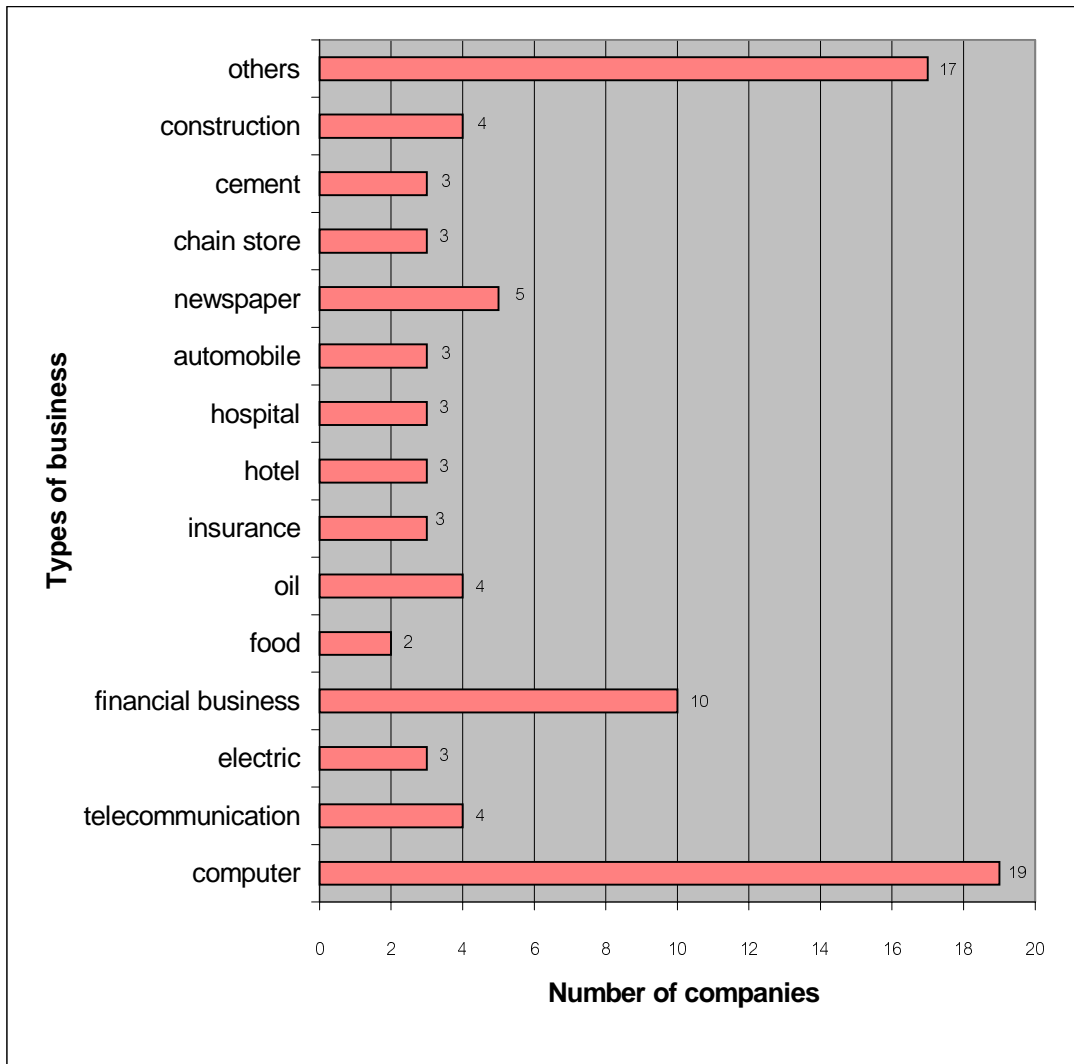
Figure 4.1 The number of companies returned questionnaires shown according to the types of business

    4. The fourth group: companies which currently do not use AI technology, and will not use in the future.

    The result in Table 4.1 shows that the percentage of companies using AI is about 20%, whereas the percentage of companies not using AI is about 62%. There are some companies which do research on AI technology (about 7%). Compared to that of universities in Section 3, the number of companies that use or research on AI is lower.

    To see the distribution of these four groups over the types of business, we added the number of companies of these groups into the graph in Figure 4.1. Figure 4.2 below shows this distribution. As some company has research and also uses AI technology, this company is counted for both "research" and "use" in Figure 4.2. For example, two computer companies have research and also use AI.

    We further investigate this result. We want to know (1) which AI technologies are the research topics for the first group, (2) which AI technologies are used by the second group, (3) what are the factors that determine for the future use of AI in the third group, and (4) what are the factors that determine for not-use of AI in the fourth group.
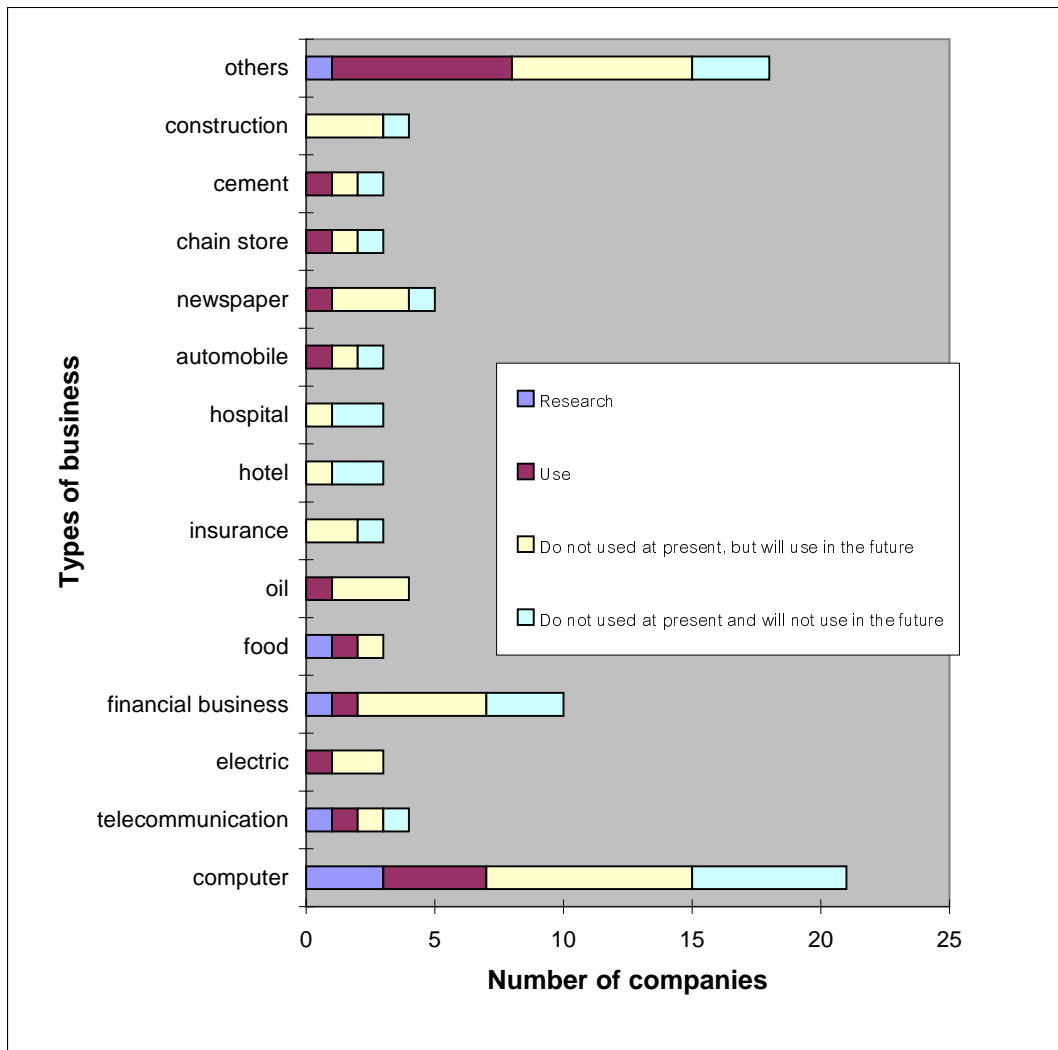
Figure 4.2 Four groups of companies shown according to the types of business

4.3 Companies That Do Research on AI (the First Group)

As shown in Figure 4.2, the types of business that have AI research are (1) three computer companies, (2) a telecommunication company, (3) a financial business, (4) a food company, and the other company. According to this result, compared to other types of companies, computer companies have more research on AI. This is not a surprising fact, as these companies do business directly concerning computer. However, we did not see the AI technology researched by other potential companies, such as automobile companies, electric companies. A number of these companies gave a reason for having no research on AI that they imported products and the technology from overseas and thus did not need to do research by themselves.

For the companies that do research on AI, the research conducted are listed below according to the field of AI.

(1) Expert System
    - Decision Analysis for Marketing
    - Bus Routing based on GPS
    - Stock Price Prediction

(2) Machine Learning
- Checking the Ramp up of the Stock Price

(3) Intelligent Computer-Aided Instruction
- CAI

(4) Natural Language Processing
- Sorting Thai Message

(5) Speech Processing
- Thai Voice Response

(6) Image Processing
- Thai Optical Character Recognition (OCR)

From this result, we can see that expert system is the most popular research area in Thailand companies. This may be because of the readiness of the expert system technology that can be used in various applications. Except for expert system, other popular researches are concerned with Thai language, such as (1) sorting Thai message, (2) Thai voice response, and (3) Thai OCR. We can also see the research on machine learning and intelligent computer-aided instruction in Thai companies.

4.4 Companies That Use AI Technology (the Second Group)
The percentage of companies in our survey that use AI technology is about 20%. The types of business currently using AI technology are (1) computer companies, (2) telecommunication companies, (3) electric companies, (4) insurance companies, (5) food companies, (6) oil companies, (7) newspaper companies, (8) chain stores, (9) cement companies and (10) others. The applications of AI technology used in this group are listed below according to the field of AI.

(1) Expert System
- Decision Support System for Business Management
- Finding the Reason of Mal-Function of Air Condition from its Behavior
- Enterprise Resource Planning
- Expert System using Fuzzy Logic for Controlling the Cement Making Process
- Minimizing Cost of Food Production by Calculating the Appropriate Ingredient
- Helping in Doing Marketing Analysis for Oil Company
- Flight Scheduling Control in Emergency Case
- Executive Information System
- Expert System Using Fuzzy Logic for Stock Price Prediction

(2) Image Processing
- Image Understanding and Processing
- Remote Sensing
- OCR
- Map Building for Telecommunication System

(3) Speech Processing
- Synthesizing Speech from Text File
- Computer Commanding by Speech

(4) Machine Learning
   - Checking the Ramp up of the Stock Price
   - Machine Learning Used in Data Analysis

(5) Intelligence Computer-Aided Instruction & Computer-Aided Design
   - Designing a Prototype of Production Machine
   - Car Designing and Car Assembling

(6) Planning and Scheduling
   - Railway Traffic Management

(7) Robotics
   - Robotics for Part Assembling

(8) Natural Language Processing
   - Sorting of Thai Message

The graph in Figure 4.3 shows the number of applications grouped by the field of AI.
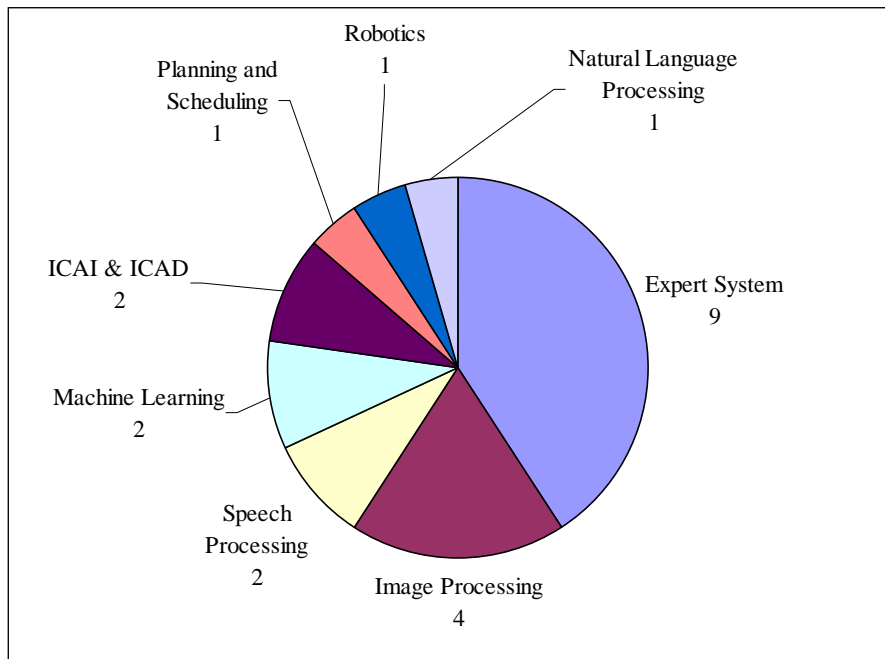
Figure 4.3 The number of applications grouped by the field of AI

It is found that various AI technologies are used in these applications. Similar to the result of AI research, the most popular one is expert system followed by image processing, machine learning, intelligent computer-aided instruction and design, etc.

Below shows how these companies obtain the above applications.
- Buy Complete Package from Overseas
- Develop by Company Itself
- Buy Tools from Overseas, and further Develop for Its Business
- Buy Tools from Another Company in Thailand, and further Develop for Its Business
- Demo Program from Microsoft

- Download from Internet
- Develop by Overseas Company for Its Business
- Joint Development
- From Mother Company

The graph in Figure 4.4 shows the percentage of the above data.
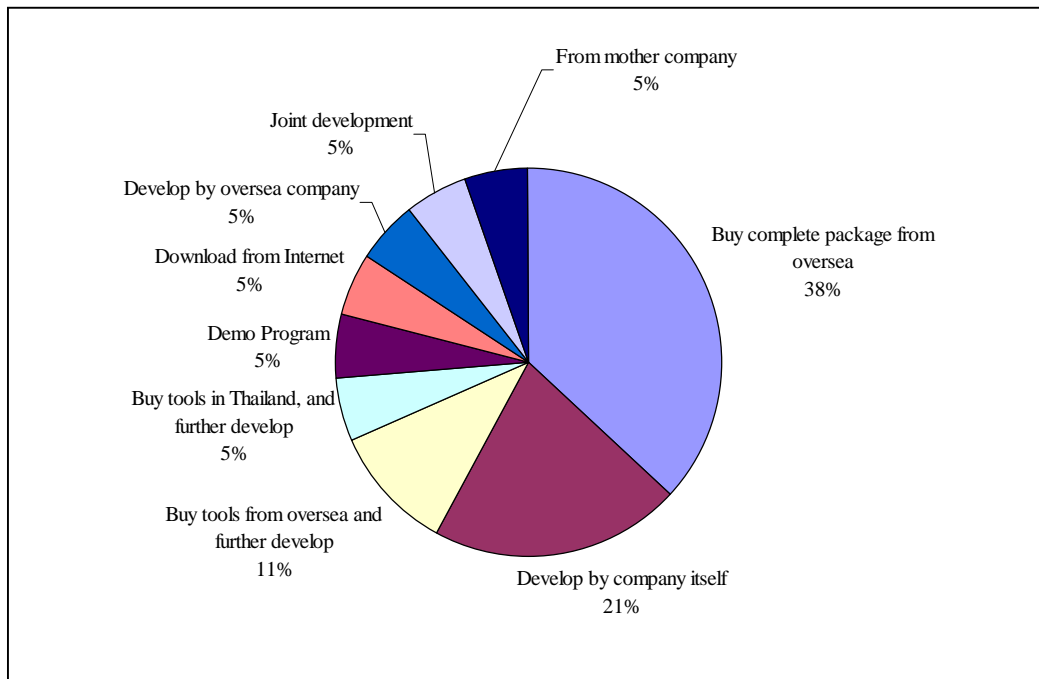
Figure 4.4 The source of AI applications in private sector

Seven companies (38%) obtained the applications by buying complete packages from oversea, three companies (21%) developed the systems by themselves, and two companies bought tools from oversea and customized for their business. Some of these companies used demonstration program from Microsoft, used program downloaded from internet, used program develop by oversea company, used program by joint development, and used program from the mother company. The result indicates that most companies use AI application by buying complete packages from oversea.

4.5 Companies That Currently Do Not Use AI Technology, but Will Use in the Future (the Third Group)

The types of business that do not currently use AI technology in our survey are (1) insurance companies, (2) hotels, (3) hospitals, and (4) construction companies. Among these companies, most of them (40/63=63%) have plans to use the technology in the future.

For the group that will use AI in the future, we asked what applications will be used in the future. The results are as follows. The number in parentheses indicates the number of companies. The corresponding graph is shown in Figure 4.5.

♦ The answers for the question "what will be used":
- Expert System (13)
- Image Processing (9)
- Computer-Aided Instruction (9)
- Machine Learning (6)
- Natural Language Processing (6)
- Robotics (6)
- Speech Processing (5)
- Decision Support System (1)

Note that one company may need more than one technology. Expert system is the most popular technology followed by image processing, computer-aided instruction, machine learning, natural language processing, robotics, speech processing and decision support system.
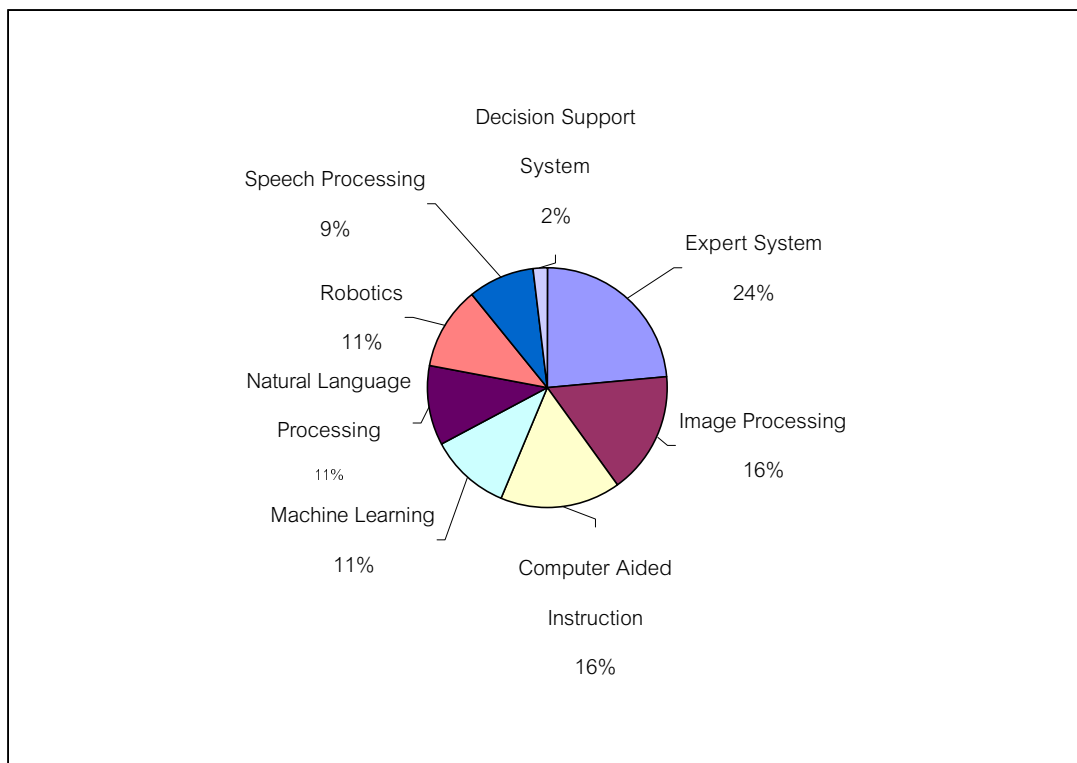
Figure 4.5 AI technology that will be used in the future for the third group

We also asked what will be the problems of using AI technology. In our questionnaire, one company may have more than one problem. We also had the companies indicate the level or the weight of the seriousness of the problems in five levels: 5 for most serious, and 1 for least serious. We then calculated the average and shows the results below. The corresponding graph is shown in Figure 4.6.

♦ The answers for the questions "what will be the problems of using AI":
- Lack of Efficient Human Resource and Knowledge (4.23)
- Insufficient Budget (2.76)
- Lack of Tools and Instruments (2.58)
- Insufficient Cooperation (2.42)

We found that the most serious problems of using AI technology will be because of the lack of person and knowledge in this technology. The lack of tools and instrument is also the problem. Insufficient cooperation from government and insufficient budget can be considered as less serious problems.
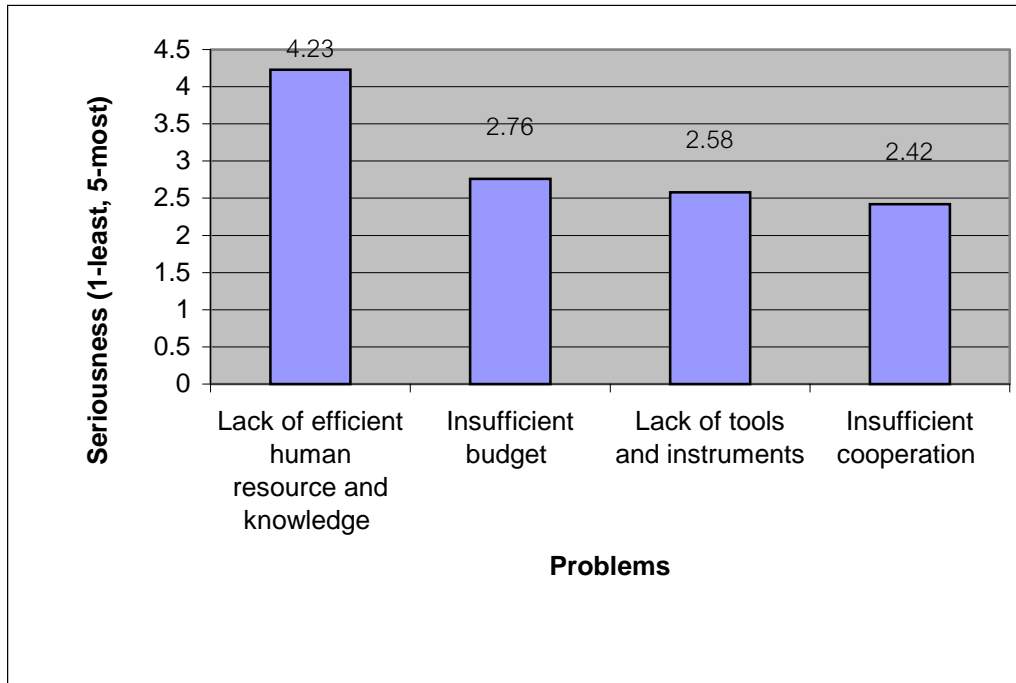
Figure 4.6 The problems of using AI for the third group

4.6 Companies That Currently Do Not Use AI Technology, and Will Not Use in the Future (the Fourth Group)

According to Figure 4.2, the types of business that do not currently use AI technology in our survey are (1) insurance companies, (2) hotels, (3) hospitals, and (4) construction companies. Among these companies, some of them (20/63=32%) have no plan to use the technology in the future.

For this group, we want to know that what are the problems for not-use of AI in the future. The result is shown below.

♦ The answers for the questions "what will be the problems of not using AI"
- No Need in Business (4.41)
- Lack of Efficient Human Resource and Knowledge (4.18)
- Insufficient Budget (3.00)
- Insufficient Cooperation (2.83)
- Lack of Tools and Instruments (1.57)

The corresponding graph is shown in Figure 4.7.

For this group, the reasons for not-use of AI in the future is that they do not need AI technology in business, or they have insufficient person and knowledge about AI technology. As described before, the types of companies that gave the answers are
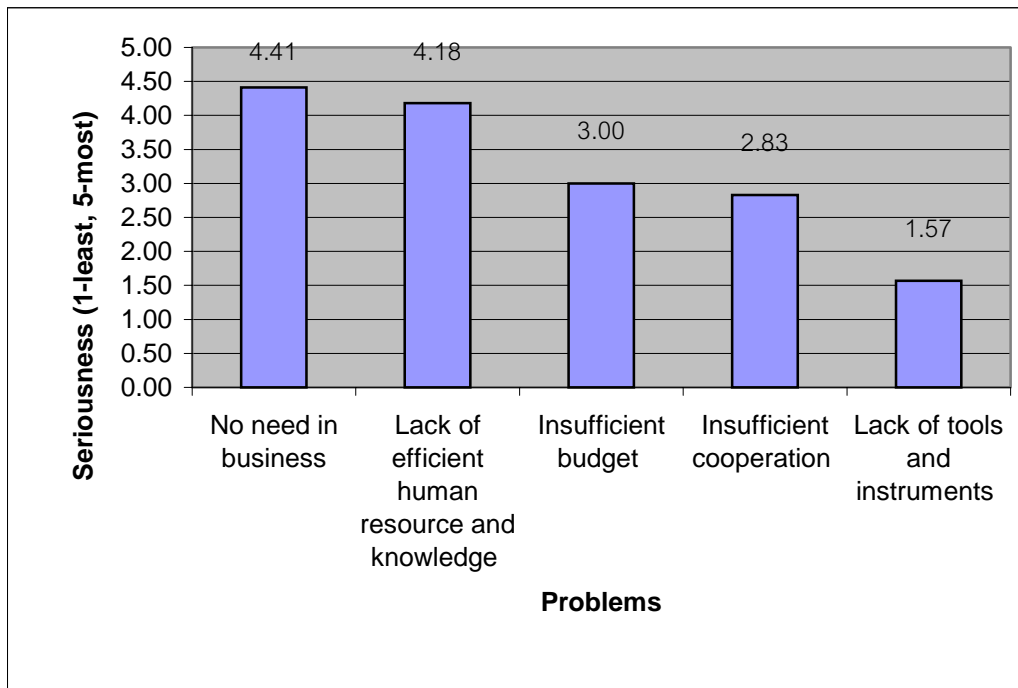
Figure 4.7 The problems of not using AI for the fourth group

insurance companies, hotels, hospitals and construction companies. Therefore, it is understandable that there is no need for AI technology in these types of business yet, as they do not use advance computer technology. However, We believe that though the AI technology is not currently used by these types of business, the technology will certainly play an important role in these business in the near future.

4.7 Observation

From the results of the survey, we found that in private sector AI technology at present receives much attention than in 1992. Though the percentage of AI research is only 7% at present, it is better than in 1992 when the percentage was 0%. Other portions also increased compared to those in 1992. For example, the use of AI changed from 12% to 20% between 1992 and 1999. We can hope for the increasing use of AI in the future, as the results also show that 40 out of 63 of companies not using AI at present are planning to use AI in the future. However, there are still some problems of using AI in the future. The most important problem seems to be the lack of person and knowledge about AI. Insufficient budget, the lack of tools and instruments, insufficient cooperation are also the problems too. If we can solve or alleviate the problems, we will encourage more companies to use AI technology. This may be done by: (1) transferring knowledge on AI from university sector to private sector, (2) transferring knowledge on AI from outside the country, (3) supporting AI education in university sector to train and produce more AI experts, (4) financial supporting.

5. Conclusions and Suggestions

This report describes the results of the survey of AI research, development and its applications in both private sector, government research institutes and universities. Compared with the previous AI survey in 1992, we found that the percentage of AI research increases from 0% to 7% for private section, and from 37% to 77% for government R&D institute and universities. The applications of AI also become popular. In the private sector, the rate of applying AI shifts from 12% to 20%. In the same way, use of AI application increases more than twice from 25% to 57%. This phenomenon indicates that research, development and application of AI become important in Thailand.

Considering AI research in universities, we found that the most important areas are speech processing, followed by natural language processing, and expert system. For private sector, the most active AI research area is expert system. Even there are very few companies doing research, the topics concerning Thai language processing is focused. Image processing is the second popular application in R&D institutes and universities. In general view, the areas of research in universities and those of private sector are in the same trend where expert system and language processing are dominant. One of the interesting points is that machine learning becomes more popular than in the past. In the near future, we can expect that the AI fields in private sector and those in research institutes will match together.

At present, most companies buy complete package from oversea while the R&D institutes and universities try to develop the system from scratch or buying some basic tools and then use it in their advance research and development. Private sector lacks knowledge on technology and experts while R&D institutes and universities lack financial support. Linking these two sectors together will strengthen AI research in Thailand. This will create the environment to do research and development which match with real needs, and can partly solve the problem of lacking funding in universities. This implies that if we can effectively link these two sectors, the use of AI in private sector will surely increase. This can be done by establishing an agency or center that has a role of connecting these two sectors.

It is also seen that university researches and produces the preliminary result, but the result is not used for real applications or products. The companies need technology but have not enough staff to do research. However, the companies want to use the technology for applications or products. Moreover, these two sectors do not know the situation or not have enough information of each other. If we can share the information together, it should increase the use and research of AI in overall. If we look at the AI technology researched in university sector and the AI technology used in private sector, we will see the match between these sectors. For example, in this survey we found that private sector wants to use expert system in the future, and the technology of expert system is also researched in many universities. This is also true for AI applications concerning Thai language, such as speech processing, image processing and natural language processing.

NECTEC Tri-Partite tried to link three sectors: university, NECTEC and private company. However, we still need more agencies, such as an AI center, that have this kind of role. Moreover, recently the technology changes very fast. There is a lot of new AI research coming out every year. Technology transfer is also an important issue. The computer environment, e.g., the Internet, becomes very convenient and

makes our world become smaller. Doing research together with researchers from several countries will become ordinary. Not only supporting research fund and being an information center, an AI center can also provide an environment to do research and cooperate among countries.

Appendix A

The list of government organizations and universities that are surveyed.

(A1)   Computer Science, Mihidol University
(A2)   Computer Service Center, Kasetsart University
(A3)   Faculty of Science, Bangkok University
(A4)   Computer Center, Ministry of Monetary
(A5)   Faculty of Engineering, Naresuan University
(A6)   Department of Technology and Information, Rangsit University
(A7)   Computer Engineering, King Mongkut's university of Technology Thonburi
(A8)   Computer Engineering, Mahanakorn University
(A9)   AI Center, King Mongkut's university of Technology Thonburi (KMUTT)
(A10) Center of Operation and Field Robotics Development, KMUTT
(A11) Computer Engineering, Chulalongkorn University
(A12) Numerical Analysis Laboratory, Chulalongkorn University
(A13) Electrical Engineering, Chulalongkorn University
(A14) Computer and Automation Technology Laboratory, NECTEC
(A15) Software and Language Laboratory, Software Engineering, NECTEC
(A16) Faculty of Engineering, King Mongkut's institute of Technology,
          North Bangkok (KMITNB)
(A17) Computer and Automation Technology Laboratory II, NECTECT
(A18) Computer Engineering, KMITNB
(A19) Computer Technology and Automation System Research and Development
          Laboratory, Kasetsart University
(A20) Computer Center, Bangkok University
(A21) Information System and Technologym, Bangkok University
(A22) Natural Language Laboratory, Kasetsart University
(A23) System Planning and Development Division, Bangkok University
(A24) Computer Engineering, Chulalongkorn University
(A25) Intelligent Systems Laboratory, Assumption University (ABAC)
(A26) Faculty of Engineering, Saint John University
(A27) Faculty of Engineering, South East Asia University
(A28) Applied Science, KMITNB
(A29) Electrical Engineering, KMITNB
(A30) Computer Engineering, Kasetsart University
(A31) Sirindhorn International Institute of Technology (SIIT), Thammasat University
(A32) Software and Language Laboratory, Language Laboratory, NECTEC
(A33) Information Technology Program, SIIT, Thammasat University
(A34) Faculty of Informatics, Sripatum University
(A35) Computer Science, Asian Institute of Technology

Appendix B

SUMMARY
The Eighth National Economic and Social Development Plan (1997-2001)

B.1 Overview

Thai society is proud of its identity. The country is open - and has been able harmoniously to adapt external cultures to its own way of life and its own unique environment. It is generally a peaceful and caring society where violent conflicts are noticeably absent. The Thai people adhere to religious principles based on rationality and moderation. The monarchy has for centuries been the centre of hope and confidence among all Thai people.The dawn of the Twenty-first Century during the period covered by the Eighth Economic and Social Development Plan is likely to see one of the most crucial transitions in the national development history of Thailand. During the past two decades, advances in information technology have brought about rapid globalization, and this dictates a need for the formulation of new world economic and social orders and for the reevaluation of international relations. All of these factors give rise both to opportunities and challenges for sustainable development of Thailand. On the positive side, globalization has expanded world markets, leading to greater mobility of production factors and increased trans-national investment. The World Trade Organization and the smaller regional trade groupings – in North America, Europe and Asia-Pacific – have been created to ensure economic stability and fair trade practices for all countries. Globalization has also accelerated the transfer and utilization of technologies for development.

On the social front, the Thai people will have a wider access to various types of information, suited to the requirements and interest of each individual. They also have the opportunity to obtain and evaluate data and information in their own homes through computer networks and other electronic media. The growth of the private sector and more direct access to information by each individual will increase the bargaining power of small units of the society, enable decentralization of power to local areas and create increasing pressure to conserve local cultures. On the other hand, however, the influence of foreign cultures and the use of foreign information by existing media in various forms – e.g. advertising and recreational activities – without proper scrutiny may well result in the promotion of undesirable values based on materialism, consumerism and extravagance among new generations, to say nothing of the risk of cultural domination.

Globalization is also resulting in the development of adjusted international values regarding democracy, human rights and gender equality as well as increasing emphasis on protection of the environment. These values have arisen from a wider belief that development based only on economic growth without due consideration of human, family, community, social and environmental dimensions cannot be sustained in the long run. If no corrective actions are adopted the people and nature will not be able to co-exist harmoniously.

B.1.1 A Vision for Thai Society

In order to cope with both the positive and negative impacts of the factors mentioned above, it is crucial for Thailand to devise a new economic and social order upon which to base national development. This is aimed at enabling the country to be

better prepared for sustainable development in the future and to become a fully developed country by the year 2020. It is envisaged that by that year the Thai economy will be the eighth largest in the world, with an average per capita income of not less than 300,000 baht or about US$12,000 at 1993 constant prices. The proportion of people living below the poverty line will be reduced to less than five per cent, resulting in a vastly improved quality of life for the majority of the Thai people. A more detailed description of the vision for Thai society as articulated by various groups of people who have participated in the process of planning may be summarized as follows:

- Thai Society is united and proud of its identity, and wishes to retain its culture and national character and to live in peaceful coexistence with other countries, enjoying recognition and respect from the people of other nations. People in the society will be happy, living in warm families within strong communities. The society is to be capable, stable, equitable, well disciplined, caring and respectful of human rights, maintaining a strong adherence to religious principles.
- Every Thai person should have greater opportunities to develop their full potential physically, spiritually and intellectually and to participate actively in the process of national development. Every Thai child should have adequate access to quality health care at all stages of development, with the assurance of good nutrition from birth, and access to at least 12 years of basic education. All Thai citizens, not only children, must have the opportunity to receive good quality basic social services.
- The Thai people should be able to adapt to the changes brought about by rapid progress in science and technology, in order to cope more effectively with international competition. Young people aged 18-24 should have an opportunity to participate in higher education. All disadvantaged people should have access to education and employment..
- The economy of Thailand is to be strong and fully competitive, broad-based, the centre of production, communication, finance, tourism and services in this region, growing on a sustainable basis, internalizing environmental and natural resources and social costs, and providing job opportunities and equitable income distribution among all groups of people in all regions of the country.
- The quality of life in the provinces and rural areas should not be inferior to that in the capital city.
- Natural resources and the quality of the environment will be properly managed on a sustainable basis for the benefit of future generations of the Thai people.
- The political system will be democratic, under the monarchy, in support of an efficient public sector. Politicians and government officers will be imbued with strong moral and ethical standards and capable of carrying out their duties to serve the real needs of the people.

B.1.2 A New Development Paradigm

The achievement of this vision of Thai society must be realized as a continuing process over a long period of time, by creating an enabling environment for the participation of all sectors in the society in formulating, programming and implementing the Plan. It also assumes their participation in monitoring and evaluation of development efforts. A sound economy is implied, as well as a society progressively freed of social problems. The Planalso implies sustained development and a greater ability to respond better to the needs of the majority of the population

than has been the case in the past.

The Eighth Economic and Social Development Plan is a first step towards adopting a new approach to national development aimed at achieving the long term vision of an ideal Thai society. Thai people from all walks of life and from various regions of the country have taken the opportunity to participate in drafting this plan from its inception. This was a deliberate change in plan formulation in order to move away from the top- down approach practiced by the public sector in the past. This can be considered the beginning of a new era in planning which emphasizes collaborative efforts of the whole population.

In past plans, the national economic and social development concept has largely been based on the acceleration of economic growth utilizing comparative advantages in terms of natural resources and low-cost labor to produce goods and services for export. This development strategy was suitable for the needs of the time and consistent with the economic and social situation of the country. However, successes in economic growth and material progress to date have not meant that all Thai people are enjoying greater wealth and a substantially improved quality of life. On the contrary, rapid economic growth has had negative effects on Thai culture, traditional ways of life, family, community and societal values. The impact on natural resources and the quality of the environment has also given cause for serious concern. Genuine sustainable development for Thailand in the future will depend on the degree to which the potentialities and creativity of the Thai people are strengthened and enhanced. For this reason, the Eighth National Economic and Social Development Plan has adjusted the development concept, shifting from a growth orientation to people-centred development. The state of the people is considered to be the final measure of success: economic improvement is treated only as a means to improve the well-being of the people rather than as the final objective of development. The planning process will also be shifted from a compartmentalized to a more holistic approach from the beginning, seeking to contribute to the whole system rather than later trying to integrate separate sectors, in order that the majority of the Thai people can realize genuine benefit from this development plan. To attain the objectives and targets of development the Eighth Plan initiates, for the first time, two new sets of key strategic approaches. The first is the establishment of good governance. This involves the strengthening of a truly harmonious relationship between the government and the people, through collaborative and participatory efforts of all parties in the society, the provision of guarantees for freedom, human rights and equity, and the settlement of conflicts through peaceful means. The second strategy is the reform of the development administration for effective translation of the plan into action. This requires a development system based on the area approach, the integration of functions and participation of all stake-holders, improvement of the efficiency of public government agencies at the central level, particularly in budget and personnel management, together with the development of indicators suitable for the monitoring and evaluation of holistic development.

As the country is moving into a new era, it is hoped that the inception of the Eighth Plan will signal the beginning of an age of unprecedented national unity and harmony, shown by the initiation of collaborative and cooperative efforts of many kinds. It is believed that the Eighth Plan will set in motion a process by which all sectors of the society march together toward common goals and themselves share mutual responsibility for the monitoring and evaluation of development implementation on an annual basis. Most important of all, this undertaking is to be a process by which all people learn to live together in an enlightened way, with mutual care for each other, in harmony, peace, justice and freedom; in other words, as Thais.

B.2 Review of Economic and Social Development in Thailand During the Past Three Decades

B.2.1 Thailand has achieved an exceptional record of economic development over the last 30 years, as witnessed by the rapid expansion of the national economy at an average rate of 7.8 per cent per annum. The Kingdom's average per capita income reached 68,000 baht in 1995, compared with only 2,100 baht in 1961. The drop in numbers of people living in absolute poverty has surpassed all expectations, falling to only 13.7 per cent of the population in 1992, far outstripping the Seventh Plan's target of 20 per cent by the end of 1996. Thailand's sound economic position is internationally recognised. In addition, sustained public investment in economic and social infrastructure has made a significant contribution to an overall rise in incomes, living conditions and quality of life.

B.2.2 However, despite the impressive rate of economic growth, most of Thailand's economic activity and prosperity has remained concentrated in Bangkok and the surrounding provinces. The average per capita income inside the Bangkok Metropolitan Region is still much higher than those found outside, and almost 12 times higher than in the country's poorest region, the Northeast. The gap between rich and poor in the Kingdom has also widened over the last 30 years. In the four years from 1988 to 1992 alone, the top 20 per cent of households saw their combined income rise from 54 per cent to 59 per cent of GDP, while the combined income of the bottom 20 per cent of households – the country's poorest – dropped from 4.6 per cent to 3.9 per cent of GDP over the same period. This growing disparity means an increasing number of Thais are being excluded from the general improvements in quality of life, and is proving to be a major obstacle to national development.

B.2.3 Development efforts have provided wider access to both economic and basic social services. By 1994, around 97.7 per cent of villages had electrification, and many also had clean drinking water, an amenity reaching 75 per cent of urban settlements outside Bangkok, and 32 per cent of rural villages. The road network connecting provinces, districts and tambons now totalled 210,025 kilometres. Thailand's rural population now has greater access to education than ever before, with 97.7 per cent of school-age children nation-wide completing at least six years of basic education. In addition, improvements in public health provision have resulted in a significant increase in average life expectancy, from 63 years in 1990 to 67.6 years in 1994.

B.2.4 However, fiercer competition for income and wealth in Thailand has brought with it greater materialism. This in turn has had a negative impact on people's behavior, bringing about a lack of discipline, declining ethical and moral standards, and the rise of practices which centre around self-interest and the exploitation of others. These unfavourable trends are threatening the traditional Thai values and ways of life, and they have contributed to the collapse of families, communities and local cultures. In addition, the social stresses that accompany economic prosperity have started to alter the patterns of sickness and mortality, bringing with the diseases of modern life, such as cancer, heart disease and high blood-pressure. The number of reported tragedies and deaths resulting from accidents and natural disasters has likewise increased.

B.2.5 Accelerated rates of economic growth have also resulted in the rapid depletion of natural resources and deteriorating environmental conditions. During the first two years of the Seventh Plan, no less than one million rai of forest was destroyed through commercial exploitation. The problems of soil erosion and falling water quality have become increasingly significant. The poor air quality, high volume of dust, and noise pollution which have become major concerns in

Bangkok and other regional urban centres bear witness to the general worsening of environmental conditions. Environmental degradation has had a discernible negative impact on quality of life. Accordingly, it has become generally accepted that a process of development which disregards natural resources, human values and local customs and lore is antithetical to sustainable national development.

B.3 Objectives and Targets of the Eighth Plan

To deal effectively with the challenges of social change, as well as the present unbalanced pattern of development — characterised by economic success combined with social problems and threats to sustainable growth — and in order to realise the long-term vision of Thailand becoming a fully developed country by the year 2020, the Eighth Economic and Social Development Plan sets the following objectives and targets for development:

B.3.1 Objectives

(1) To foster and develop the potentials of all Thais, in terms of health, physical well-being, intellect, vocational skills and ability to adapt to changing social and economic conditions.
(2) To develop a stable society, strengthen family and community, support human development, improve quality of life and promote increasing community participation in national development.
(3) To promote stable and sustainable economic growth, and to empower the people to play a greater role in the development process and receive a fair share of the benefits of growth.
(4) To utilise, preserve and rehabilitate the environment and natural resources in such a way that they can play a major role in economic and social development and contribute to better quality of life for the Thai people.
(5) To reform the system of public administration so as to allow greater participation of non-governmental organisations, the private sector, communities and the general public in the process of national development.

B.3.2 Targets

To attain the above objectives, the Eighth Plan sets the following development targets to be used as indicators of success:

(1) Increase the availability of good quality care and education for well-balanced early childhood development.
(2) Improve the quality of education at all levels; extend basic education from six to nine years to all school-aged children; provide continuous training for all school teachers; and work towards the further extension of basic education to 12 years.
(3) Upgrade the skills and basic knowledge of industrial workers, particularly in the 25–45 age group.
(4) Provide opportunities for underprivileged groups to realise their full development potential, and increase their access to basic social services.
(5) Reduce the number of preventable accidents, particularly focusing on the workplace, traffic, the transport of toxic chemicals, and fires in high-rise buildings.
(6) Lower the current account deficit to 3.4 per cent of GDP by the last year of the Plan, while keeping the rate of inflation at not more than 4.5 per cent per year,

in order to safeguard economic stability.

(7) Increase domestic savings to 10 per cent of GDP by the last year of the Plan.

(8) Upgrade and expand infrastructure provision in the regions and rural areas.

(9) Reduce the incidence of poverty to less than 10 per cent of the total population by the last year of the Plan.

(10) Preserve and rehabilitate forest areas to cover no less than 25 per cent of the country, including no less than one million rai of mangrove forest, by the last year of the Plan.

(11) Increase awareness of sustainable alternative agricultural methods, and increase opportunities for their application.

(12) Promote investment in the rehabilitation and protection of urban, regional and rural environments.

B.4 Development Strategies

In order to attain the objectives and targets outlined above, the Eighth Plan proposes the following major strategies:

B.4.1 Empowerment of the Individual, through the promotion of optimal population size and structure; improving patterns of human settlement in line with each area's development potential; revision of the overall learning process, focusing on spiritual development, basic education and intellectual development; preparing Thai people to meet the challenges of social change; and creating a more skilled and competitive labour force. Also included in this strategy is the improvement of public health by development of health services and health education for all Thais.

B.4.2 Creation of an Enabling Environment for Individual Development, by strengthening families and communities; providing opportunities for individuals, families and community organisations to participate in the development of their own communities; developing a more efficient social security system; improving and strengthening the justice system to ensure more security in life and property; and promoting the role of culture in human development.

B.4.3 Improving the Development Potential of the Regions and Rural Areas, by redistributing income on a more equitable basis and decentralising development activities to regional and rural areas; promoting popular participation in development through the empowerment of community organisations; supporting and expanding community learning networks; promoting the role of the private sector and non-governmental organisations in job creation; and managing development at all levels through co-operative partnership.

B.4.4 Development of Economic Capability to Support Human Development and Quality of Life, by supporting stable and sustainable economic growth; restructuring production to adapt to changes in global markets; developing science and technology as a foundation for sustainable development; and undertaking area-based and community-based development, including the upgrading of infrastructure, to promote higher productivity and better quality of life.

B.4.5 Natural Resources and Environmental Management, including directions for conserving and rehabilitating natural resources that will promote balance in the ecosystem; maintaining and upgrading environmental conditions to enhance quality of life and to provide an enduring resource base to support development; improving management systems for natural resources and the environment in order to ensure proper supervision, efficient utilisation, and fair distribution of benefits to the community and society; and management

guidelines for the prevention and relief of natural disasters.

B.4.6 Development of Sound Governance, seeking to enhance the effectiveness of the public sector in carrying out the main mission of empowering the individual, and to foster a warm and trusting relationship between government officers and the people. Principal development guidelines include upholding the rule of law in public administration; managing conflicts through peaceful means; encouraging the participation of people from all walks of life in public activities; reform of the administrative system; and ensuring continuity and consistency in public management by promoting universal understanding of public policy and wide participation in the determination of national agendas.

B.4.7 Improvement of Development Management to Ensure Effective Implementation of the Plan, comprising guidelines for the creation of a development management system based on an area approach, the integration of functions and the participation of all stake-holders (the area-function-participation system); for the development of public-sector management mechanisms and service delivery systems; for promoting a co-operative partnership approach to the development process; for improving the efficiency of centralised public agencies where they are involved in implementing the Plan; and for empowering non-governmental organisations to play a greater role in national development. This strategy also includes the formulation of a set of development indicators for monitoring and evaluating progress towards the goal of holistic people-centred development.

B.5 Nature and Application of the Eighth Plan.

B.5.1 The Eighth Plan serves as a guideline for national development during the next decade, and more specifically for the five-year period 1997–2001. It emphasises shifting the development paradigm from a segmented approach to holistic people-centred development, with the goal of achieving a pattern of development which is efficient, sustainable and ensures all Thai people receive a fairer share of the benefits of development than they have in the past.

B.5.2 The development strategies proposed in the Eighth Plan indicate only directions in which national development must go in order to achieve the major long-term goals. They do not set out a detailed development approach by economic and social sectors and short term measures currently undertaken by various implementing agencies. Hence, in order to translate the Plan into action, all the parties involved should use these guidelines as frameworks for the formulation of programmes, projects and measures. This process will also include the setting of specific development targets, launching projects which are people-centred, and providing support for projects initiated partly or entirely by the people.

B.5.3 An holistic approach, emphasising the co-operation and participation of agencies concerned in the formulation and implementation of programmes and projects consistent with the Eighth Plan's development strategies, must be encouraged. The area-function-participation system should be adopted in programming, budgeting and manning, as well as in monitoring and evaluating.

B.5.4 In monitoring and evaluating success in the achievement of the Eighth Plan's objectives and targets, it is necessary to establish five categories of development indicators, both overall and for individual programmes and projects:

(1)   Overall Development Indicators: To measure genuine progress towards the achievement of holistic people-centred development covering all aspects – human, social, economic, and in terms of natural resources

and the environment.

(2) Sectoral Development Indicators: To monitor and evaluate the impacts of the area-function-participation system in each development sector.

(3) Strategy Development Indicators: To measure the success or failure of the implementation of the Eighth Plan's development strategies.

(4) Performance Efficiency Indicators: To measure the capacity and efficiency of various agencies at all levels in implementing the Plan. These indicators will relate to how the agencies co-ordinate programming, budgeting and manning, based on the delegation of authority to regional and rural areas as well as collaboration with other development partners. The indicators will be useful in improving the quality and efficiency of the work of implementing agencies at all levels.

(5) Actual Condition Indicators: Statistics or basic development data and information are to be collected in order to measure the final outcome or effectiveness of development at both the macro and micro levels.

Appendix C

National Science and Technology Development Plan
(1997-2006)

C.1 Overview

Over the past three decades, Thailand has registered remarkable success in the national economic development, as evidenced by the 28-fold increase in per capita income. In 1994, the economy expanded by 8.2 percent, with per capita income of over 60,000 baht. Despite impressive economic growth, it is evident that the structure of export-oriented industries, serving as a main thrust for growth dynamism, still mostly relies on natural resources and cheap labor, with less emphasis on technology-intensive production. Science and technology is considered essential to the national economic and social development of the country in the years ahead. To enhance the development of these two elements, greater emphasis has to be placed on a more systematic approach to the acquisition and transfers of technology, from both domestic and foreign sources, which will lead to research and development activities (R&D) for the creation of innovations and more commercial value-added. This approach also requires the availability of basic infrastructure such as technical consulting services, information services, metrology, intellectual property right protection, and the improvement of rules and regulations to upgrade the development potential of relevant parties and to facilitate the implementation of activities related to science and technology development. Furthermore, the provision of these basic services should be in harmony with science and technology manpower production required in the labor market. Human beings, in this regard, are users, creators and developers of science and technology, and, they, in turn, will be the beneficiaries of any progress created thereafter. Hence, it is very crucial for the Thai people to acquire greater knowledge of science and technology for the sake of higher quality of life and the sustainable economic and social development of the country, without detrimental effects on environmental equilibrium and national security. Throughout the past three decades of national development, there are both weaknesses and strengths in Thailand' s science and technology development, which can be summarized as follows :

C.1.1 Strengths

C.1.1.1 Existence of Certain Level of Continuous Science and Technology Development

Since the Fifth Plan period (1982-1986), emphasis has been placed on the creation and development of S&T infrastructure such as responsible agencies, information systems, legislation, and suitable environment. In 1979, the government set up the Ministry of Science, Technology and Energy, which has been renamed as the Ministry of Science, Technology and Environment. During 1983-1986, several specific technology centers were established, including the.National Center for Genetic Engineering and Biotechnology, the National Metal and Materials Technology Center, and the National Electronics and Computer Technology Center. The establishment of specific organizations, such as the National Science and Technology Development Agency, and The Thailand Research Fund induced greater flexibility in S&T development.

C.1.1.2 Competent Science and Technology Manpower

Despite the limited available S&T manpower, the existing personnel at all levels is well qualified, with a certain level of development potentials. Students, researchers, university lecturers, scientists in applied sciences, and school teachers have shown strong development potentials in their careers. It is anticipated that, with intensive government support, these groups of people will definitely serve as a main thrust for future S&T development.

C.1.2 Weaknesses

Thailand's S&T development over the past years has not been very successful due to several reasons. Major constraints include the following.

C.1.2.1 Inconsistency between S&T Development Policy and Implementation

S&T development during the past few years has lacked explicit targets and strategies in creating elements essential to the enhancement of the country's competitiveness and basic S&T potentials. Furthermore, S&T development does not correspond with the development policy and guidelines in other sectors, coupled with no linkages between policy-making and implementing agencies. As a consequence, S&T has not been systematically utilized to enhance the country's long-term international competitiveness.

C.1.2.2 Lack of Science and Technology Manpower in both Quality and Quantity

A major constraint in S&T development is the lack of manpower in both quality and quantity. According the studies conducted by the Thailand Development Research Institute (TDRI) in 1995, Thailand produced only 3,140 science graduates and 11,803 engineers at the undergraduate level, and 124,172 technicians. Given the entire labor structure, the share of S&T manpower in Thailand is 10-fold lower than that of Malaysia, Singapore, Taiwan, and South Korea. It is projected that, in 2001, the shortages of engineers of over 11,610 persons will prevail, including 6,500 scientists at the undergraduate level, and 35,200 technicians. According to the National Research Council of Thailand, the number of S&T researchers in Thailand in 1994 was only 2 per 10,000 population, compared with 6 in Malaysia and 15-30 in the Newly Industrializing Economies (South Korea, Taiwan, and Singapore). Another overriding concern is the quality of the manpower available. Based on the research conducted by The Thailand Research Fund, the number of internationally published researches by Thai science researchers in universities is less than 1 per person on in 10 years, 10 times lower than what is supposed to be. This implies that there is hardly any invention by Thai researchers. The aforementioned figures indicate that Thailand has placed less emphasis on the production of high-quality S&T manpower. The production of personnel at the.doctoral level who will play a key role in scientific research is almost non-existent. The number of S&T researchers in Thailand is insufficient to support R&D due to the absence of a professional researcher development system, in both public and private sectors. The remuneration and career paths of researchers in the government sector are not good enough to attract qualified personnel. The private sector is not interested in technology development, and, in turn, hardly employs R&D personnel. The country's economic prosperity in the recent years has generated several challenging jobs with attractive remuneration, such as advertising, public relations, finance, and real estate development. In contrast, scientists and science teachers who have to study harder

do not enjoy the same benefit. Thus, students are not interested in pursuing S&T fields, leading to a low supply of qualified science students. Emphasis should be placed on the development of manpower production under a well-integrated system, covering primary and secondary education as well as university levels. The knowledge and working skills of students and those entering into or already in the work force have not been strengthened to enable them to keep pace with technological changes and the need to enhance international competitiveness, resulting in no interaction with economic development and the business sector.

C.1.2.3 Limited Technology Transfer Capabilities

Thailand evidently has limited capabilities in screening, seeking, absorbing, transferring and developing technology due to the insufficient technology and marketing information sources, and an inadequate supply of qualified manpower to absorb foreign technology. Moreover, Thailand lacks educational management which helps stimulate the proper learning, adaptation and development of technology, coupled with very limited science and technology teaching personnel with experience in transferring modern technology. In addition, the government does not provide enough incentives to bring about technology transfers and development in response to the changing production technology and market environment, resulting in the constraints in upgrading the country's technological capabilities. Concrete technology transfer strategies have never been formulated.

C.1.2.4 Low Investment in Science and Technology Development

Investment in science and technology development, in comparison with economic development and industrial expansion, is very minimal and insufficient to generate new inventions. Expenditures on R&D activities have been very low, representing about 0.2 percent of GDP throughout the periods of the Fifth and Sixth Plans. R&D expenditures remained constant, and, in fact, dropped to only 0.17 percent of GDP in 1993, the last year of the Seventh Plan. The budget allocated for R&D has tended to drop continuously while private R&D has mostly been made by large companies. The government investment in science and technology development has mainly involved those activities related to public services. No concrete support has been given to the private sector in this regard. In addition, there is no support for private organizations, academic or professional associations, as well as relevant foundations, so as to assist the government in science and technology development. Although the government has adopted a new mechanism to support R&D, rules and regulations of the Ministry of Finance have posed obstacles to investment leading to R&D activities, utilization of R&D results, and efficient technology transfers. Furthermore, the public.investment in infrastructure supporting the enhancement of international competitiveness does not respond to the country's urgent development needs.

C.1.2.5 Insufficient and Inconsistent Science and Technology Infrastructure Development

Several government agencies involved in the promotion of science and technology development independently determine their own policies and plans, without systematic coordination among themselves. The weaknesses in this regard also include the absence of information networks and the lack of explicit managerial targets, supporting legal frameworks, and atmosphere conducive to science and technology development. Moreover, the general public, youth, administrators, businessmen, politicians, and media still do not have basic knowledge of science and technology.

C.1.2.6 Thailand, not a Science Society

Conventional beliefs in the Thai society still persist despite its exposure to foreign cultures and adjustment to rapidly changing environment. At present, the Thai society is not a science society where people believe in science rather than superstition, resort to initiatives rather than duplication, use data rather than emotion, and depend on their intellects rather than assets. The Thai society is then not very conducive to science and technology development.

C.2 Future Situation

C.2.1 Global Competition Condition

Thailand is currently losing its comparative advantages due to depleting natural resources and the emergence of new competitors with cheap labor in Asia and Eastern Europe. Furthermore, it becomes more imperative that Thailand upgrade its international competitiveness, and adopt certain measures concerning environmental protection and sustainable development because of more opened world trade and intensifying competition; the obligations under the framework of multilateral and regional economic groupings such as the World Trade Organization (WTO), and the Asia-Pacific Economic Cooperation (APEC); as well as strict obligations on environment concerns.

C.2.2 Strong Competition in Science and Technology Development

Developed countries in Asia such as Japan and South Korea have set the good examples of using modern science and technology as a major stimulus for rapid economic achievements. Both have established the linkages between marketing strategies and technology development policies in mobilizing and upgrading their technological capabilities. Japan, for instance, has utilized science and technology for product development that fits the needs of foreign markets by placing emphasis on systematic science and technology development. Basic science has been developed to support R&D in the long term and create the country's capabilities in developing its own technologies. Science and technology manpower has been continuously developed to ensure a secured industrialization process of the country. Japan has continued attaching great importance to the application of modern science and technology to economic development by emphasizing high technologies. Major agencies involved in science and technology R&D serve as important sources of manpower. The South Korean Government, on the other hand, has explicitly stressed the technology-led policy in its social and economic development by initiating huge research projects, with cooperation among leading industries and public research institutions, aimed at developing modern technology, under the inter-disciplinary approach. Moreover, its science and technology policies and R&D operations have been continuously adjusted to respond to the changes in the industrialization policies. At the initial stage of industrialization, South Korea adopted the import-substitution policies, together with the export promotion measures. The government promoted the purchases of foreign technologies. Moreover, various public research institutions were established so as to create solid R&D infrastructure. The government later adjusted the mechanisms of developing imported technologies, promoted R&D for industrialization, stepped up the production of engineers and high-quality scientists, and encouraged technological development in the industrial sector. Focus was placed on basic scientific research, R&D for hi-tech development, and price dumping strategies aimed at increasing its

exports. The most efficient application of technology and selection of appropriate technology have enabled Korea to continuously upgrade technological capabilities, succeed in rapidly developing important industries, and finally become one of the Newly Industrialized Economies. Marked successes in science and technology development experienced by these two countries have resulted in wider gaps in international technology development since Thailand, which has a rather weak technological foundation, is unable to catch up with modern technological development. Greater reliance on foreign technology is evident, and, in turn, forces Thailand to accelerate science and technology development.

C.2.3 Thailand' s Growing Dependence on Imported Technologies as a Result of Increasing Competition

Thailand' s national economic development in the past has relied heavily on the abundance of natural resources and cheap labor, with a strong emphasis on rapid economic growth fueled by trade. Entrepreneurs are mostly oriented towards short term profits. Thailand' s economic growth over the past years has not been the outcome of technology-led strategies, but attributed to abundant natural resources and cheap labor. The global economy, however, has shifted away from the labor intensive industries to the capital and technology intensive production, prompting Thailand to upgrade its science and technology capabilities with a view to enhancing international competitiveness. At present, Thailand still has to rely on foreign technologies in increasing production, improving production processes and product quality, as well as adding more variety to the Thai products. Most imported technologies are direct purchases of technologies in the forms of purchases of machinery or capital goods; payment of royalty fees for published know-how, licensing, copyrights, trademarks, and management; and hiring foreign experts. Many technologies accompany foreign direct investment. The data of the Bank of Thailand clearly show that the spending on imported machinery and capital goods rose from 105,916 million baht in 1987 to 613,794 million baht in 1994, representing an increase of over four times. The payment of patent and trademark fees, and technical assistance increased by five times during the same period, from 2,882.8 million baht in 1987 to 15,568.6 million baht in 1994..Nowadays, technological changes are very rapid. Most technologies are highly complicated, resulting in wider gaps among countries. Most Thai entrepreneurs, however, do not realize the significance of technology upgrading, and deem it unnecessary to develop their own technologies on account of an easy access to foreign technologies.

C.2.4 Thailand' s Favorable Investment Climate

During the first three years of the Seventh Plan (1992-1994), the Thai economy registered an average growth rate of over 8.3 per cent, partly attributable to active investment promotion and the expedition of public spending on infrastructure development. In addition, there are several projects in the pipeline that need a high level of science and technology application, for instance, telecommunications projects, satellite projects, expressways projects, and private investment projects in major economic zones. These projects will stimulate, and provide more opportunities for Thai people to upgrade their technological capabilities.

C.2.5 Application of Foreign Manpower in Science and Technology

Amid the rapid economic expansion in Asia and the Pacific region, several countries are experiencing economic recessions. The declining industrial investment growth and production have driven their science and technology manpower out of the labor

market. Thus, this is an opportune time for Thailand to recruit these people with extensive experience and diverse expertise, including Thai professionals working overseas with a view to enhancing Thailand's science and technology development.

C.2.6 More Education and Training Opportunities Available in Educational Institutions and R&D Training Centers Abroad

A number of renowned educational institutions and R&D training centers overseas have provided foreign students with greater educational opportunities. They can, moreover, participate in joint study or research projects which will contribute to Thailand's development of science and technology manpower.

C.2.7 Role of Modern Science and Technology in Enhancing the Development of Local Wisdom, Arts, and Cultures

The long history of Thailand has generated a great variety of local wisdom in agriculture, food production, herbal therapies, as well as arts and cultures. Their development and diffusion through the application of modern science and technology will greatly contribute to the fostering of the national cultural identities. Successful science and technology development requires at least 2 major forces, namely (1) market forces which will encourage the application of science and technology in creating short-term competitiveness, and (2) political will which is a state force determining the long-term visions and plans of science and technology development. These two forces have proven to be effective factors in many countries. Some countries attach greater importance to political will whereas others with the strong private sector tend to rely more on market forces. Nevertheless, both forces cannot make successful science and development possible without full financial support.

C.3 Policy Guidelines

These guidelines are aimed at developing both basic and applied knowledge of science and technology supporting national economic and social development efforts.

C.4 Objectives

C.4.1 To upgrade production capabilities to become more competitive in the world market
C.4.2 To ensure the greater efficiency of resource allocation for the improvement of the quality of life and society; and the balanced and sustainable economic development.
C.4.3 To strengthen the country's long-term science and technology capabilities

C.5 Targets

C.5.1 Manpower Development

1) To achieve the following targets of manpower production by the year 2001: approximately 13,000 scientists (undergraduate level), 27,000 engineers, 88,400 industrial technicians, and 24,100 researchers (from the current level of 12,000)
2) To improve the quality and quantity of science and technology teaching personnel by recruiting at least 700 qualified engineering lecturers and 650 science lecturers from both domestic and foreign sources every year, no fewer than 350 additional technician teachers, and at least 800 science and

mathematics teachers at the secondary education from both domestic and foreign sources every year

3) To increase science and technology manpower and improve their understanding of the development of the quality of life and society.

C.5.2 Technology Transfer

1) To strengthen technology transfer capabilities of every production sector, with a greater emphasis on target technologies such as food processing, textiles, garments, jewelry, automobiles, electronics, parts and components, metal parts, petrochemicals, new materials, genetic engineering, and intellectual inventions.

2) To encourage the application and development of clean technologies, traditional technologies, and technologies for environmental protection.

C.5.3 Research and Development

1) To increase the total R&D expenditures to no less than 0.75 per cent of GDP, 0.5 percent by the government, and 0.25 percent by the private sector. As much as 60 percent of R&D budget is allocated for international competitiveness enhancement, 30 percent for the improvement of quality of life and society, and 10 percent for the development of science and technology knowledge.

C.5.4 Infrastructure Development.

1) To create linkages between science and technology; and agriculture, industries as well as services in the areas of product standards, intellectual property protection, modern databases on trade and technology, improvement of rules and regulations, as well as both fiscal and monetary measures to enhance production efficiency and product quality

2) To instill public conscience and interests in science and technology development leading to the improvement of quality of life and society

3) To promote the establishment of academic networks between domestic and foreign educational institutions

C.6 Guidelines and Measures

C.6.1 To Expedite the Production and Development of Science and Technology Manpower

1) To increase and develop manpower with excellence in basic science by extending compulsory education from 6 to 12 years, require that students take mathematics and basic science as mandatory subjects, and support schools with excellence in science and mathematics in both Bangkok and regional areas

2) To promote and enhance cooperation between public and private educational institutions in the production and development of highly qualified teachers, including the improvement of educational curricula and learning processes

3) To encourage the cooperation between domestic and foreign educational institutions, as well as industrial technology institutions specialized in specific sectors in the production and recruitment of personnel at every level in line with the demand of the industrial sector

4) To expedite the recruitment of specialists in science and technology, including Thai nationals working abroad and foreigners in the areas in great demand

5) To encourage the private sector to play a more active role in manpower production in response to technological changes through the following measures

of the Ministry of Finance:

  5.1)   To provide more incentives for the private sector to upgrade the skills of the work force by allowing special deduction of training expenses from taxable income

  5.2)   To require that private companies set aside a certain percentage of their revenues for training based on the company size and number of employees, with training subsidies supported by the government.

6) To support the application of information technology in both formal and non-formal education systems, as well as on-the-job training programs organized for science and technology manpower.

7) To utilize science and technology manpower in the military to a greater extent so as to alleviate the shortages of manpower in this field

8) To encourage certain universities and institutions to offer science and technology courses

9) To ensure that the manpower development for the ISO-9000 and the ISO-14000 quality systems can help industry maintain international competitiveness

C.6.2 To Improve Technology Transfer Capabilities

1) To survey the demand for technology and construct a technology assessment system in order to set short and long-term priorities for technology development targets, and formulate a master plan for technology transfer to be used as a framework for the public and private cooperation in technology transfer and manpower production in line with the demand of agriculture, industry and services

2) To stimulate, expedite and encourage transnational corporations with specialization in targeted technology to launch their investment projects in Thailand, with the provision of promotional privileges as well as fiscal and monetary measures to encourage the technology transfer

3) To impose technology transfer requirements on foreign counterparts in such mega projects as telecommunications projects, the Bangkok Mass Transit project and the Second Bangkok International Airport Development Project.

4) To offer fiscal and monetary assistance to educational institutions, professional associations and non-government organizations responsible for training and the diffusion of targeted technologies

5) To support the organizing of exhibitions on world-class developments of industrial production technologies in both central and regional areas

6) To promote the establishment of additional engineering consulting firms and professional associations, and help enhance their technological capabilities

7) To continuously conduct national campaigns aimed at promoting visions and common understanding of the significance of technology acquisition and transfer among high-ranking executives in both public and private sectors.

C.6.3 R&D Budget

1) To provide more financial support for R&D activities, especially those related to target technologies, and establish a mechanism to commercialize R&D results

2) To promote the establishment of specific research and development institutions such as an organization involved in implementing tasks relating to bio-diversity, and the Design and Manufacturing Center with a view to achieving greater self-sufficiency in technology development

3) To create mechanisms, and fiscal and monetary measures to encourage the participation of the private sector in R&D activities such as the provision of 200-percent.deduction of R&D expenditures, accelerated depreciation of machinery

and equipment used in these activities, financial support for investment in commercial projects, and soft loans

4) To implement R&D projects aimed at using research results for the benefits of the public, and combining local wisdom and modern know-how with a view to achieving the maximum benefits to the society

5) To promote cooperation between domestic and international educational institutions and research centers in the production of manpower at the graduate levels capable of conducting research

6) To create national science and technology projects with emphasis on advanced research

C.6.4 Infrastructure Development

1) To develop metrology systems and product quality standards so as to augment Thailand' s international competitiveness by
   1.1) Speeding up the establishment of the National Metrology Institute, and supporting the private sector and educational institutions in both Bangkok and regional areas in providing services relating to metrology, testing, analysis and quality control;
   1.2) Providing training, consulting and certification of ISO 9000, and making preparations for ISO 14000 to enhance the private sector' s understanding and competitiveness

2) To set up a database containing information on technology and trade as well as electronic data systems to efficiently support the implementation of the above measures, with the government investing in national information infrastructure and networks

3) To promote the establishment of the Science and Technology Fund to provide financial support for manpower development, technology transfer, and R&D by improving the efficiency and effectiveness of the management of the existing funds and offering financial and fiscal incentives

4) To amend and streamline obsolete laws and regulations to facilitate manpower development, technology transfer, and R&D activities

5) To promote benefits to be derived from Intellectual property protection as incentives for technology development

6) To instill the recognition of the importance of science and technology among politicians, businessmen, media, the youth and the general public

C.6.5 Management of Science and Technology Development

1) To improve the management of science and technology development by augmenting the cooperation among public agencies, private companies, academia, media and the general public in the formulation of action plans, securing sufficient.financial support, and creating the linkages between the private sector' s financial plans and the Science and Technology Development Plan with a view to stimulating political will and market forces which will ensure the efficient translation of the Plan into action

2) To conduct periodical monitoring and evaluation of the implementation of the Science and Technology Development Plan by an independent and reliable group of people, with index indicating the progress of the Plan, and disseminate the evaluation results to the public

To create a coordinating mechanism to ensure the consistency of all specific areas of the Science and Technology Development Plan so that the Plan can be efficiently translated into action