The 30th STAG Board Meeting

Topic 3: Strategies for Industry Foresight and Innovation

Subtopic 1: Review of and Outlook for Mid- and Long-term Advanced Industrial Technology Research

~As demonstrated by ITRI's Advanced Research Program~

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Outline

I. Historical Development of the Advanced Research Program

II. Major Technical Achievements and Applications

III. Forward Looking

IV. Issues to be Discussed

I. Historical Development of the Advanced Research Program

Historical Background in the late 1990's

- Fierce international competition: lack of self-developed technology and products, fast follower in production and paying high licensing fees
- Tremendous threats: no more advantages in adopting the business models of reducing cost and improving production flexibility

- Excerpts from the conclusions of "Government Science & Technology Budget Allocation Policy" (19th STAG Board Meeting, 1998):
  - DoIT of MOEA to set aside a part (about 20%) of its R&D budget to focus on advanced R&D
  - Must focus on tasks which could generate new products or new industries in 5 to 10 years, not an extension of the present technology or process

Launch of the Advanced Research Program

Conclusions of the 19th STAG Board Meeting in 1998

Conclusions of the fifth S&T Review Meeting of Executive Yuan in 1999

Key Points to Strengthen the Advanced R&D Portion in Science & Technology Projects

Advanced Research Program*

To assist domestic industries to break away from technology followers and to embrace competition advantages

To adjust the organization and operation, and to establish a research environment to facilitate advanced research programs and related talent utilization in the institutions

***Program was initiated in ITRI in 2001, then in III in 2002. Currently, eight research organizations have implemented these programs.**

Program Effectiveness

- **MOEA's activation of the Advanced Research Program has successfully promoted a culture of high challenge and risk taking in the research institutes**
- **Key successful factors**
  - **Autonomously managed system which allows flexibility of project modification**
  - **Aim high while tolerating failure**
  - **Actively invite outside experts to participate**
  - **Assistance from ARAC and TAC**

MOEA's Advanced Research Program was awarded the Executive Yuan's Excellence Award in 2009

Relationship of Advanced Research Program with Others

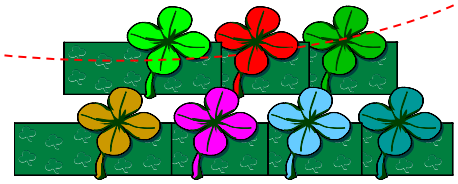
- Timely invest
- Encourage innovation

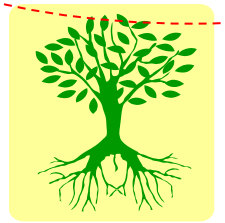
Advanced Research Program (bud)

Technology Development Program (sapling)

- Planning 2 years ahead
- limited number of projects

Industrial R&D Projects (full grown trees & forests)





Infrastructure Program (cultivate and breed)

Commercialization (harvest)

Authorized Management and Program Assessment Mechanism

Authorized Management

- **Simplify review & evaluation processes and endow execution flexibility**
  - **Results oriented**
  - **Programs modified as needed**
  - **Flexible budget allocation**
  - **Interim review in the 2nd half of the year**

Program Assessment

- **Every 3 years: Internal assessment**
- **Every 5 years: MOEA's evaluation**
- **Every year: NSC's review of selectively monitored programs**
- **Review criteria:**
  - **Technology Competitiveness**
  - **Quality of patents and papers**
  - **Personnel utilization**
  - **Technology application**

Overall Strategy in Program Development

Establish Advanced R&D Infrastructure

- **Establish autonomous management system**
  - **Encourage cross lab collaborations among academic, international and internal institutions**
  - **Actively recruit talent**
  - **Dynamically adjust programs and organizations**
  - **Establish the Creativity Center to facilitate cross-discipline innovation**
- **Establish Advanced Research Advisory Committee (ARAC)**
  - **Advise on research direction, strategy, mechanism, and recruiting**
- **Establish Technical Advisory Committee (TAC)**
  - **Invite domestic and international experts from industries, research institutes, and universities to advise on specific topics in specific fields**

Characteristics of Advanced Research Program

- **In comparison with other MOEA research programs, institutes are able to:**
  - **Pursue long term, rather than short term, results**
  - **Support long term goals and cross field collaboration**
  - **Cultivate a culture of high challenge, risk taking and failure tolerance**
  - **Establish autonomous management mechanisms, which could adjust research directions and strategies effectively and efficiently**
  - **Promote the industry's desire for the research of innovative technology**

Culture Activation by Advanced Research Program (Case Study)

- **Long term and Interdisciplinary Collaboration**
  - **Flexible PI substrate: material + component + process + equipment → flexible display industry**
  - **Electret material: Novel nanoporous low-k electret material + international collaboration → flexible speaker**
  - **Solid state capacitor: material + process + equipment → solid state capacitor industry, a spin-off company: the world's fourth largest manufacture**

- **Flexibility in Adjusting Program Directions**
  - **STOBA material: found that the material could crosslink due to high heat → the research direction was switched to solve the safety issue of lithium batteries**

- **Value Creation through Multidisciplinary Collaboration**
  - **Creativity Center: linking multidisciplinary technology with culture, and arts through researchers in various educational background**

Major Comments from Recent Assessments

- March 2004 - Survey of 48 experts from industry, academia, and research institutes
  - Mechanisms of cross field collaboration should be further devised
  - Recommend more aggressive recruiting to attract talent
- June 1, 2006 – Internal Assessment (committee members: 史欽泰, 林敏雄, 黃舜仁, 單驥, 杜紫宸)
  - Cross field collaboration projects should be given higher priority
  - The Advanced Research Program has positive impact on ITRI
- December 7, 2007 – DoIT Consultant Meeting
  - Enhance the fulfillment of commercial benefits
  - Patents granted should be benchmarked with universities or international research institutes
- August 2, 2010 – Internal Assessment (committee members: 史欽泰, 王俥, 吳丁凱, 陳文村, 王弓)
  - Management mechanism is feasible and effective
  - Delighted that risk taking and failure tolerant mentality are nurtured in the course of development of leading technologies
  - Should further encourage improvement of cross field, or even cross institute collaboration to take on more difficult research topics
  - Attention to progresses in related fields, especially the emerging ones

Benmarking with International Counterparts

- **ITRI was the only R&D institute listed among the top 50 in global ranking of US patents granted in 2009**

R&D Institute	2006		2007		2008		2009	
	patents	rank	patents	rank	patents	rank	patents	rank
ITRI	**225**	**75**	**229**	**79**	**286**	**57**	**389**	**48**
Fraunhofer	65	273	49	344	69	253	64	296
AIST	49	380	53	316	62	292	60	321
SRI	44	424	45	380	49	349	47	404

Source: USPTO; Delphion; ITRI

Ranking of the Most Cited US Patents in 2005-2009

R&D Institute		ITRI (Taiwan)	SRI (USA)	FhG (Germany)	NRC (Canada)	AIST (Japan)	CSIRO (Australia.)	TNO (Netherlands)
Top 5%-cited Patents	No.	64	52	20	8	17	5	1
	%	4.7	19.1	6.4	6.0	4.8	5.0	1.7
Top 20%-cited Patents	No.	214	115	70	29	55	23	6
	%	15.7	42.3	22.4	21.6	15.7	22.8	10.3
Total No. of US Patents		1,364	272	312	134	351	101	58

II. Major Achievements in Technology Innovation & Applications

1. Flexible PI Substrate

- **Promote the emerging flexible electronics and displays industry**
  - **70 manufacturers participated in the strategic alliances such as flexible electronics, continuous flexible liquid crystal film, etc.**
- **Interdisciplinary collaboration & cooperation**
  - **Solely developed the debonding layer technology of flexible substrate, compatible with TFT-LCD glass manufacturing process**
  - **High temperature, transparent and flexible PI substrate (transparency ~ 90 %)**
  - **low temperature flexible microcrystalline silicon transistor array backplane technology (process temperature ~200℃)**

(Video Source: Wall Street Journal)

2010 R&D100 Awards (R&D Magazine)
Wall Street Journal Technology Innovation Award
(Gold Medal – top overall prize)

TIA comments

- **Open the market to wide range of genuine new applications for consumer electronics and interactive terminal products**
- **Offer a simple and elegant solution**

2. Electret Materials & Paper Thin Speaker

- **Novel nanoporous low-k electret materials**

Characteristics: light, thin, bendable, low power, high quality sound, promising potential market

  - Specific electret voltage over 400V/μm, significantly higher than the incumbent perfluoropolymer electret (AF~100V/μm, FEP~50V/μm)
  - 1mm thick, pliable, capable of delivering high quality sound with low power consumption (roughly 1/5~1/10 of traditional speakers)
  - Well suited for mobile phones, 3C products, auto stereos, and commercial ads. etc.

(Video Source: CNBC)

- **A large area (10 m × 0.5 m) flexible speaker has been test produced by an R2R process**
- **In 2008, the Taiwan Electrets Electronics Corporation was founded to produce electro-acoustic products**

3. Solid State Capacitors

- **Self-assembly of conducting polymer on porous surface overcomes the leakage problem in traditional liquid-state capacitors. Moreover, the in-situ polymerization technique enhances infusion of conducting polymer into the electrodes and results in lower electrical resistance. The conducting polymer may be used in motherboards, mobile phones and notebook computers for antistatic, EMI, and anticorrosion applications.**
  - **APAQ Co., spun off from ITRI in 2005, is one of few companies which can produce winding type solid state aluminum capacitors. It is the fourth largest company in solid state capacitors, and expected to become the third largest (capacity: 1.2 billion units/year) in 2011 after expansion.**

4. High Safety Lithium Battery Materials

STOBA

(Self Terminated Oligomers with Hyper Branched Architecture)

Comparison of safety features

Nail penetration test(O.D 2.5mm,20mm/s)				
MCL STOBA inside	503759 soft packaging	Electricity capacity 1400mAh	Apply in Smartphone/ PDA	100% pass
Sony				50% pass
EXA				40~60% pass

- Incubation of the 3C and High Power Lithium Batteries Industry
  - STOBA R&D alliance was formed with 6 companies
  - Licensed to four big Taiwanese lithium companies and assist them in joining international strategic alliances and EV supply chains
- During abnormal heat spikes, ITRI's STOBA material can effectively suppress lithium-ion conduction and thus prevent thermal runaways originated from short circuits caused by cross linking reactions

5. Linking Technology and Culture

- **The Creativity Lab was established in 2004 to create new value by assisting the industry to transform from "Made in Taiwan" to "Innovation in Taiwan"**
  - **Formed NEXT consortium with Media Lab, MIT and local companies, and provided consultation services and training courses**
  - **Designed and constructed the Pavilion of Dreams at the 2010 Taipei International Flora Exposition**
    - **Consigned by Taipei City Government**
    - **Based on 6 technologies and 15 patents, worked with 9 artists and 4 interactive media companies to develop 18 exhibits**
  - **Promote integrated technology applications through cross field collaboration and innovation**
    - **Collaborated with the Palace Museum in Taipei on the development of Hsing Chi (行氣) calligraphy**
    - **Co-developed a concept motorcycle, dubbed RoboScooter, with Sanyang Co.**

III. Forward Looking

- **The Advanced Research Program has successfully promoted a culture of high challenge and risk taking in the research institutes, therefore it should be supported continuously with stable resources**
  - **Flexible management mechanism**
  - **Performance evaluation emphasized on long term benefits**
- **Part of the management mechanism requires adjustment to enhance the development strategies in both R&D and commercialization stages**

R&D Stage Strategy

- **Provide stable resources, select main topics, build long term relationships with top leading institutes worldwide, link to discovery based research**
  - **Promote the cooperation of "domestic academia + research institute + overseas academia"**
    - **e.g. National Yang Ming University (FLIM, single photon diagnostic tech.), ITRI (FLIM-CARS system miniaturization and integration), and NRC (National Research Council, Canada) (Hepatitis C virus kinetics, CARS) to develop Digital FLIM-CARS Microscope***
  - **Invite the top domestic and overseas scholars through sabbatical leave to join the research**

* FLIM: Fluorescence Lifetime Imaging Microscopy
CARS: Coherent Anti-Stokes Raman Scattering

Commercialization Stage Strategy

- **Enhance the industrial value creation of system and service technologies**
  - **Promote the research collaboration on advanced technology application by expanding the early participation of the industry, utilizing the policy tools (ex. Industrial Advanced Technology Program), and integrating the resources from industry and research institutes**
  - **Demonstrate the application value of system, service, or integrated technology and culture using the demo field trial through the collaboration of industry, government, academia, and research institutes**

IV. Issues to be Discussed

- **Discussion 1:**

  How can the proprietary academic R&D assets from domestic and overseas be connected for "Discovery Based Research", and how can research results be applied to industrial technology?

  - **Establish screening mechanisms, timely select and support key projects with breakthrough potential**
  - **Work on the business models and business plans in parallel**

- **Discussion 2:**

  How can government, industry, academia, and research institute be encouraged to work together to build system and service trial platforms to speed up the application of innovative and advanced research?