Design of In-Depth R&D Program Evaluation System and its Application in Korea

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~ Contents ~

I Purposes
II NRL Program ?
III Evaluation system of Nat’l R&D Program
IV Evaluation of NRL Program
V Suggestion of On-going NRL Program
I. Purposes of this study

- Suggesting evaluation system of Nat’l R&D program to evaluate NRL program in Korea
- Evaluating NRL program and analyzing its results
- Suggesting the directions of future NRL

※ NRL program has been successfully promoted in last 7 years as a major program of Ministry of Science and Technology (MOST)
II. NRL Program ?
1. Program Goals

- To support cross-cutting core technologies to strengthen national S&T competitiveness
- To select and nurture small sized research bodies which are centers of excellence in Korea
- Lab. should carry out public missions (internet homepage, workshops or seminars, technological consulting to related companies)

- To acquire of nationwide creative innovation capability
- To strengthen networking of NRLs which are the key sources of NIS in Korea
2. Key Features of NRL

- About 450 laboratories in progress
  (# of total core technologies in Korea is about 4400)
- R&D fund: $150,000 – 300,000 / (project.year)
- R&D period: 5 years maximum
- Interim evaluation after 2 years (2 + 3 system)
3. Management system of NRL Program

- Project selection
  - first year
  - second year
  - third year
  - forth year
  - fifth year

  - annual review
  - annual review
  - annual review

  Interim evaluation (screening out under 20%)

  Final evaluation
## 4. NRL supporting status

<table>
<thead>
<tr>
<th>Year</th>
<th>Applying</th>
<th>Selecting projects</th>
<th>Competing ratio</th>
<th>Yearly Funding (million US $)</th>
<th>Total Labs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>2,783</td>
<td>140</td>
<td>20:1</td>
<td>39</td>
<td>140</td>
</tr>
<tr>
<td>2000</td>
<td>1,586</td>
<td>160</td>
<td>10:1</td>
<td>75</td>
<td>296</td>
</tr>
<tr>
<td>2001</td>
<td>1,454</td>
<td>129</td>
<td>11:1</td>
<td>104</td>
<td>397</td>
</tr>
<tr>
<td>2002</td>
<td>948</td>
<td>55</td>
<td>17:1</td>
<td>110</td>
<td>416</td>
</tr>
<tr>
<td>2003</td>
<td>585</td>
<td>54</td>
<td>11:1</td>
<td>110</td>
<td>444</td>
</tr>
<tr>
<td>2004</td>
<td>380</td>
<td>27</td>
<td>14:1</td>
<td>59</td>
<td>241</td>
</tr>
</tbody>
</table>
Ⅲ. Evaluation System of Nat’l R&D Programs
### 1. Evaluation Issues

**Relationship between evaluation issues and system variables**

<table>
<thead>
<tr>
<th>Evaluation Issues</th>
<th>System variables</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>policy</td>
</tr>
<tr>
<td>appropriateness</td>
<td>✓</td>
</tr>
<tr>
<td>economy</td>
<td></td>
</tr>
<tr>
<td>effectiveness</td>
<td></td>
</tr>
<tr>
<td>efficacy</td>
<td>✓</td>
</tr>
<tr>
<td>process efficiency</td>
<td></td>
</tr>
<tr>
<td>quality</td>
<td></td>
</tr>
<tr>
<td>impact</td>
<td></td>
</tr>
<tr>
<td>additionality</td>
<td>✓</td>
</tr>
<tr>
<td>displacement</td>
<td></td>
</tr>
<tr>
<td>process improvement</td>
<td></td>
</tr>
<tr>
<td>strategy</td>
<td>✓</td>
</tr>
</tbody>
</table>

2. Evaluation System

Evaluation system of Nat’l R&D Programs

National Goal ↔ Market Demand ↔ Technology Opportunity

Appropriateness → Policy → R&D goal

Effectiveness

Impact

Outcome

Efficacy

Input ↔ Activity ↔ Output

Micro factor analysis

Efficiency

* Revised EC (1997), Evaluating EU Expenditure Programs
IV. Evaluation of NRL Program
1. Methods and Strategy

KISTEP

Advisor Committee

Bibliometric Analysis
- Input status
- Output · Outcome
- Material Report · Thesis research

Survey Analysis
- Target on 200 NRL participant and non participant researchers

Synthetic analysis & evaluation
- Evaluation on appropriateness, effectiveness, efficiency, efficacy of NRL

Suggestion of On-going program
- Environmental change analysis
- Program objective, operation and support system, evaluation and management system
2. Logic Model for NRL Program Evaluation

NRL program goal
- Foster COE 450 on core technology
- Strengthen the practice of public function

- Support the cross cutting core technology
- I.A.R competitiveness
- Sunset, Build and Scrap

• effective maintenance and development of COE
• Strengthen national innovation system network

Inputs:
- Budget
- manpower
- facility and equipment
- infrastructure

Outputs:
- paper, license
- develop model and algorithm
- prototype
- seminar/WS
- improve SNT knowledge

Outcomes:
- improve process
- improve productivity
- new products
- diffusion of knowledge
- networking
- spill over

Impacts:
- strengthen national competitiveness
- social economic level spill over
- improve GDP
- improve the quality of life

Evaluation
- Appropriateness
- Effectiveness
- Efficacy
- Efficiency
- Micro Factor Analysis
# 3. Evaluation Issues

<table>
<thead>
<tr>
<th>Evaluation issues</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appropriateness</td>
<td>- correspondence with S&amp;T policy&lt;br&gt;- Program positioning (distinction from similar R&amp;D programs)&lt;br&gt;- program’s direction of promotion and relevance of input</td>
</tr>
<tr>
<td>Effectiveness</td>
<td>- measurement of program goal attainment</td>
</tr>
<tr>
<td>Efficiency</td>
<td>- return on investment (ROI) compared with other programs&lt;br&gt;- analyze operation and management of the system: structure, process</td>
</tr>
<tr>
<td>Efficacy</td>
<td>- scientific and technical utility&lt;br&gt;- social economic utility: industrial growth, employment creation, public welfare</td>
</tr>
<tr>
<td>Micro factor analysis</td>
<td>- analysis on successful and insufficient factors&lt;br&gt;- analysis on output and/or outcome of 5 year completed projects classified by technologic field</td>
</tr>
</tbody>
</table>

**Method**

- Bibliometric Analysis
- Survey Analysis
- Self analysis
4–1. Evaluation Results—Appropriatenessness

Appropriateness of Program goal and strategy

- NRL program has reasonable program goal and promoting strategy for its well acceptance of national goal and social needs

<table>
<thead>
<tr>
<th>National goal and need of external environment</th>
<th>Suggestion</th>
<th>Program goal and strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>deindustrialization crisis as decreasing of research expenditure after economic crisis</td>
<td>Maintenance and development of pre-established research basis are needed</td>
<td>Foster COE 450 on core technology</td>
</tr>
<tr>
<td>Importance of source technology has raised rather than applying and manufacturing tech. after economic crisis</td>
<td>Security of core &amp; source technology is required</td>
<td>Support cross-cutting core technology of several industries</td>
</tr>
<tr>
<td>Lack of quality oriented intensive support on small premium research group compare to quantity of research bodies</td>
<td>Quality oriented intensive support on small premium research group</td>
<td>I.A.R competitiveness and Operating of COE</td>
</tr>
<tr>
<td>Strengthen establishment of national innovation system</td>
<td>Need of building national infrastructure for knowledge creation and diffusion</td>
<td>Strengthening of public function as research base of I.A.R</td>
</tr>
</tbody>
</table>

Suggestion

NRL program has reasonable program goal and promoting strategy for its well acceptance of national goal and social needs.
4-1. Evaluation Results—Appropriateness

Program Positioning

Target technology
Cross-cutting core technology
researcher nurturing
creative idea

Introducing  developing  Maturing

Technology life cycle

Support one project
Support multi projects

SRC  NCRC  ERC  CRC  NRL  ATC
4–1. Evaluation Results—Appropriateness

Program Positioning

- Research Oriented
- Knowledge Creation

- Development Oriented
- Knowledge Diffusion & Application

More than 10 researcher

Several researcher

Individual researcher

Support one project

Support multi projects

SRC

A.B.

S.B.

CRC

NCRC

ER C

NRL

ATC
4-1. Evaluation Results—Appropriateness

Good match with National strategic technology

- **NTRM related**
  - Highly related with NTRM (2003 73.3%, 2004 83.4%)

- **6T related**
  - Weight of 6T is increasing continuously since 2001
  - Focus on IT, BT, NT which are national strategic technology

```
<table>
<thead>
<tr>
<th>Year</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Others</td>
<td>2.5</td>
<td>2.6</td>
<td>2.6</td>
<td>2.6</td>
</tr>
<tr>
<td>NTL Safety</td>
<td>4.0</td>
<td>4.6</td>
<td>4.6</td>
<td>4.6</td>
</tr>
<tr>
<td>Traditional T.</td>
<td>19.4</td>
<td>21.2</td>
<td>22.0</td>
<td>22.0</td>
</tr>
<tr>
<td>ET</td>
<td>5.8</td>
<td>7.4</td>
<td>8.5</td>
<td>8.5</td>
</tr>
<tr>
<td>BT</td>
<td>7.5</td>
<td>5.8</td>
<td>4.0</td>
<td>4.0</td>
</tr>
<tr>
<td>IT</td>
<td>17.4</td>
<td>16.7</td>
<td>17.3</td>
<td>20.9</td>
</tr>
<tr>
<td>Total</td>
<td>104.191</td>
<td>105.986</td>
<td>107.816</td>
<td>59.927</td>
</tr>
</tbody>
</table>

- 源自：国家研究开发事业综合管理系统
```
## 4-2. Evaluation Results—Effectiveness

### Attainment of NRL’s goals

- Overall attainment on program’s goal is concluded to outstanding

<table>
<thead>
<tr>
<th>Program goal</th>
<th>Specific goals</th>
<th>Results</th>
<th>Evaluation</th>
</tr>
</thead>
</table>
| Effective maintenance and development of pre-established research basis | ○ support and run premium lab about 450 projects  
○ practical support of research expenses (app. 200 million won /yr.) | ○ maintenance 428 labs average on year of 2001～2003  
○ support 254.1 million won average on year of 2001～2003  
※ supported 244 labs on 2003 | ○good  
○good |
| Effectively ensure the innovation’s ability of core technology (core technology) | ○ support core technology  
○ induce I.A.R to competition | ○ focused support on national strategy (weight of 6T was 82.1% based on 2004)  
○ average competitive rate was 14:1 at the selection of subject (Bottom-up selection method)  
※ based on 2004 | ○good  
○good |
| Strengthen the network of national innovation system | ○ activity for cooperation and base of I.A.R [dissemination of technology]  
○ dissemination of outcomes | ○ regulates technology exchange program and begins operation of homepage  
○ held outcome exhibition twice | ○normal  
○normal |
4-3. Evaluation Results – Efficiency

Output analysis

**Papers by expenditure**

- Unit: #/100,000 U.S.$

**Patents by expenditure**

- Unit: #/100,000 U.S.$

Graphs showing the efficiency of papers and patents by expenditure, comparing various categories such as Advanced Nations avg. ('00), MOST R&Ds ('98-'02), HAN, and others. The graphs display different expenditure categories and their corresponding output analysis.
### 4–3. Evaluation Results—Efficiency

#### Analysis of research outcome

<table>
<thead>
<tr>
<th>Classification</th>
<th>Technical level</th>
<th>Improvement of technical level</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ex post labs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At start</td>
<td>53.65</td>
<td>–</td>
</tr>
<tr>
<td>At completion</td>
<td>88.87</td>
<td>1.656</td>
</tr>
<tr>
<td>Present</td>
<td>89.17</td>
<td>1.662</td>
</tr>
<tr>
<td><strong>On going labs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At start</td>
<td>50.14</td>
<td>–</td>
</tr>
<tr>
<td>Present</td>
<td>81.83</td>
<td>1.632</td>
</tr>
<tr>
<td>At completion</td>
<td>95.17</td>
<td>1.898</td>
</tr>
</tbody>
</table>

- The world’s highest technology level regarded to 100

- Ex post Labs
  1: Starting
  2: Final
  3: Current

- On going Labs
  1: Starting
  2: Current
  3: Final
**Social economic utility : industry support and employment expand**

- Industry support and expand employment effect such as technology transfer appear as the completion of selected lab on ‘99 and ‘00
- Outstanding outcome in industry support and employment expand over research expenditure comparing to other programs

<table>
<thead>
<tr>
<th>Program</th>
<th>Supported research expense (100,000 U.S.$)</th>
<th>Industry support outcome</th>
<th>Employment Expand effect</th>
<th>Expanssion** (men)</th>
<th>Establishment** (men)</th>
<th>Total (men)</th>
<th>Outcome over research expense (#/100,000 U.S.$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NRL</td>
<td>1,842</td>
<td>778 270 140 1,188 0.645</td>
<td>45 163 208 0.113</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NCRC</td>
<td>127</td>
<td>2 2 2 0.016</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SRC/ERC</td>
<td>1,523</td>
<td>263 295 3 561 0.368</td>
<td>11 4 15 0.010</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CRC</td>
<td>697</td>
<td>18 12 1 31 0.044</td>
<td>13 6 19 0.027</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Source: Survey, Analysis and Evaluation of Nat’l R&D Program (’03~’04)
- Expenditure: Sum of government and private
- of Business
Successful and insufficient factors of program

**Successful factors**

- Bottom-up selection method: give discretionary power to high leveled researcher (PI)
- Offer R&D concentration and stability
- Adopting appropriate competing system
- Providing honor to researcher

**Insufficient factors**

- Transfer of some projects to other programs by external factors
- Insufficient networking of projects

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**4–5. Evaluation Results—Micro factor analysis**
4–6. Evaluation Results—Summary

Appropriateness evaluation result
- NRL program has reasonable program goal and promoting strategy for its well acceptance of national goal and social needs
- NRL program is technology development program to secure core & source technology, which is able to cover up the gab between basic research and product R&D

Efficiency evaluation result
- Overall attainment on program's goal is interpreting as outstanding

Effectiveness evaluation result
- Actual publishing of thesis and patent performance over research expanse shows that outcome of NRL program is very high compare to developed country and domestic average

Utility evaluation result
- Academic aspect shows quantitative outcome and social economic spill over such as industry creation shows outstanding outcome compare to other program
- Recognition of improvement level in industry competitive power through NRL program sets most affirmative value on [technology preoccupancy effect at world market]

Micro factor analysis result
- Factors of success are bottom-up selection method, offering R&D concentration and stability, adopting appropriate competition system and providing honor to researcher
V. Suggestion of on-going NRL Program
## 1. Supporting direction of Neo-NRL

<table>
<thead>
<tr>
<th>Research subject</th>
<th>NRL</th>
<th>Neo-NRL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research subject</td>
<td>I.A.R</td>
<td>Academy (R.I. : collaboration)</td>
</tr>
<tr>
<td>Promotion strategy</td>
<td>Single strategy : foster COE</td>
<td>Multi strategy : foster COE + strengthen networking between projects</td>
</tr>
<tr>
<td>Research stage</td>
<td>Basic, applying, developing</td>
<td>Basic, applying</td>
</tr>
<tr>
<td>Technology life cycle</td>
<td>New born, growth, maturation</td>
<td>Focus on growth</td>
</tr>
<tr>
<td>Research term</td>
<td>2+3 : core technology development + core technology development</td>
<td>3+2 (+3) : core technology development + networking (+ collaboration)</td>
</tr>
</tbody>
</table>
2. Supporting area and form of Neo-NRL

(Before)
- support all fields from basic level to developing level
- support I.A.R

(after)
- concentrated support for basic and applying level except for developing level
- college NRL can be supported in early basic stage
- I.A and I.R collaboration labs can be supported in applying stage

Tech. level

Existing NRL program

Neo-NRL

Supporting Area

Supporting form

Basic
Applying
Developing

College NRL (250 Labs.)
Collaboration of I.A and I.R (50 Labs.)
Connection with ATC
Thank you!