

Jubilej Metalurškega inštituta na pragu novega razvojnega obdobja

Metallurgical Institute's Jubilee on Threshold of New Development



Čas, ki ga preživljamo ob pomembnem štiridesetletnem jubileju, zahteva od nas jasno, racionalno in odločno usmeritev nadaljnjega dela in razvoja, ne dopušča pa oddiha, v katerega bi nas zaneslo preveliko zadovoljstvo nad uspehi in morda pretiran ponos ob pogledu v preteklost.

Doseženi uspehi, zbrane izkušnje in nakopičeno znanje iz preteklega obdobja so dragocena osnova in velika obveznost za prihodnost, nikakor pa še ne predstavljajo zagotovila za nadaljno uspešnost. Le neprestano iskanje novega, boljšega in drugačnega z učinkovitim razvojem in uveljavljanjem novega znanja omogoča napredek in uspešnost.

V preteklem obdobju je to Metalurškemu inštitutu dobro uspevalo, tako da so se na njegovi razvojni poti izoblikovala zelo značilna obdobja, ki so prava slika razvoja te panoge doma in v svetu.

USTANOVITEV IN RAZVOJ METALURŠKEGA INŠTITUTA V LJUBLJANI (MIL)

Štiridesetletnica dela MIL se navezuje na petdesetletni jubilej Odseka za metalurgijo na Univerzi v Ljubljani, ki smo ga proslavili marca 1989 v Cankarjevem domu in na slavnostnem posvetovanju pregledali razvojno pot slovenske metalurgije.

Če upoštevamo, da so v povojnem obdobju kadrovske zmogljivosti slovenske metalurgije komaj zadoščale za osnovno organiziranje in vodenje proizvodnje, je ustanovitev Metalurškega inštituta **maja 1950** kar zelo spoštljiv datum. Za to gre vse priznanje profesorju **Cirilu Rekarju**, pobudniku in prvemu direktorju Metalurškega inštituta. Vsi slovenski metalurgi pa priznavamo za nestorja slovenske metalurgije. Široko po Evropi je kot mednarodno priznani strokovnjak uveljavil ugled slovenskih metalurgov, ki nam še danes odpira marsikatera vrata v strokovne kroge. Kar 16 let je vodil inštitut ob istočasnem bremenu univerzitetnega profesorja.

Še iz tistih let izvira današnje strokovno in prijateljsko sodelovanje z najvidnejšimi evropskimi inštituti, kot so Max Planck v Düsseldorfu, IWU v Clausthalu, IRSID v Parizu, CSM v Genovi in Rimu, takratna BISRA v Londonu ter drugi. Prof. C. Rekar je že pred tremi desetletji visoko cenil in spodbujal izpopolnjevanje mladih raziskovalcev v navedenih tujih vodilnih raziskovalnih centrih. Mnogi današnji vodilni metalurgi izhajajo iz tako šolanih raziskovalcev.

V času svojega nastajanja in uveljavljanja se je Metalurški inštitut racionalno zgledoval po uveljavljenih inštitucijah v svetu. S kritičnim presojanjem realnih možnosti je zelo razodno oblikoval svojo razvojno pot. Iz univerzitetnega inštituta je v letu 1958 prerasel v osrednji inšti-

The times we are living in at the moment of our fortieth jubilee require a clear, rational, and resolute setting of objectives to obtain further development of achievements and expansion of operations, not allowing the relaxation we could be lured into by too great a contentment over our success or even pride in the past.

The success we have had, the experiences and knowledge we have obtained throughout the past years, provide a solid and valuable basis for the future, but it cannot guarantee future success. Only a continuous pursuit, and encouragement of new, better and different ways combined with efficient development and progressive acquisition of knowledge can stimulate further success and progress.

Success has marked the development of MIL in the past, and its accomplishments mirror a whole period of development of this branch of science at home and abroad.

FOUNDATION AND DEVELOPMENT OF METALLURGICAL INSTITUTE IN LJUBLJANA (MIL)

The Fortieth Anniversary of MIL's work is directly connected to the Fiftieth Jubilee of the Metallurgical Department at the University of Ljubljana celebrated in March 1989, revising the development of Slovene Metallurgy from its beginnings to present achievements.

Considering the post-war scarcity of metallurgical staff in Slovenia, barely enough to organize and manage basic production, May 1950 as the foundation date of the Metallurgical Institute is a respectable achievement. The founder and first manager of the Metallurgical Institute was Professor Ciril Rekar, gratefully acknowledged by Slovene metallurgists as initiator of Slovene metallurgy. All over Europe he has been recognized as an international metallurgical expert whose reputation still opens many a door for us. He was head of the Metallurgical Institute for 16 years, simultaneously teaching at the University.

Our professional and friendly cooperation with well known European Institutes such as Max Planck of Dueseldorf, IWU of Clausthal, IRSID of Paris, CSM of Genoa, and Rome, the then BISRA of London, and others are based on those years. Professor Rekar, even as long as three decades ago well aware of the importance of the exchange of knowledge encouraged young researchers to improve their knowledge at these leading foreign research centers. Several of today's leading metallurgists followed his instructions.

During the period of development and growth MIL took the best examples from the most advanced institutions in the world. The Institute's development was

tut jugoslovanskih železarn in kasneje v osrednji raziskovalni Inštitut slovenske metalurgije. Vseskozi pa je ostal tesno povezan z metalurškim odsekom Univerze v Ljubljani, ne samo pri raziskovalnem delu, ampak, tudi pri vzgoji strokovnjakov. S tem se je Inštitut vse bolj povezoval z metalurško industrijo, kar je bilo še izrazi-teje v obdobju od leta 1966 do 1986, ko je vodil inštitut direktor Alojz Prešern.

Metalurški inštitut je že zelo zgodaj in vztrajno naka-zoval razvojno pot slovenske metalurgije in uveljavljal pomen raziskovalnega dela.

Šele v šestdesetih letih je bila dosežena taka kadrovska osnova, da so se lahko ustanavljali Raziskovalni oddelki v metalurški industriji, ki so se povezovali z Uni-verzo in Metalurškim inštitutom. Delo je usmerjala in nadzirala najprej posebna komisija, od leta 1970 pa Odbor za znanstveno raziskovalno delo, ki ga je do današnjih dni vodil prof. dr. Marin Gabrovšek. V zadnjem desetletju pa tudi Odbor za raziskave pri Splošnem združenju metalurgije ter livarn. To sodelovanje se je močno okrepilo in dobilo nov zagon z združitvijo sloven-skih železarn in predelovalcev v sestavljeno organiza-cijo, v katero se je 27. 11. 1973 vključil tudi MIL. Ob zdru-žitvi je MIL ohranil svoj status osrednje raziskovalne inštitucije slovenske metalurgije. Status, s kakršnim je bil ustanovljen, je ohranil vse do danes.

Neposredno povezovanje je dajalo celotni razisko-valno-razvojni (RR) dejavnosti prave usmeritve, delitev dela pa je sama opredeljevala vsebino in izvajalce temeljnih, uporabnih in neposrednih raziskav za reševa-nje proizvodne, kakovostne in razvojne problematike.

Raziskovalci MIL imajo danes v razvojnih projektih in v raziskovalnih programih bolje opredeljene, specifične naloge ter jasnejšo vlogo, ki je povezana z njihovim spe-cifičnim znanjem.

K načrtnjšemu razširjanju znanja je zlasti v zadnjem obdobju mnogo pripomogla usmeritev Raziskovalne skupnosti Slovenije (RSS), ki v Skupnem programu spodbuja ustvarjanje novega znanja v stroki, v Posebnem programu pa razvoj novih izdelkov in tehnologij. Uveljavlja se tudi akcija »Novi raziskovalci«, ki že daje spodbudne rezultate.

NADALJNI RAZVOJ SLOVENSKE METALURGJE IN RAZISKOVALNEGA DELA

Trdno zasnovan in strokovno utemeljen razvoj slovenske metalurgije, tako črne kot barvne in livarstva, je v težkem kriznem obdobju zdržal pritiske agresivno ustvarjenega in pretežno nasprotujočega javnega mne-nja. Danes že predstavlja solidna izhodišča ter jasne perspektive nadaljnjega razvoja naših najpomembnejših investicij v modernizacijo proizvodnih naprav.

V preteklem obdobju delovanja MIL se je v tehnolo-giji in raziskavah zgodilo toliko novega, da se tega ob vsakdanjem delu sploh ne zavedamo.

Pretekli dve desetletji sta bili obeleženi z intenzivnim razvojem tehnologij izdelave kovinskih gradiv. Ob velikih dosežkih pri zagotavljanju čistosti in enakomernosti kemične sestave v zelo ozkih mejah se je vse bolj uveljavljala intenzifikacija procesov, obenem z zmanjševanjem porabe energije.

Začela se je intenzivna industrijska aplikacija novih postopkov na področju litja, predelave in toplotne obde-lave, kar odpira nove možnosti v proizvodnji močno legiranih jekel, litin, zlitin in superzlitin.

Strategija razvoja je bivše cilje »več in bolje« pre-usmerila v »novo in drugače«!

Pod tem geslom se v zadnjem času uveljavljajo prav revolucionarne novosti, s presenetljivimi tehnološkimi

based on critical judgment and realistic possibilities. In 1958, MIL became the central Institute of the Yugoslav ironworks, and later the central Institute of Slovene metallurgy. Throughout this period its work was closely linked with that of the Metallurgical Department at the University in Ljubljana. So, the cooperation between the Institute and the metallurgical industry grew closer from day to day which was shown during the last twenty years (1966—1986) when the Institute's manager was Alojz Prešern, most clearly.

Thus MIL was early able to set objectives for Slovene metallurgy, and assiduously advance its research.

It was in the sixties that the formation of research departments in industry could be planned, and connected with the University's work and the Metallurgical Institute. The foundation of these departments was supervised by a special board, and since 1970 by the Committee of Scientific Research whose Chairman was Professor Marin Gabrovšek. During the last ten years he supervisor was the Committee for Research at the General Association of Metallurgy and foundries, too. When Slovene Ironworks and remanufacturers associated and founded a Combined Organization the cooperation became closer and livelier. MIL incorporated on November 27, 1973.

Upon association MIL kept its status of the central research institution of Slovene ferrous metallurgy, which has been preserved up to now.

This direct association oriented the whole develop-ment and research towards real and valuable objectives; problems arising from production, its quality and devel-opment were solved by means of direct research, which was based and practically specified by division of labour.

Today, MIL's researchers engage in precisely speci-fied development projects and research programs, depending on their specific knowledge. During the last few years the Research Association of Slovenia (RSS) encouraged the science to plan the obtainment and expansion of knowledge; as its general plan is to include know how in science, and its special program to support the development of new products. The program "Young Researchers" was introduced by the same Association, and its results proved to be encouraging.

FURTHER DEVELOPMENT OF SLOVENE METALLURGY AND RESEARCH

The development of Slovene metallurgy based on solid and professionally firm grounds came through a difficult period of crisis, caused by the aggressive and generally contradictory public opinion, intact. Today, we have already set solid starting points and clear direc-tions for future development based on the accumulation and deposition of our most important investments in the modernization of our production outfit necessary for the basic part of our manufacture program.

The period of the last two or three decades has brought so many novelties into the technology that some thinking is necessary to grasp them all.

During the past two decades, the steel industry has shown an intensified development in technology such as: cleanliness assurance, and narrower scattering of chemical composition, and energy saving while process intensifying.

Introduced was the development of industrial appli-cation of new processes in casting, hot working, and heat treatment of steels was intensified, indicating new possibilities in production of high alloyed steels and superalloys.

inovacijami. Takšno je na primer **litje polizdelkov, čim bližje končnim oblikam in dimenzijam, ter skrajševanje tehnoloških postopkov predelave**, ki je danes v ospredju intenzivnih raziskovalno-razvojnih prizadevanj.

Povsem razumljivo je, da tak razvoj zahteva »novo in drugače« tudi v raziskovalno razvojnem delu.

Nove možnosti prinaša uporaba računalništva, tako pri raziskovalnem delu kot pri vodenju procesov.

Pomen samo laboratorijskega preizkušanja in neposrednega prenosa laboratorijskih dosežkov v metalurško industrijsko prakso je že v šestdesetih letih močno zbledel, v toku sedemdesetih let pa povsem izgubil svoj pomen v taki obliki, kakršna je bila značilna za prejšnje, dolgo trajajoče obdobje. Neposredno industrijsko raziskovanje je obsegalo sistematično zajemanje podatkov, tako za redno kontrolo kot za raziskave z visoko razvito metodologijo statističnih analiz in z računalniško podprtimi informacijskimi sistemi. Laboratorijske raziskave so dobivale vse bolj pomen pojasnjevanja dogajanj, iskanja in utemeljevanja zakonitosti. Vgrajevanje višjih fizikalno-kemičnih zakonitosti v računalniško podprto krmiljenje tehnologije je postalo osnova razvoja ekspertnih sistemov.

Strategije razvoja najnaprednejših danes ne bi mogli več označevati s klasičnim geslom »več in bolje«, ker se vse bolj usmerjajo v »**novo in drugače**«, in to večkrat pomeni tudi »**manj in več vredno**«.

Ustrezna **specializacija in sposobnost hitrega prilagajanja** predstavljata odločilno pomembno poročstvo uspešnega poslovanja.

V preteklih štiridesetih letih si je Metalurški inštitut Ljubljana nabral toliko izkušenj, da se prav dobro zavedamo, da je treba že za leto 1992, še bolj pa za vstop v 21. stoletje, način dela, pristope k nalogam in sploh miselnost raziskovalcev ter vseh sodelavcev temeljito spremeniti. Če hočemo biti še naprej uspešni, si moramo pridobiti ustrezen položaj in odnose v mednarodni mreži raziskovalno-razvojnih dejavnosti.

Ne bomo namerno zavirali posameznih področij dejavnosti, ki smo jih doslej razvili, zavedamo pa se, da je širina našega udejstvovanja brez posebnih udarnih konic preširoka. Vzdrževali in gojili bomo široko osnovo znanja in obnavljali izkušnje, nove napore in vlaganja pa bomo usmerjali predvsem v najperspektivnejše smeri na osnovi mednarodno veljavnih meril.

Inštitut, ki ni vsaj kje v ospredju, ne more pričakovati uspešnega mednarodnega sodelovanja in učinkovite menjave.

PILOTNE NAPRAVE

V sodobni visoko produktivni in močno avtomatizirani proizvodnji se izvajanje raziskav prenaša iz laboratorijskih na **pilotne naprave za raziskave in razvoj novih materialov in tehnologij**. Po osnovnih karakteristikah se približujejo pogojem industrijske proizvodnje. Take pilotne naprave so predrage, da bi jih izkoriščali samo za raziskave, zato morajo dajati tudi določen delež neposredne proizvodnje, s katerim je po možnosti treba pokrivati vsaj lastne stroške delovanja in vračanje investicijskih vlaganj. To je zelo pomembno tudi za večjo, nujno potrebno neodvisnost raziskovanja. Informacije in rezultati raziskav ter meritev na napravah pilotne proizvodnje so velikega pomena za hitrejši nadaljnji razvoj. Na ta način z izkoriščanjem pilotnih naprav ne motimo redne proizvodnje z eksperimentiranjem ali pa jo motimo mnogo manj. Poleg raziskovalnega pomena ima taka pilotna proizvodnja tudi velik pomen za **razvoj in osvajanje tržišča**, saj daje normalne proizvode v manjših količinah za neposredno uporabo. Ko količina proizvodov iz

The course of development turned the past motto "more and better" to "new and different".

Lately, the new motto has introduced some revolutionary novelties, which were launched not only by the simple and inventive changes in the manufacture programs, but also by astonishing innovations in the technology itself. Research is engaged in casting of semi-finished products and in shortening the necessary technological process of hot working.

It has become quite clear that such development needs new and different approaches to research, and different methods of work.

During the sixties, the importance of laboratory experiments, and the direct transfer of their results to industry slowly faded and in the seventies, they were no longer important in the sense that was characteristic for the previous, long lasting period. The direct industrial research which collected data for regular checking and research systematically, by means of highly developed statistical analyses and computer supported information system, was no longer wanted. The laboratory research was used to explain special events, to search for rules and prove them. The rules acknowledged by chemistry and physics used in computer supported technology control introduced the expert systems.

The advanced development strategy could no longer be explained by the motto "more and better" as it is aimed at "new and different" which often means "few and of higher value".

Specialization and flexibility are the sole guarantors for success.

The experience gained in the course of forty years has given MIL directions how to work; the approach to tasks and the thinking generally done by the researchers and fellow workers have to become subject to modification, thus preparing the way to 1992 and especially the twenty-first century.

Being well aware that the scope of our work has become too widespread, we are going to give our full attention to some of the most important fields of work without intentionally curtailing the activities in individual fields that have been developed up to now. Thus, the wide range of our knowledge is going to be further cultivated, subjected to change, and new efforts put into the most promising fields of activities considering present international problems.

An institute cannot take pride in successful international cooperation and effective exchange unless it has a lead in at least one line.

PILOT PLANTS

Modern, highly productive and fully automated industries transfer their research from laboratories to pilot plants where new materials and technologies are investigated or developed in almost identical conditions as in industry. The high expenses do not allow such plants to engage in research alone; they must bring profit — at least to cover the operating costs and investments. Not interrupting any industrial processes, such experiments provide realistic results which are necessary for further progress. Pilot plants manufacture a small amount of products for immediate use. Provided, such products prove to be useful, the industry takes over their manufacturing together with the experiences gathered.

Today, the research institutes all over the world including MIL, acknowledge the task of shortening technological proceedings as the most important one, the

pilotnih naprav ne zadošča več potrebam, se z vsemi izkušnjami ta proizvodnja prenese v industrijske obrate.

Skrajševanje tehnoloških postopkov je danes najpomembnejša splošna tehnološka usmeritev RR programov tako v svetu kot na MIL. Razvojna razmišljanja in intenzivna prizadevanja za racionalizacijo tehnoloških procesov so privedla do usmeritev nadaljnjih tehnoloških raziskav, katerih cilj je »**izdelava polizdelkov, ki so čim bližji dimenzijam in oblikam končnih proizvodov**«.

To prinaša zelo pomembne prihranke v specifični porabi energije, dela, orodij in drugih proizvodnih sredstev, zmanjševanje tveganja neuspele proizvodnje in izmečka, predvsem pri težje predelavnih materialih, močno povečuje izkoristke materialov, skrajšuje dobavne roke in lažje zagotavlja kratke roke »just in time« brez povečanih zalog, manjše celokupne proizvodne stroške — torej mnogostransko splošno racionalizacijo proizvodnje v drugačni obliki in vsebini, kot smo racionalizacije pojmovali doslej.

Zametki pilotne proizvodnje MIL so se pričeli z nabavo 25 kg-ske vakuumske indukcijske peči pred 25 leti. Skupno s kasneje nabavljenimi predelovalnimi agregati za hladno in toplo predelavo je omogočala mini proizvodnjo predvsem mehkomagnetnih materialov, obrabno in korozijsko odpornih ter posebnih zlitin, ob istočasnem vzdrževanju kondicije ljudi in naprav, ki so važen element pri eksperimentiranju in raziskovanju. Ob zagonu novih pilotnih naprav SŽ na MIL so predstavljale jedro: 25 kg vakuumska indukcijska talična peč, 70 kg indukcijska talična peč, naprave za vroče in hladno valjanje in vlečenje, vakuumska peč za toplotne obdelave, delno pa se bosta vključili tudi napravi za atomizacijo talin in hitro strjevanje tankih trakov.

V letu 1989 je bil na MIL montiran sklop pilotnih talin in livnih naprav Slovenskih železarn. Ta najmodernejša oprema omogoča razvoj novih asortimentov materialov do superzlitin.

Najpomembnejši segment pilotnih naprav MIL predstavlja linija za horizontalno neprekinjeno litje žic in palic. V prvi fazi razvoja trožilne naprave predvidevamo osvajanje litja žic, dimenzij od $\varnothing 3$ mm do $\varnothing 12,5$ mm. Pomembnejša za industrijsko proizvodnjo pa bo preureditev na eno žilo večjih dimenzij in različnih oblik, seveda v kombinaciji z ustrežno vročo ter hladno predelavo.

Naprava za klasično električno pretaljevanje pod žlindro, s katero ima MIL dolgoletno raziskovalno tradicijo in bogate razvojne izkušnje, je dograjena z napravo za najnovejši postopek ponovčne metalurgije pod imenom elektro-žlindrino-ogrevanje (EŽO), ki je bil po patentu našega razvojnega kooperacijskega partnerja prvič uporabljen in praktično preizkušen na MIL. S tem je med drugim MIL pridobil možnost izdelave posamičnih super čistih ingotov ali ulitkov do največje teže 800 kg, kar je izredno pomembno za razvoj tehnologije, namenjene industrijski proizvodnji v železarni Ravne.

Dosedanje eksperimentalne naprave z dopolnilno opremo za metalurgijo prahov in tehnologijo hitrega strjevanja odpirajo novo zaokroženo, fleksibilno in visoko specializirano področje raziskovalno-razvojnega udejstvovanja, usmerjenega na razvoj novih materialov, seveda z novimi tehnologijami. S toplotno obdelavo v vakuumu imamo že kar solidne izkušnje in tudi spodbudne raziskovalne rezultate. Dopolnjuje jih nov razvoj na področju toplotne obdelave v lebečem sloju.

Z izdatno pomočjo Raziskovalne skupnosti Slovenije in Slovenskih železarn je MIL v zadnjem času tudi pomembno moderniziral svojo raziskovalno opremo. Pri izbiri opreme smo v zadnjem obdobju iz razumljivih stra-

manufacturing of semi-finals that would bear resemblance to final products in design and dimensions to the highest extent possible is another of research objectives.

The technological research strives to achieve a longer durability of tools and equipment, to save energy and work, to reduce waste of materials (when working hard-to-treat materials), to shorten delivery time, and secure the "just in time delivery", to reduce the number of articles in store and production costs.

In short, in achieving such results, production would be rationalized in features and contents in a way, quite different from the previously achieved ones.

The beginnings of MIL's pilot production were created 25 years ago when MIL acquired a 25-kg vacuum induction furnace, which together with the later purchased equipment for cold and hot working process started the mini production of softmagnetic materials, special steels and alloys, resistant to wear and corrosion, and super alloys; at the same time it kept the workers and outfit in good condition. Upon starting up the new pilot plants of SŽ at MIL, the 25 kg vacuum induction furnace, the 70 kg induction melt furnace, the hot and cold drawing machine, the vacuum furnace for heat treatment represented the most essential part of the plant. The atomisation and the rapid cooling technology with adequate equipment will carry out their share of work, too.

In 1989, MIL erected the pilot plant of Slovenske železarne, specialized in melting and casting. This modern outfit is going to support further development of new assortments of material, including super alloys.

The horizontal continuous casting line for wires and rods is the essential part of MIL's pilot plant. The three-strand wire caster is limited to the range 3—12,5 mm diameter in the first stage. However, further development with adaptation of the three strand caster to the single-strand caster for bars of larger sizes and different shapes, attached to the corresponding machines for cold and hot working and heat treatment is of utmost importance to industry.

To the equipment for conventional electro-slag-remelting which has been for many years researched and developed by MIL, the equipment for the newest procedure of tundish metallurgy known as electro-slag-heating (ESH) was attached. The latter was originally applied, and tested by MIL after MIL's cooperator took out a patent for it. So, MIL gained the opportunity to procure individual "super clean" ingots or casts weighing up to 800 kg, which are of vital importance to the production of Železarne Ravne.

The previous experimental machines equipped with additional outfit used in the powder metallurgy and the technology of rapid solidification provide a new, complex, flexible and special field of research and development which is aimed at the development of new materials based on new technologies. The vacuum heat treatment of materials has already brought stimulating results and valuable experiences, supported by present development of fluidized bed heat treatment of materials.

Lately, MIL was able to modernize its research outfit by the generous support of Research Association and Slovene Steelworks. The outfit MIL chose on the basis of strategic research orientations was the one for synthesis of materials.

The survey of this short description shows MIL's participation in changes and innovations of technological

teških raziskovalnih usmeritev namenjali določeno prednost opremljenosti za sintezo materialov.

Že ta kratki opis pojasnjuje, kako se MIL vključuje v novosti tehnološkega razvoja in kam namerja udarna področja svojega raziskovalno-razvojnega udejstvovanja.

Z novimi pilotnimi napravami in novo raziskovalno opremo si MIL utrjuje svoje sedanje mesto in povečuje svoje potencialne na področju aplikativnih in osnovnih raziskav, obenem pa se pomembno vključuje v vzgojo strokovnjakov, študijske programe in postdiplomske programe.

Končno je dosežena tista stopnja opremljenosti, ki že vzbuja interese tudi pri najrazvitejših in dejansko omogoča vključevanje v mednarodno delitev. To dokazuje odpiranje skupnih projektov z inštitucijami in podjetji v ZDA, ZRN, Franciji, Italiji, Švedski in Avstriji.

Razmišljanje o nadaljnjem razvoju raziskovalno-razvojnih dejavnosti MIL lahko strnemo s paralelo:

Tako kot se v industrijski tehnologiji uveljavljajo novi kombinirani postopki, ki racionalizirajo tehnološke poti in združujejo obstoječe naprave in prednosti tehnoloških novosti z novimi specializiranimi napravami v nove optimirane in direktne kontinuirne postopke, tako razvoj novega znanja bogati obstoječe izkušnje in z novo organizacijo interdisciplinarnega teamskega povezovanja v raziskovanju uveljavlja dognanja znanosti in dosežke raziskav.

Samo z znanjem in bogatimi izkušnjami se na zastarelih in izrabljenih napravah ne da razvijati novih materialov in tehnologij.

Ustrezna vlaganja v opremo in strokovnjake so neizbežen pogoj razvojnih, pa tudi raziskovalnih uspehov.

Za razvoj znanja moramo zagotoviti financiranje primerno izbranih osnovnih raziskav, usmerjene uporabne raziskave pa moramo uveljaviti tako, da bodo namesto segmenta stroškov pridobile inovativni značaj.

V nadaljnjem razvoju se bomo morali bolj kot doslej zavedati, da

raziskave služijo razvoju, cilji razvoja pa opredeljujejo in usmerjajo raziskave,

saj se to pravilo v svetu vse bolj uveljavlja tudi z novim modelom povezovanja osnovnih in uporabnih raziskav z razvojem.

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development, and the direction of the essential part of its research and progress.

New pilot plants and research outfit give support to MIL to keep its present position and to promote its potentials in the field of applicable and basic research. At the same time they offer students and staff an opportunity for advanced education.

The MIL's outfit has been improved to such an extent, that it became interesting even to highly developed countries and so opened up many an opportunity to participate in international research. Joint projects with institutions and firms of U.S.A., West Germany, France, Italy, Sweden and Austria, clearly prove it to be done.

The following could be the summary of the previously done thinking on further progress of research and development of MIL:

As the industrial technology introduces new combined procedures that rationalize the technological methods and attach specific machines to the present ones with technologic innovations, thus creating new optimum direct continuous procedures; so the development of knowledge contributes its latest experiences, and the modern interdisciplinary research teams apply the research results and scientific statements to industry.

Even excellent knowledge and rich experience can not make the old and worn machines develop new materials and technologies.

Successful research and development may be achieved on one condition only, and that is: appropriate outfit and professional staff.

In the future, MIL will financially support the development of knowledge according to the chosen basic research. The applied research and the individual investigations within this research will contribute to industry by striving to be innovative and productive.

In the future we must acknowledge the fact that

progress is based on research, and the objects of development determine and specify research.

The world has already approved of the idea which is shown in adapting the basic and applicable research to development.

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