TECHNOLOGY EXCHANGE PROGRAM

prepared
by

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TECHNOLOGY EXCHANGE PROGRAM

A. INTRODUCTION

1. Overview

The present document has been prepared with the thought in mind that a technology exchange between organizations in the state of Minnesota and in the Soviet Union would be productive for both parties. What we are proposing, in essence, is to start exploratory discussions to determine whether or not programs of this type are of interest to organizations in the Soviet Union.

Section B of this document describes an about-to-be-created Cold Weather Resource Center. This Center will encourage the application and development of cold weather technology in the state of Minnesota. Most people in the United States regard cold weather as a liability, but we in Minnesota have the advantage of knowing how to cope with it.

A total of seven possible technology exchange programs are suggested in Section C of this document. This is a small sample of what is possible, since there are many possible organizations in the state of Minnesota who could participate in such a program. These include the University of Minnesota, departments of the State Government and private industry.

2. Initial Steps

It is difficult to predict the exact scale of the various technology exchange programs. As a starting point we have been thinking of two week visits by technologists to one another's country. Perhaps only one or two Soviet and American technologists would make these initial reciprocal trips for each project. This would be an intensive two week period of meetings and field trips. Then after reviewing the results of these meetings of two weeks duration the basis for further technological exchange would be established. This may seem like a modest beginning, but would place the later technology exchange on a firm basis.

3. Governor Perpich Initiative

About six months ago the Governor of the state of Minnesota, Rudy Perpich, created a Blue Ribbon Commission to consider the creation of a Cold Weather Resource Center (CWRC). The Commission has now completed its work and has recommended that the state of Minnesota proceed to create such a Center. The next step now is for the Center to be authorized by the Minnesota State Legislature. If this proceeds according to plan, funds for the CWRC will become available on 1 July 1989.

The CWRC will then become a small coordinating agency that will bring various groups together to solve problems resulting from Minnesota's cold weather.

The purpose of the present document is to describe the CWRC in a general way, and then to suggest some possible areas for technology exchange. It is assumed that these will be reviewed by scientists and engineers in the Soviet Union. If there are areas where a technology exchange would be productive then these will form the basis for further discussions and meetings.

4. Comparative Climates

It is well known that the Soviet Union has an abundance of cold weather in the winter. Most encyclopedias will reveal that the coldest spot in Siberia is Verkhoyansk in the District of Yakutsk. Apparently the coldest weather on record at this location is -93^{o}F. In any case, the Soviet Union has much colder weather than does the northernmost part of the state of Minnesota. For example the coldest recorded temperatures in the northwestern part of the state ranges from -45^{o}F to -55^{o}F. The coldest recorded temperature in the Minneapolis /St. Paul area is -40^{o}F. These two cities are at a latitude of 45^{o}N.

The latitude of Moscow is almost 56^{o}N, so Moscow is nearly 660 nautical miles farther north than Minneapolis and St. Paul. In spite of this difference in latitude, the winter weather in Moscow is apparently fairly similar to the weather in the Minneapolis/St. Paul area in terms of temperature and

snowfall. This observation was made recently by a Control Data engineer who spent the first decades of his life in Moscow and has lived the last decade in Minneapolis.

B. COLD WEATHER RESOURCE CENTER

As a means of explaining just what we mean by the name Cold Weather Resource Center, a series of charts are given below. They are largely self-explanatory, but a brief paragraph adding further comments will be given to aid the reader in understanding the organizational role of the CWRC.

1. CWRC Benefits

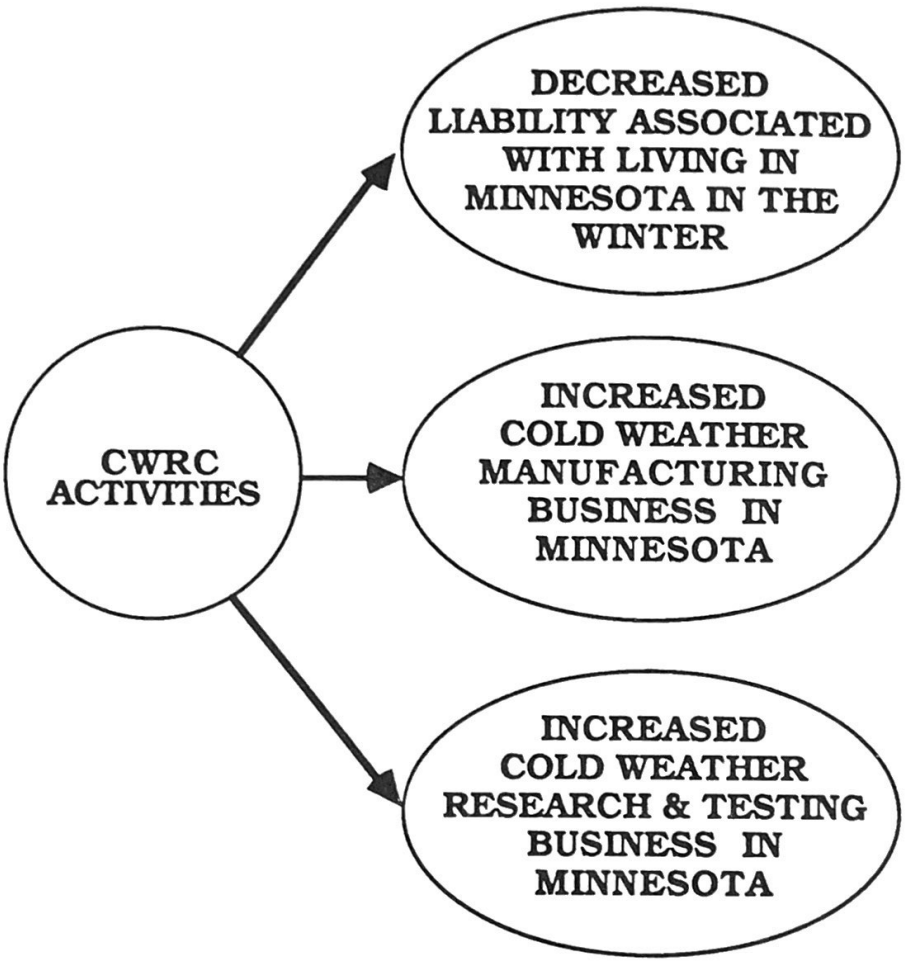
The first chart is entitled CWRC BENEFITS. On the right hand side of this chart three kinds of benefits are shown.

(1) There are certain liabilities associated with living in cold weather. We estimate that in the state of Minnesota this amounts to at least 4% of the Gross State Product. The Minnesota Gross State Product in 1989 will be $87 billion ($87 \times 10^9$ dollars). At 4% the cold weather liability amounts to about $3.5 billion per year. Any new technology that can be applied to reduce the "cost of winter" will produce an overall benefit to the people of Minnesota.

(2) The middle ellipse on this chart refers to business in Minnesota in which products are manufactured for cold weather activities. At present these manufactured products are in excess of $1 billion per year. The increased sale of these products will provide additional jobs for the people of Minnesota.

(3) At present there are at least $10 million per year of cold related research, testing and technology transfer activities in the state of Minnesota. Most of this is funded through the University of Minnesota or through State Government Agencies. The testing

CWRC BENEFITS



of a wide range of commercial products is being done at International Falls, Minnesota.

The next chart is entitled CHARACTERISTICS OF THE THREE MAJOR CATEGORIES OF CWRC BENEFITS. Comments are made regarding the present and future economic benefits associated with CWRC activities for each of the three categories in question.

2. Relation of Affiliate Organizations

The next chart is entitled RELATION OF AFFILIATE ORGANIZATIONS TO THEIR OWN SPECIALIZED TRADE ASSOCIATIONS. It is expected that the CWRC will have dozens of Affiliate Organizations. As a coordinating agency the CWRC will aid the Affiliate Organizations in various ways. It is assumed that the Affiliate Organizations are located in the state of Minnesota, however their customers will be scattered around the United States and the rest of the World. It is assumed in this chart that many of the Affiliate Organizations will have their own trade associations. For example, T-1 may be a forestry trade association, T-2 may be a building trade association, etc. It is assumed that the CWRC will interface with the trade associations as well as with the affiliates.

3. Sources of Cold Weather Technology

The next chart is entitled POSSIBLE SOURCES OF COLD WEATHER TECHNOLOGY. While some of these are located within the state of Minnesota others are located in other places. Among the other countries of the world it is assumed that the best cold weather technology exists in the Soviet Union, Scandinavia and Canada.

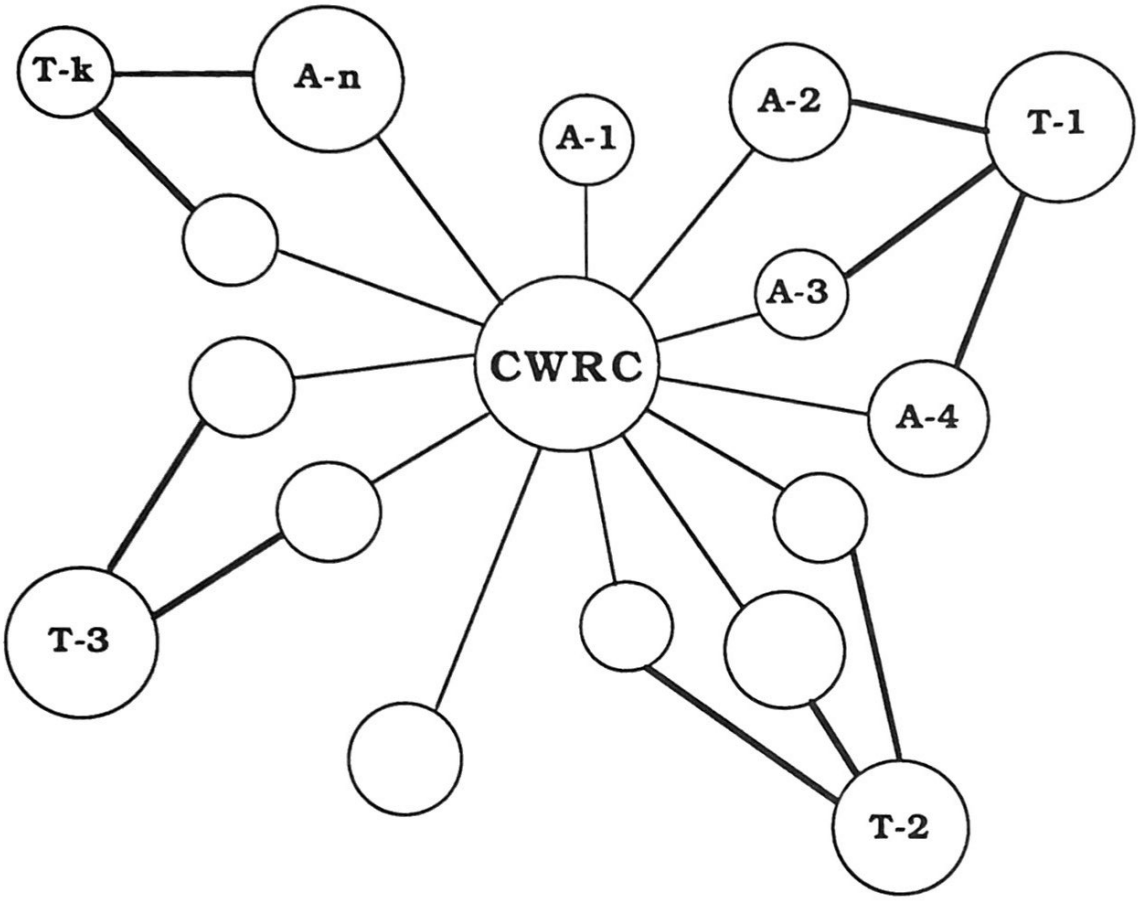
4. Possible CWRC Publications

The next chart is entitled POSSIBLE CWRC PUBLICATIONS. The first document that the CWRC will prepare is a Capabilities Brochure. This will indicate the kind of cold weather research and testing capabilities that exist within the state of Minnesota. Since much of the testing will be done in an outdoor environment, a Climatology Brochure will be needed.

CHARACTERISTICS OF THE THREE MAJOR CATEGORIES OF CWRC BENEFITS

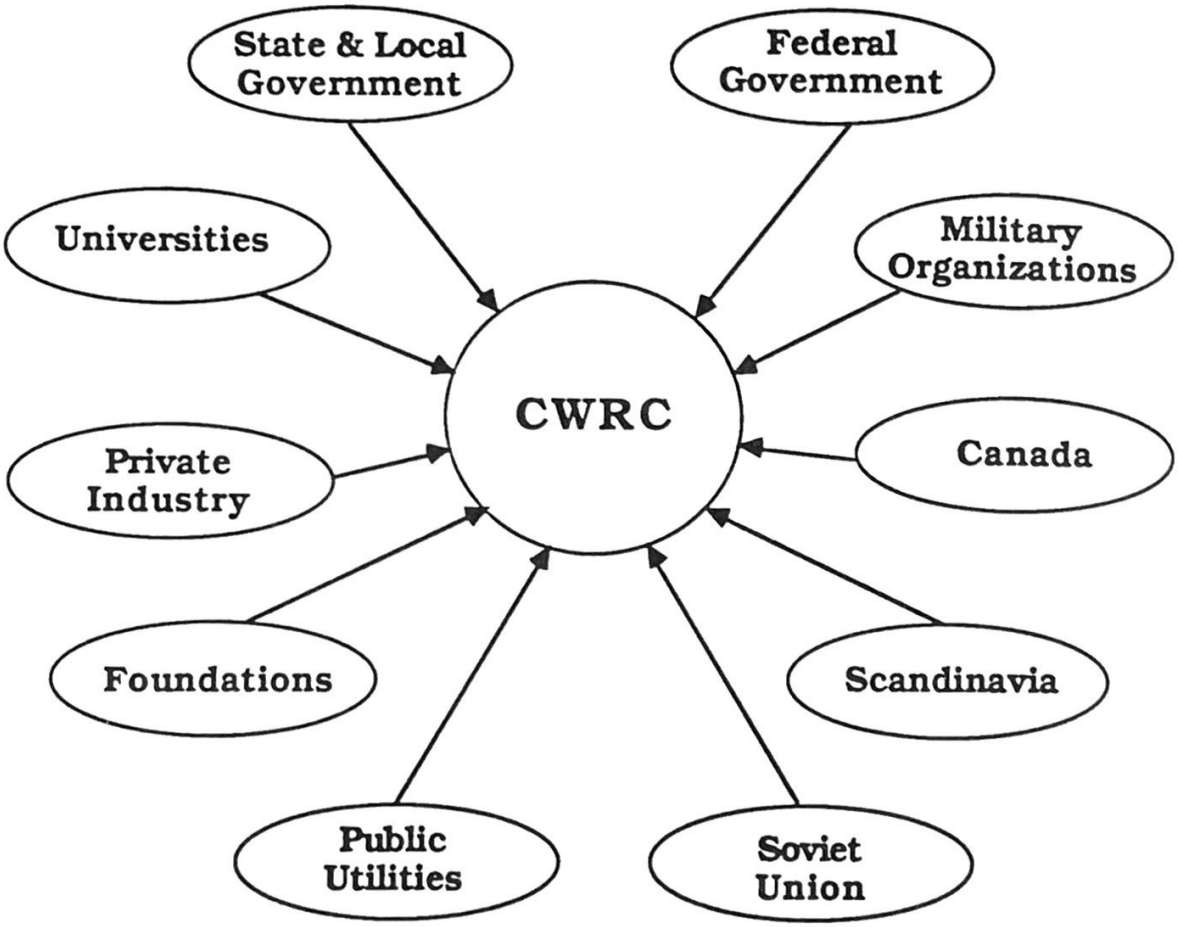
CATEGORY	PRESENT	FUTURE
1. DECREASED CW LIABILITY	THE LARGEST CURRENT BENEFIT.	WILL BE THE MOST IMPORTANT DURING THE FIRST DECADE OF THE CWRC.
2. INCREASED MANUFACTURING BUSINESS RELATED TO CW	INTERMEDIATE BENEFIT	THE LARGEST LONG RANGE POTENTIAL, PARTICULARLY FOR THE SECOND DECADE OF THE CWRC.
3. INCREASED RESEARCH, TECHNOLOGY TRANSFER AND TESTING RELATED TO CW.	THIS CATEGORY IS THE SMALLEST.	THE LARGEST PERCENTAGE GROWTH IN THE NEXT DECADE, BUT IN THE LONG RUN WILL BE SMALLER THAN (1) AND (2).

RELATION OF AFFILIATE ORGANIZATIONS TO THEIR OWN SPECIALIZED TRADE ASSOCIATIONS

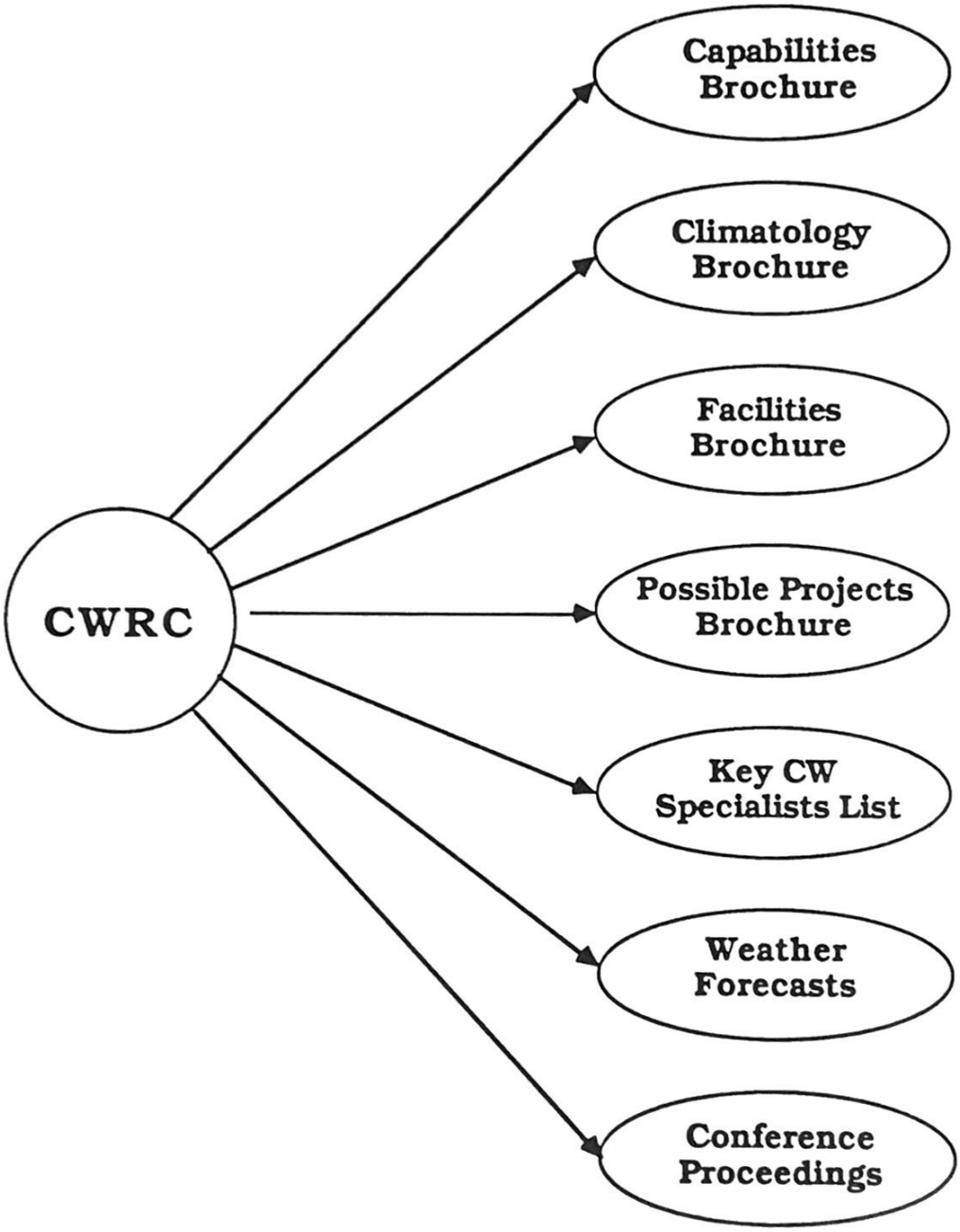


Key: A = AFFILIATE ORGANIZATION
T = TRADE ASSOCIATION

Possible Sources of Cold Weather Technology



Possible CWRC Publications



The other items are largely self-explanatory, suffice it to say that Weather Forecasts will be an important element in the work of the CWRC. In this case we will make 10 day forecasts for the northern one-half of the state of Minnesota. When certain types of extremal weather are about to occur, say very cold weather in Northern Minnesota, an alert will be sent out to organizations that are associated with the CWRC.

It is expected that the CWRC will be located in International Falls, Minnesota, probably at the Rainy River Community College. It is recommended that conferences take place at this location covering various specialized topics relating to cold weather. (See later chart entitled Areas of Interest of the Cold Weather Resource Center.) Thus, Conference Proceedings will be published.

5. Activities of the CWRC

The next chart is entitled ACTIVITIES OF THE CWRC. In this chart six major activities are cited. These are then further subdivided into a total of 28 categories.

6. Areas of Interest of the CWRC

The next chart is entitled AREAS OF INTEREST OF THE COLD WEATHER RESOURCE CENTER. There are six major categories and a total of 19 subcategories. From an economic point of view the first two major categories, Man-Made Structures and Transportation, represent the most significant items.

7. Costs of Winter

The next two charts are entitled COSTS OF WINTER. These charts list in a rather random way a variety of costs resulting from winter. Our overall goal is to reduce these costs of winter using the most advanced technology available.

ACTIVITIES OF THE CWRC

1. BUSINESS DEVELOPMENT
    - 1.1 New Business Opportunities
    - 1.2 Grantsmanship
    - 1.3 Capabilities Brochure
    - 1.4 Possible Projects Brochure
    - 1.5 Climatology Brochure
    - 1.6 Economic Development Possibilities
    - 1.7 Annual Meeting

2. CUSTOMER SERVICE
    - 2.1 Weather Forecasting
    - 2.2 Facilities Brochure
    - 2.3 Outdoor Test Sites
    - 2.4 Temporary Offices
    - 2.5 Summer-Winter Facilities
    - 2.6 Middleman Role

3. AFFILIATE ORGANIZATIONS
    - 3.1 Capabilities & Interests
    - 3.2 Organizational Linkages
    - 3.3 Technology Transfer
    - 3.4 Synergism

4. EDUCATION
    - 4.1 T.V. Series: Coping with Cold
    - 4.2 Special Group Conferences
    - 4.3 National & International Conferences
    - 4.4 University Level Lectures

5. PUBLIC RELATIONS
    - 5.1 News Media Interfaces
    - 5.2 CWRC Video
    - 5.3 State Legislature

6. INFORMATION STORAGE & RETRIEVAL
    - 6.1 Key Cold Weather Specialist List
    - 6.2 Recent Cold Weather Publications
    - 6.3 Conference Proceedings
    - 6.4 DocumentSearches

AREAS OF INTEREST
OF THE
COLD WEATHER RESOURCE CENTER

1.0 MAN-MADE STRUCTURES
- 1.1 Buildings
- 1.2 Public Utilities

2.0 TRANSPORTATION
- 2.1 Routes
- 2.2 Vehicles

3.0 MAN'S OUTDOOR ACTIVITIES
- 3.1 Outdoor Living
- 3.2 Winter Recreation
- 3.3 Public Safety
- 3.4 Conditions Requiring Medical Treatment

4.0 COLD WEATHER BIOLOGY
- 4.1 Human Biomedical Research
- 4.2 Farm Animal Survival
- 4.3 Wildlife Survival
- 4.4 Plant Environmental Adaptation

5.0 NATURAL MANIFESTATIONS OF WINTER
- 5.1 Impediments to Transportation
- 5.2 Effects on Bodies of Water
- 5.3 Climatology & Meteorology
- 5.4 Airborne Particles & Droplets

6.0 CONSUMER PRODUCTS
- 6.1 Foodstuffs
- 6.2 Electronic Equipment
- 6.3 General Product Evaluation

COSTS OF WINTER

(Divided according to
"Areas of Interest" Classification)

1.0 MAN-MADE STRUCTURES

- Heating of homes, offices and manufacturing plants
- Added insulation and thermopanes in construction of buildings
- Increased cost because of need for basement and/or deep footings (frost)
- Stronger roofs to support snow load
- Deicing equipment and water damage from ice dams on roofs
- Maintenance of building exteriors, sidewalks, and driveways due to ice and frost heaves
- Basement flooding because of poor winter and early spring external drainage
- Increased maintenance costs incurred by public utilities
- Seasonal unemployment in the construction industry

2.0 TRANSPORTATION

- Added car insurance
- Maintenance of highways caused by freezing and thawing cycles
- Snow and ice removal on roads and airports
- Extra costs of vehicular maintenance (battery charging, rust deterioration, lower gas mileage, snowtires, chains, accidents)
- Time delays in going to and from work
- Reduced highway and bridge construction activity
- Seasonal variations in barge traffic
- Winter reduction in shipping to and from Duluth, Two Harbors, etc.

COSTS OF WINTER (Contd)

3.0 MAN'S OUTDOOR ACTIVITIES

- Added costs for public safety (police, fire department, etc.)
- Cost of winter clothing
- Lower productivity (lower work rate)
- Under-utilization of resort facilities

4.0 COLD WEATHER BIOLOGY

- Increased feed and shelter needed for farm animals
- Reduced agricultural yields associated with short growing season
- Added costs associated with fish and wildlife survival
- Diminished forestry crop yields because of limited growing season
- Winter kill of trees, shrubs and flowers
- Seasonal drop in productivity and income for "crop only" farmers

5.0 NATURAL MANIFESTATIONS OF WINTER

- Increased cost of medical care
- Lost time at work because of sickness
- Lost time at work because of storms
- Increased cost of food
- Spring flood control
- Cost of shovels, snowblowers, and snowplows
- Increased cost of water mains and sanitary sewers (below frost line)
- For urban areas, reduced employment of landscaping personnel

For example, one study has shown (approximately) how the efficiency of workers who are outdoors varies with temperature. (See book by Landsberg, H.E., Physical Climatology Ed.2, Gray Printing Company, Inc., DuBois, Pa., 1958, 446 pp.)

It is evident that man's efficiency decreases rapidly as the ambient temperature decreases. Some of the decreasing efficiency at low temperatures is due to protective clothing that must be worn.

EFFECT OF TEMPERATURE ON MAN'S EFFICIENCY

AIR TEMPERATURE (^{o}F)	EFFICIENCY (%)
70	100
20	75
0	50
-23	25
-40	14
-50	10
-80	0

Below -40^{o}F almost all man's energy is devoted to survival, so very little useful work is done. By designing better clothing an improvement in efficiency can be achieved.

C. TECHNOLOGY EXCHANGE PROJECTS

There are literally dozens of possible technology exchange projects that can be considered. In the text given below we have identified seven projects, but the Soviet reader may have others that he wishes to suggest. The first three projects involve the biological sciences and the last four deal with engineering.

The projects that are described below contain both theoretical and practical elements. Some have greater economic implications than others. A large share of the world's supercomputers have been constructed in the Minneapolis/St. Paul area, so mathematically difficult computer simulations will present no difficulty for those of us in Minnesota. At the other end of the spectrum are the practical problems that require cold weather for their ultimate evaluation. Northern Minnesota can provide this environment down to -30 degrees F and colder; however, the Soviet Union can provide an even more stressful climate in which temperatures at least 30 degrees F colder than this occur regularly.

PROPOSED PROJECTS

PROJECT NAME	TYPE OF ACTIVITY
1. Hypothermia	Biomedical Research
2. Cold Climate Hardiness	Agricultural Research
3. Cold Climate Hardiness	Forestry Research
4. Cold Regions Pavement Research	Highway Design
5. Winter Clothing Components	Garment Design
6. Cold Weather Survival	Training
7. Buildings for Cold Climates	Building Science

The final determination of which of these projects are pursued (if any of them, or if all of them) will rest on more detailed discussions between representatives of organizations in the Soviet Union and in the United States.

For further information on these projects, please contact:

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Professor Braun is the Chairman of the Governor's Blue Ribbon Commission on Cold Weather Research.

1. Hypothermia

The Hypothermia Laboratory of the University of Minnesota-Duluth is located in the Physiology Department of the Medical School in Duluth, Minnesota. The laboratory has been in existence for ten years under the direction of Dr. R. S. Pozos, Professor of Physiology. The other faculty members involved with the program are Dr. L. E. Wittmers, Associate Professor of Physiology, and Dr. R. Hoffman, Assistant Professor of Behavioral Science. At the present time, the laboratory has four staff persons: (1) a masters degree physiologist—D. Israel, (2) a computer specialist—B. Ingersoll, (3) an exercise physiologist—K. Heydon, and (4) a senior laboratory technician—B. Dromeshauser.

Over the years the Hypothermia Laboratory has developed a number of areas of interest with the major emphasis being man's physiological and psychological response to cold stress. The areas of interest contain both basic and applied science. In the realm of applied science the laboratory has been involved in the evaluation of protective clothing designed for both cold air and cold water survival. The protocols for evaluation involve the use of human volunteers and the actual testing of the protection gear in cold water and air laboratory environments. When required, the cold waters of Lake Superior and the Winters of Northern Minnesota provide an excellent opportunity for field studies. Such evaluations have been done for Stearns Manufacturing Company, America's Cup Company, and the United States Navy.

With respect to the basic science endeavors of the laboratory, the projects involve numerous aspects of the responses to cold air and water exposure. Examples of these are the following:

Shiver Excitation. Onset and magnitude of shiver resulting from cold exposure. We are interested in the neurophysiology of shiver, its development,

severity, and variability among individuals of the same race, different races and sexes, and individuals of different environmental backgrounds.

Stress Evaluation. Evaluation of stress induced by cold exposure by measurement of urinary and plasma catecholamine levels. Also how the stress response is altered as a function of repeated cold exposure (acclimatization) is an area of great interest.

Vascular Responses. Peripheral vascular responses to cold exposure. Employing immersion of the extremities in cold water and evaluation of the frequency and magnitude of cold induced vasodilation (CIVD) in both the fingers and toes. We are interested in this peripheral vascular response among individuals of the same race, different races and sexes, and individuals of different environmental backgrounds.

Diving Reflex. Cardiovascular response to face immersion in cold water – the diving reflex. We have approached this project employing both human and animal protocol.

Pain. Perception of pain and its relationship to peripheral and core temperature during cold exposure. We have studied this under local cooling as well as during total body immersion.

Cognitive and Physiological Responses. Cognitive and physiological responses to a combination of cold air and cold water. The protocol includes addition of sleep deprivation in order to evaluate the effect of fatigue and cold on the subjects physical and mental abilities. We will be evaluating techniques of controlling shiver and therefore increasing motor control.

Animal Studies. Although the majority of efforts deal with human response to cold, we have also done studies on animal and cell culture models.

In the past we have collaborated with Dr. B. Kaufman of the University of Wisconsin, Dr. B. Mills of the University of Alaska, and Dr. D. Sessler of the University of California.

The members of the Hypothermia Laboratory at the University of Minnesota-Duluth are excited about the possibility of collaborative efforts with fellow scientists in the USSR. Such informational exchange will be of great benefit to all of us. The group is interested in any kind of research effort, and we are willing to visit and exchange data and ideas.

2. Cold Climate Hardiness—Agriculture

A significant fraction of the world output of agricultural products is grown in northern climates, such as exists in the state of Minnesota. In these areas there is a continuing quest to identify or develop hardy plants that thrive and produce a good yield in short growing seasons. The ultimate purpose, of course, is to economically satisfy national and worldwide agricultural requirements.

The University of Minnesota is an excellent resource for exchange of plant technology. Its programs include hybridization activities and laboratory hardiness research. Promising plants selected from their own breeding efforts or acquired from other sources are tested in field experimental stations.

These programs encompass studies of many factors that are important to plant growth and yield. Among these are the following:

1. Length of growing season
2. Frost protection
3. Climatology
4. Crop selection
5. Cold climate hardiness
6. Cold weather germination
7. Effects of drought
8. Stress tolerance
9. Adaptability
10. Soil requirements
11. Replacement cycle
12. Yield
13. Growth habit

As a starting point we suggest that the following projects be considered for technology exchange.

Any Woody Plant Germ Plasm. This project will address the exchange of the germ plasm in fruit or environmental plants. The investigations will include techniques involving either cuttings or pollen. Winter hardiness is the prime objective.

Grape Breeding. Grapes are currently grown in Minnesota; however, a large improvement in quality and yield is very likely possible. This study will include exchange of the fruit pollen or germ plasm.

3. Cold Climate Hardiness—Forestry

The state of Minnesota has a strong forestry industry based upon extensive forests located in the northern part of the state. For many years these forests have provided timber for the construction industries and wood pulp for paper manufacturing, as well as firewood for heating.

Additionally, the forests are important to the ecology of Minnesota. They provide havens for wildlife including many kinds of animals and birds. Nestled within the forests are numerous lakes rich with many species of fish.

It is well known that northern Minnesota has a short growing season. Therefore, the subject of cold climate hardiness is of great interest. We offer the following projects for consideration in a technology exchange program.

Timber Harvesting under Snow and Cold Weather Conditions. Winter provides opportunities and problems in timber harvesting. Thus, it is necessary to plan and manage the lumbering activities to take advantage of specific sites and conditions when extreme weather situations exist. Special considerations must be made for the use of equipment and personnel.

Windbreaks and Shelterbelts. Windbreaks and shelterbelts consisting of woody plant materials provide a means for moderating snow and cold weather conditions for energy and agricultural purposes.

Reforestation Considerations in Cold Climates. Technology exchange for reforestation is important in the following areas:

1) Site preparation
2) Environment
3) Planting techniques
4) Selection of hardy plant material for conifer forests

Hydrologic Processes of Forested and Peat Land Watersheds. For this project we suggest the development and modification of stream flow simulation models capable of predicting response from natural and disturbed upland forests and peat land systems in cold climates.

Utilization of Cold Climate Woody Plants for Commercial Uses. Here we are recommending the exchange of technology relating to the use of woody plant materials for composite boards and to acceptance testing methods in this industry.

The Selection of Woody Materials for Cold Climates. The objectives of this study are to identify breeding zones and models for distribution of woody plant materials appropriate to cold climatic conditions.

4. Cold Regions Pavement Research

The Minnesota Department of Transportation will construct a cold region pavement research test facility in 1989. The primary objective of the pavement research test facility is to conduct intensive pavement research. It will accelerate the present research process by allowing a wide range of pavements to be studied concurrently. By providing a setting where the multitude of pavement variables can be better monitored and controlled, the quality of the research undertaken will be greatly enhanced. Since emphasis

will be placed on cold region pavement performance, the pavement will be heavily instrumented and provide real time data under real traffic loadings.

The test facility will be constructed parallel to Interstate Highway 94 in rural Wright County (approximately 40 miles northwest of Minneapolis). The test facility will be approximately two miles long. Without interruption, actual westbound traffic will be diverted onto the test facility to provide the needed loadings. The length of time that traffic will remain on the test roadway will depend on design life of the various pavement test sections. The test facility will be constructed to also accommodate low volume roads as well as a test pad for environmental testing.

The development of the cold region pavement research test facility will supplement the Strategic Highway Research Program by providing possible specific project sites for the long-term pavement performance study. The cost of the test facility, in excess of 5 million dollars, will depend on such things as actual length of the test roadway (affecting right-of-way and construction costs), amount of instrumentation and manpower.

The timing for the center is ideal. The Minnesota Department of Transportation and the University of Minnesota are both seeking a stronger relationship and a better understanding of pavement performance. Also, the recent creation of the Center for Transportation Studies, located at the University of Minnesota, can provide valuable support in the various activities associated with the test facility.

The university has already hired a new Pavement Engineering Professor who will devote 50 percent of his time to the technical management of this facility. Additional support people will be provided by the Minnesota Department of Transportation and the University. The realized improvements in pavement technology will continue Minnesota's commitment to high technology, innovation and excellence.

5. Winter Clothing Components

Winter poses severe, life-threatening risks to humans in the form of cold temperatures, precipitation, and wind. Hence, it is important to have effective protective clothing. Moreover, the clothing should be efficient in order that the individual will not be encumbered in his activity,.

For centuries man has had to depend on animals for materials that are effective for insulation, windbreak, and moisture transfer, as well as water repellency. Wool, skins, and furs are examples of such materials. Recent developments in synthetic materials are providing outstanding materials for winter clothing. Two examples are described in the following paragraphs.

Thinsulate Thermal Insulation. Almost a decade ago, 3M introduced a product that created a new category in winter clothing components--Thinsulate Thermal Insulation.[1] This insulation was different from any man-made insulation that preceded it because it was constructed of microfibers and offered excellent warmth, without the bulk usually associated with winter clothing insulation. In fact, it was nearly twice as warm as a similar inch of polyester fiberfill and 1 and 1/2 times as warm as the same thickness of down. Thinsulate insulation is one example of the new high-tech insulations from 3M based on specialty microfibers.

Thinsulate insulation has been widely used in ski jackets, parkas, hunting coats, gloves, hats, boots, and many other uses where warmth, slim styling, ease of movement, and nonretention of moisture are important.

3M researchers have developed considerable expertise in measuring thermal insulation values and other physical and performance properties important to insulation. They have built state-of-the-art equipment, calibrating it to primary standards so that real performance can be measured. They also participated in standard-setting groups to assure commonality in testing among laboratories around the world. Additionally, they pioneered the use of infra-red

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[1]Thinsulate is a registered trademark of the Minnesota Mining and Manufacturing Company (3M).

imaging to visualize the heat loss from clothing constructions while they were being worn.

3M's research doesn't stop with laboratory testing protocols; they take real garments into the field for actual field testing on ski slopes, camping, backpacking, and elsewhere. They have learned how to correlate laboratory testing with real garments worn by people in real use situations.

The insulation research program at 3M has developed many variations of Thinsulate insulation for different uses. The original Type C was augmented with a softer version called Type M. A special product for boots and shoes was developed. The most recent product introduced was a unique stretchable insulation for action wear.

Thintech Waterproof Breathable Fabric. In the past year, 3M has entered into a new area of outdoor clothing components with the introduction of Thintech Waterproof Breathable Fabric.[1] This ultra thin membrane is composed of a microporous polyolefin matrix which is completely impregnated with a hydrophilic urethane polymer. It can be laminated to a wide variety of woven, nonwoven, and knit fabrics to yield a composite which possesses a high measure of waterproofness (over 100 psi water holdout). Yet it is highly breathable (allowing moisture vapor and perspiration to escape).

Thintech fabric laminates give excellent protection from rain, yet allow the wearer to remain dry and comfortable. Most interestingly, Thintech membrane can be combined with Thinsulate insulation in the same garment or accessory and give outstanding warmth, wind protection, and waterproofness at one time.

Testing and measurement of these new composite materials offered a challenge to 3M. Not only were there many different lab tests for waterproofness and breathability in the marketplace, but the tests were poorly verified by actual wear tests. 3M, working with key academics in the area of

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comfort perception, was able to identify which laboratory tests were meaningful indications of field performance.

6. Cold Weather Survival

Every individual who lives, works, or plays in a cold climate runs the risk of experiencing cold together with other factors which may tax his or her capability to survive. The ravages of winter result in the loss of life, increased medical cost, and lost time from work. Cold weather survival training offers a way of reducing these costs and helping people to function more effectively in winter environments.

There is yet another use for survival training. Many organizations have recognized the value of survival training to develop better managers. Survival trainees learn how to solve problems together with other people in ways that often require great ingenuity. They learn much about working with people, recognizing leadership qualities, and developing their own leadership qualities. Successful completion of a survival course enhances a person's self-confidence.

Thus, there are many reasons and opportunities for providing survival training. The state of Minnesota offers an excellent environment for cold weather survival training with its extensive wilderness, lakes, and cold winters. In fact, an existing program at Ely, Minnesota provides an outstanding opportunity for exchange of technology in the art and science of cold weather survival.

It is the Boy Scouts of America Northern Tier National High Adventure Program which operates out of the Charles L. Sommers National High Adventure Base. The base camp is located in the heart of the Superior Quetico boundary waters, an area of roughly 4,000 square miles. The base is only six miles from the Canadian border on Moose Lake, where civilization ends and the wilderness begins.

The Sommers Base is operational throughout the year, and both summer and winter camping programs are provided for the Boy Scouts of

America. The cold weather camping program is called OKPIK, the Inuit name for the snowy owl.

The first canoe trip from this camp occurred in 1923, and the Region 10 Scout Program was started in 1926. Since then the Sommers Base has grown steadily to become a premier facility for outdoor activity and training for survival in the wilderness.

The cold weather survival program has operated for 7 years, though survival courses were begun in 1971. The typical course is 5 days in length, and weekend courses are also offered to the Boy Scouts. A typical class consists of 20 to 25 participants.

The courses are offered during January, the coldest month of the year. Temperatures are generally in the range from 0 to -50° F (-18 to -45° C).

A nearby site is used for survival training. Thus, heavy concentration can be placed on training with little time wasted on transportation. The course work is approximately divided equally between academics and field experience. Extensive wilderness permits more cross-country experience if that is desired.

Some users supply their own clothing. However, the camp commonly provides supplemental clothing for the Boy Scouts. Skis and snowshoes are provided by the camps. The skis are adjustable for packboots.

The Sommers High Adventure Base is involved in international foreign exchange programs with a number of countries and welcomes the opportunity to establish additional exchange programs.

7. Buildings for Cold Climates

The buildings for cold climates must withstand a wide range of temperatures, and their structures must therefore permit a large amount of expansion and contraction. These buildings must also support substantial snow loads.

Thermal efficiency dictates effective insulation and sealing to prevent thermal conduction and air infiltration through the outer walls. However, tighter buildings create indoor air quality problems that may result in unhealthy conditions for building occupants and contribute to the deterioration of the buildings themselves.

Because of these design challenges, the University of Minnesota has created an affiliated organization called The Minnesota Cold Climate Building Research Center (MNBRC). This organization brings together researchers who are concerned with solving problems associated with the construction and operation of buildings in cold climates. MNBRC will provide both a focus for the development of interdisciplinary research and technology transfer concerning these issues and a common source of information germane to cold climate buildings. The goal of this activity is the transfer of knowledge to appropriate public and private entities directly involved in the construction and operation of buildings to enhance the quality of existing and new Minnesota building stock.

Only one year old, MNBRC already has launched programs to look at a number of issues including the following:

Foundation Insulation Program. This program has been designed to address the questions and problems posed by insulating a building foundation in a cold climate.

Technology Transfer for Architects and Design Professionals. The objective of this program is to supply technical assistance to architects and other design professionals necessary to improve the design and energy performance of selected mid-size building types. Three tasks are central to achievement of this objective. The first is identification of building types that offer the greatest potential to achieve significant energy savings in Minnesota. The second is the identification of commercially available technologies necessary to achieve these savings. The third is to understand the context within which these technologies will be implemented so that transfer might be effectively accomplished.

Energy and the Indoor Environment Program. This program addresses the energy efficiency and effectiveness of various methods of controlling indoor air contaminants. This will require the study of air distribution systems, local exhaust systems, particulate and gas removal systems, and the storage and release of moisture and other gases from structural and interior furnishing materials.

Daylighting/Lighting of Buildings. The services provided under this program are intended to educate energy users and the design professionals who serve them to make informed decisions about the energy-conserving role of daylighting and lighting systems in building design and retrofit. Achieving these objectives involves three major tasks.

Providing User Accessibility to DOE2. DOE2 is the most extensive and best verified computerized energy analysis program available. The goal of the project is to greatly enhance user accessibility to DOE2 by creating a "front end" and "back end" to DOE2 which would run on a microcomputer and access DOE2 running remotely on a large-scale computer.

Performance of Buildings Relative to User Comfort. The purpose of this project is to study the role of user comfort factors in prediction of energy performance of buildings.

Enhanced Low-Income Weatherization Program. The services under this program are intended to refine and transfer the procedures for enhanced weatherization developed under a recently completed contract performed by the Building Energy Resource Center for the Department of Energy and Economic Development. The lessons learned from this project identified quality control and enhanced auditing diagnostics as important ingredients in providing energy savings.

MNBRC contributors include faculty from the Institute of Technology, the Department of Forest Products, the Department of Design, Housing and Apparel, and the Department of Agricultural Engineering.

The recent discovery that the radon gas content in Minnesota homes is the second highest in the United States, with 46 percent of the homes tested having more than 4 picocuries per liter of air (the federal standard). Driving this number down to lower levels, particularly for tightly sealed homes in the winter, presents a special problem.

In summary, Minnesota's freezing winters and sweltering summers pose difficult problems to architects and builders. We believe that a multi-disciplinary team such as MNBRC can make significant progress in solving these problems. We would welcome a technology exchange project with representatives of the Soviet Union.

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