Written Public Comments Submitted to PCAST

January 20, 2021 to October 13, 2021

(Written Public Comments are in order of date received)

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From: Atanu Mazumder <[redacted]>
To: MBX OSTP PCAST <MBX.OSTP.PCAST@ostp.eop.gov>
Sent: Sunday,1/24/2021 2:47 AM
Subject: Suggestion to Reduce Gasoline Usage at Covid Lines

Every day thousands of people line up to get tests or vaccines. The lines are almost always serpentine and all vehicles in the line must keep their engines running while they inch forward toward the vaccine/testing tent.

Say the serpentine line has 100 cars and it takes them 2 hours to get to the tent. That's almost 200 hours of gasoline wasted and pollution created. Now multiply that by 4 for an 8 hour day so at least 800 hours of gasoline burnt and pollution created - at each location!

Now imagine the parking lot set up so that as cars arrive they pull into a column of 10 cars and turn their engines off. The next 10 cars pull into the next column and turn their engines off, and so on. When vaccine/testing starts the first column of ten cars turn on their engines and head towards the tent(s) - to however number of lines there are at the tent(s). The other 90 cars in the other 9 columns keep their engines off - except to occasionally heat or cool their cars. As column one is almost done the cars in column 2 start their engines and head towards the tent(s). Since column one is now empty, guides direct the new arrivals to pull into column 1 and wait with their engines off until column 10 is almost done.

This way only about 10% cars have their engines running while the remaining 90% cars have their engines off. This scheme assumes 100 cars in 10 columns of 10 cars each. Depending on the available parking lot the cars can be arranged into many columns with 10 to 20 cars in each column so that many more cars will be waiting with their engines off!. With about 90% of the cars waiting with their engines off I assume about 90% of the gasoline previously burnt will be saved, with the associated pollution prevented.

I am hoping I can pass this idea to some federal or state agency that can evaluate the concept and send out a circular to testing and/or vaccine sites. Thanks.

Atanu

From: cleiton godoy <[redacted]>
To: MBX OSTP PCAST <MBX.OSTP.PCAST@ostp.eop.gov>
Sent: Wednesday, 2/10/2021 7:24 PM
Subject: Is there no way to send this idea to scientists?

Dear President, Director, and PCAST:

You know how much an idea is worth if it is successfully completed and knowing that antimatter because a gram has never been made would lead to a lot of money.

Hello I had this idea of anti h2 about a simple covalent bond between two atoms of anti hydrogen, as to make hydrogen gas I needed two atoms of hydrogen and the bond and to try to do with the antimatter it would be the same thing only more difficult why to make the antimatter the anti protons and anti electrons join, as the hydrogen has the positive nucleus protons and the electron is the charge in the antimatter it was the opposite then in the junction of two anti protons came the anti h2.The antimatter for being expensive and rare to be done and is still being studied, making anti h2 was more complicated. If I could make grams of antimatter, or anti H2, it would be too good.

From: Adriana Mora <[redacted]>
To: MBX OSTP PCAST <MBX.OSTP.PCAST@ostp.eop.gov>
Sent: Tuesday, 2/16/2021 12:46 AM
Subject:

Hello,

My name is Adriana Mora ,I am a citizen of Mexico so I apologize for my grammar. I am in the need to contact mathematical science experts regarding the millennium priced equations due to the process in which I am unable to get in touch..

Id like to present my work it is an absolute solution with no mathematic error and a Marge of 3 percent on the planets movement due to the global inflation which I know is a matter of not answered science questions…

My process on the knowledge of these answers has had me on a global knowledge on theories spirituality science facts and natural laws that are not to be in function at the time but it is of my concern not to cause disorder on the actual order in which many beliefs stand on …Stephen Hawing mention that there would be one only equation that would answer the whole universes function and so I have it…id like to know whom I may address to expose my work and get my payoff not a public recognizicion since of my knowledge there is nothing but evolution to do it work in an orderly way …

My theories involve the change of many words that are not well interpreted the evolution of Darwins theories the relativity as a fact the history of human race regarding their beliefs in god the functioning of our human body in the vibration to earths supplies as well as the brain and its dead functions and the function in which the universe returns the information with out the use of the binary code since it is not a language but a just a label to keep and order ……

The mysteries to unsolved sacred geometry or unfound objects that in really are symbolic to our origin all of this information is not just a solved mysteries or solution to facts but it is a movement that can change evolution without a notice since it is a one piece movement and not partial like all of the great scientist that use their I Q to invent solutions to the better of mans life and not to the better of the potential of mans intelligence…

Id appreciate a response

Sincerely : Adriana Mora

From: JARGUS <[redacted]>
To: MBX OSTP PCAST <MBX.OSTP.PCAST@ostp.eop.gov>
Sent: Tuesday, 2/16/2021 8:22 PM
Subject: Buometric Integration and Online Identity

It is in my best interest to inform of newly developing potentials for biometric usage and integration.

1. There is currently a failure of subsequent laws determining the collection, appliance, and usage for Artificial Intelligence developers. Regulations of these endeavors with the genetic code and depiction of one's biometric data is becoming a third-party game.
2. Without proper regulation of biometric usage and asset standards, any and all individuals internationally are allowed to collect data using paid services and public record databases to provide dosias of all registered and non-registered U.S. Citizens.
3. With much intent for biometric data being sold to federal services without licensing and regulation it becomes a international issue.
4. Entities of the IT community are at any leisure to distribute collected information sold and available under 3rd party services with people associated to their biometric data. Any entity can begin acquiring said information for advertising purposes and malicious intent given opportunity.
5. All matters involving the protected rights under new orders from the president hold distinguishing characteristics for documenting citizens. All biometric data being held in genetic sequence hold identifications for protected classes including highly governed personnel within public/private services such as casinos.
6. Protection of documentation of U.S. assets with the use of biometric data collecting information on security services. It will become impractical for there to become any protection for potential individuals on selective duties within high security systems.

Thankyou,
Jargus

From: Margaret Beegle <[redacted]
To: MBX OSTP PCAST <MBX.OSTP.PCAST@ostp.eop.gov>
Sent: Thursday, 4/29/2021 10:37 PM
Subject: Personal Rapid Transit is Essential for the Climate

PLEASE SHARE WIDELY

Transportation is responsible for 28% of Greenhouse Gas emissions in the U.S. (EPA 2018). The climate crisis is escalating and conventional transportation methods are only exacerbating the problem. In addition, the NHTSA reports that there were 36,096 motor vehicle traffic fatalities in 2019 and, despite Covid, the fatality rate actually increased in 2020. Yet, it seems almost impossible to get people out of their cars due to convenience. We need a genuine breakthrough in technology and it turns out that it already exists: Personal Rapid Transit (AKA Intelligent Transportation Network Systems, Podcars, Automated Transit Networks, etc. The name is in flux.). As President Biden proclaimed in his inaugural speech, we need to be bold. Our federal government can finally facilitate the development and deployment of Personal Rapid Transit (PRT).

PRT may be envisioned as an automated circulator system like a monorail only composed of small vehicles attached to a guideway. Small stations are spaced every few blocks and are off the main line. Vehicles are generally designed to carry circa 2–4 passengers, allowing room for a wheelchair, luggage, etc.

A thumbnail description of Personal Rapid Transit (PRT) follows:

- Small, lightweight, automated vehicles attached to an elevated rail (guideway)
- Nonstop transportation from origin to destination; no transfers necessary
- Small stations off the main lines
- All weather, 24-hour availability
- Little or no wait for vehicles
- Capability to use alternative energy sources such as solar
- Small guideways, posts, and stations, with small footprints
- Easily movable guideways
- Virtually silent movement

The United States used to be the acknowledged leader in innovation. Regrettably, the transportation sector has stagnated and continues to advocate for 19th century technology like light-rail. The one bone thrown to the future concerns automated automobiles, which does not take cars off the road. If we are serious about having multi-modal transit opportunities, PRT must be included.

All the components of a PRT system are already in use in various capacities and include such features as dual redundant computers, linear induction motors, lightweight materials, and complex algorithms. PRT systems exist internationally, although not in as sophisticated, state-of-the-art forms as their potential allows.

Any number of experts in innovative transportation are eager to be consulted. Edward J. Anderson, Professor Emeritus of Aerospace Engineering, University of Minnesota, can be reached at [redacted]. The Advanced Transit Association has detailed information about PRT. Peter Mueller of PRT Consulting and principal in a potential PRT start-up in Rwanda, called Vuba, is reachable at [redacted] with e-mail at Info@PRTConsulting.com. Jerry Schneider, Professor Emeritus at the University of

Washington, hosts a useful website at >http://staff.washington.edu/jbs/itrans/< and his e-mail address is [redacted]

Why isn't PRT in the mix of multi-modal transit options in the United States? To put it candidly, the Light-Rail, Automobile, Highway, and Big Oil interests are too powerful to allow a seat at the table for PRT because PRT is the only transportation method that will actually get people out of their cars.

Please investigate and then implement the promise of PRT. It is critical to rescuing our environment and saving lives.

Sincerely,

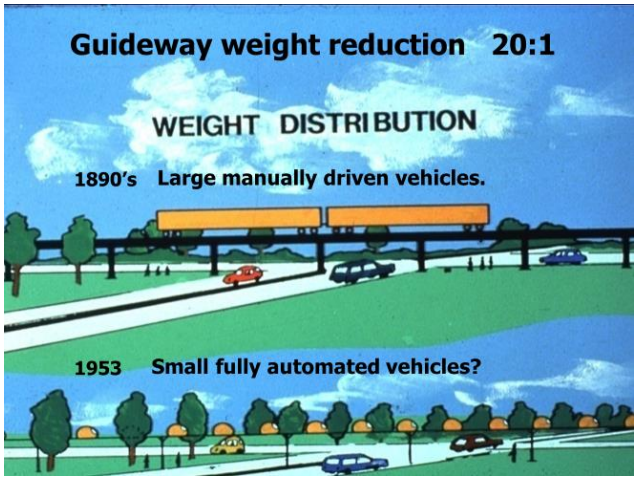
Margaret R. Beegle 550 Varner Circle North
[redacted]
p.s. I am attaching a summary of PRT authored by Dr. Edward Anderson.

"How to Reduce Congestion"

J. Edward Anderson, Ph.D., P. E.
PhD in Aeronautics & Astronautics
Massachusetts Institute of Technology
First President, Advanced Transit Association

Former
Aeronautical Research Scientist in Structures, NASA
Principal Engineer & Manager of Space Systems, Honeywell
Professor of Mechanical Engineering
University of Minnesota & Boston University

Virtually every week the newspapers contain articles about increasing congestion, often with suggested solutions – pathetically inadequate. More and more scenes like this exist and take hours to untangle.



Congestion is not new. In the 1890s, congestion got so bad in Boston, New York, Philadelphia, Cleveland, and Chicago that planners were directed to consider a new level – elevated or underground. As we know, they did both. Since underground is more expensive, they planned and built elevated rail systems, still at great expense, using the technology then available: Large, manually driven vehicles.

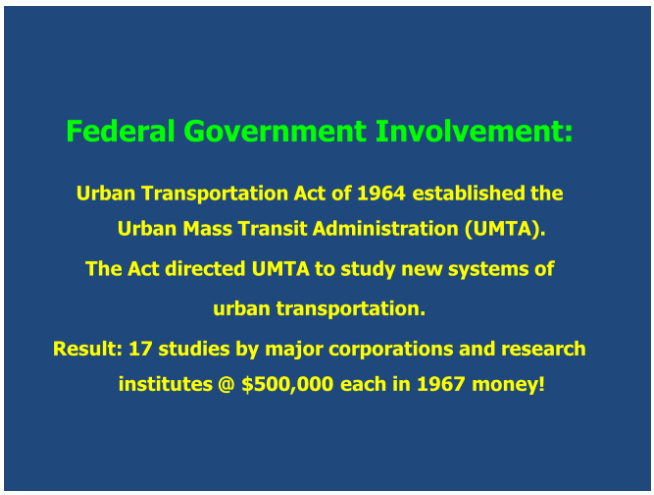
In 1953, two transportation engineers, Donn Fichter[1], working in Chicago, and Ed Haltom[2], working in a Dallas suburb, independently calculated that if the large vehicles would be replaced by many small, light-weight vehicles, the guideway size, weight and cost could be reduced by a factor upwards of 20:1. Automation had come out of World War II and they were convinced that it could control these vehicles. They understood that the vehicles could not be allowed to stop on line, but, to minimize trip time and maintain throughput, *stops would have to be off-line*, just like on a freeway! This combination of four ideas came to be called "Personal Transit" and later "Personal Rapid Transit" or "PRT."[3]

[1] Donn Fichter, *Individualized Automatic Transit and the City,* Providence, 1964.

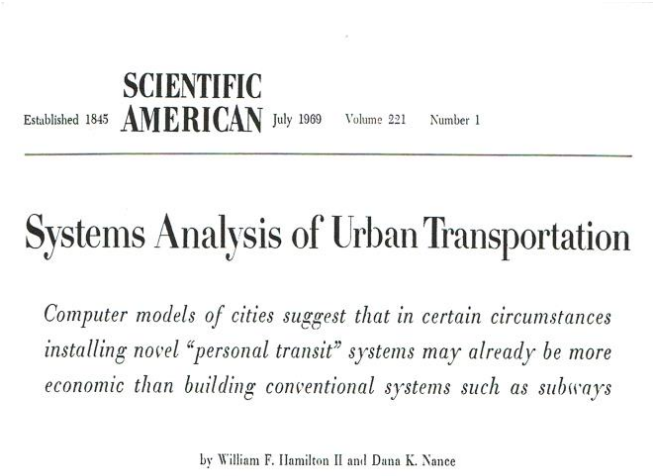
[2] Monocab, Incorporated, p. 86-7, *Personal Rapid Transit II*, University of Minnesota, December 1973.

[3] Today, some planners call it an "Automated Transportation Network," ATN.

Autonomous cars are much in the news. Some people argue that they will replace PRT, but will they? With the considerations given here, they will be complementary. In a mix of manually driven and autonomous cars, with the autonomous cars programmed to maintain a safe separation, a manually driven car will invariably slip in between, thus requiring the rear car to slow down and thus the cars behind to brake, thus increasing congestion. PRT is for congested roads where there is no room for a bus or a train, and where autonomous cars will get bogged down with the rest of the traffic.



In addition to Fichter and Haltom, during the late 1950s and early 1960s at least four other transportation thinkers independently invented, or is it better to say "discovered" the concept now called PRT? Some of them talked to Congressmen, because of which, when the Urban Transportation Act was passed in 1964 funds were authorized to study the new ideas.


SCIENTIFIC AMERICAN

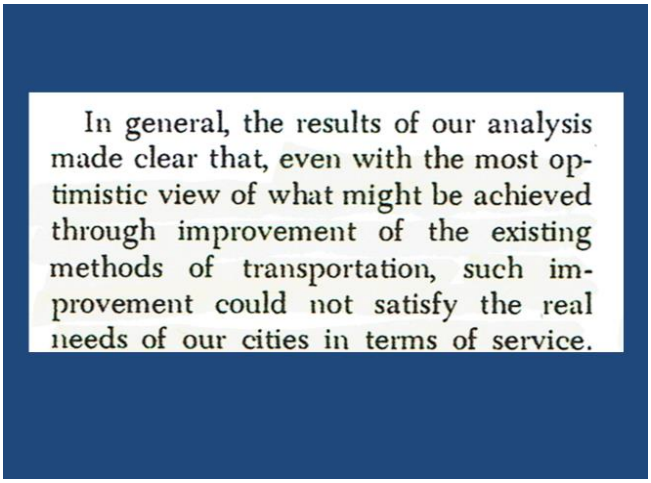
Established 1845 July 1969 Volume 221 Number 1

Systems Analysis of Urban Transportation

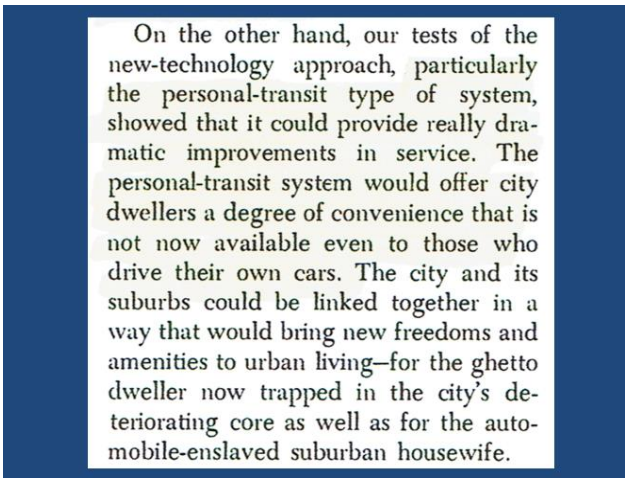
Computer models of cities suggest that in certain circumstances installing novel "personal transit" systems may already be more economic than building conventional systems such as subways

by William F. Hamilton II and Dana K. Nance

Scientific American featured the work of one of those companies, the General Research Corporation of Santa Barbara, California. GRC, with experience in defense and space research, performed a comprehensive systems analysis of urban transportation problems and their solutions using the mainframe computers they had then and involving an interdisciplinary team of 18 professionals. As their basis, they laid out PRT guideways in Boston, Houston, Hartford and Tucson, and estimated ridership.

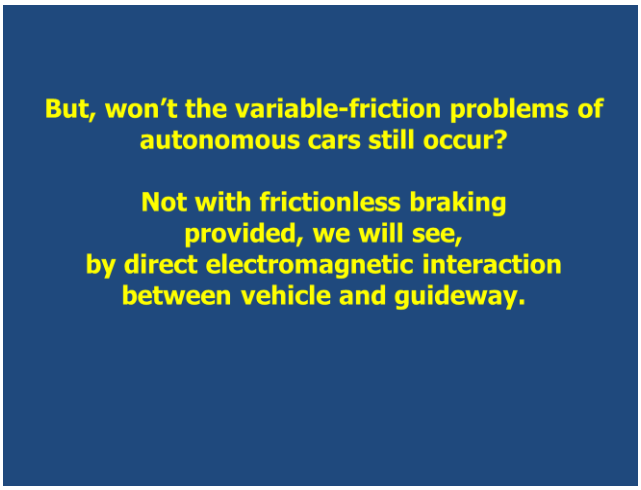


I went to the *Scientific American* website and found that for $8 I could download the July 1969 issue. In the article entitled "Systems Analysis of Urban Transportation," I found this statement by the GRC team.



Near the end of the article, I found this statement.

In 1968, UMTA summarized all 17 studies in a report called *Tomorrow's Transportation: New Systems for the Urban Future*, in which, among other systems, they described PRT and urged its development.



- Computers in PRT systems reroute empty vehicles from stations where they are in excess to stations needing them or in or out of storage stations, and the vehicles run only when there are demands for service; whereas in conventional transit, in which the stations are on line, the vehicles must run on a schedule regardless of the need to pick up or drop off passengers. *Off-line stations permit a very substantial decrease in operating cost and energy use.*

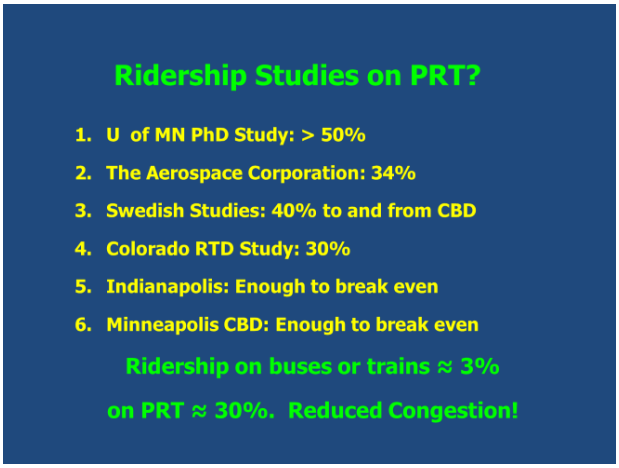
- Since computers reroute vehicles between stations 24/7, service is always available. In off-peak periods, there will always be at least one vehicle waiting in every station. In peak periods, computer simulations show that the average wait is about one minute. There is no need to shut down because vehicles do not move unless there is a demand for service.

- With off-line stations and small vehicles, the stations can be sized to demand. Some stations may need only two or three loading berths and others up to 15 to 20. With on-line stations, every station must be as long as the longest train because a person could wish to get on or off at any point. With off-line stations and small untrained vehicles, station cost is saved!

- In planning the light-rail line in St. Paul, Minnesota, the planners initially intended to place stations a mile apart to permit an average speed of about 27 mph. But, when announced, citizens demanded that the stations be placed every half mile, which reduces the average speed at most to about 19 mph, *which substantially reduces RIDERSHIP*. With conventional transit, speed must be sacrificed for access or access for speed. With off-line stations, the system has both speed and access.

- With nonstop trips, the wait time for a random passenger to join a passenger already in a vehicle increases as the square of the number of stations,[4] and after a few stations is too long to be of interest. Thus, if a person is alone, he or she rides alone, and otherwise with one's own travelling companions.

[4] J. E. Anderson, *Transit Systems Theory,* p. 89. www.advancedtransit.org/library/books.



These ridership studies[5] show that in a developed PRT system roughly a third of the trips in an urban area will be taken by PRT. In the latter two studies, a mode-split calculation was not made, but the ridership was sufficient for these systems to break even. Except in rare situations, in conventional rail systems average ridership is so low that fare revenue pays only about one third of the operating costs and none of the capital cost. The rest must be covered by taxes.[6] If the Federal Government did not contribute to these costs, these systems would not be built.

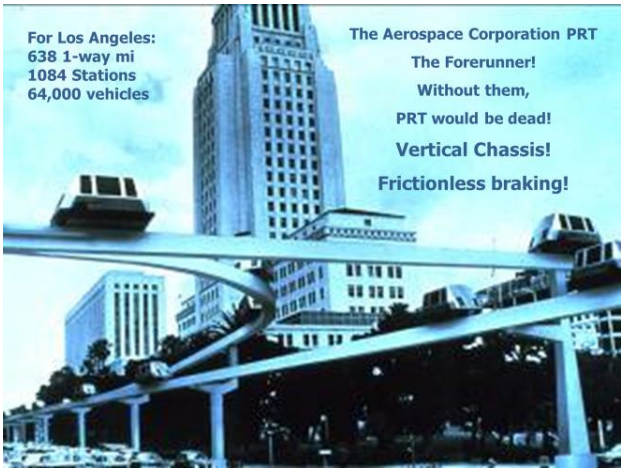
The University of Minnesota's Center for Urban and Regional Affairs was given the task of responding to the Legislature. I was given the task of coordinating the work of the Task Force. We visited all sites in the USA at which PRT systems were being developed, some with full-scale test tracks.

We found that by far the most promising PRT system was designed at The Aerospace Corporation[7] by a team of systems engineers working under the direction of genius Vice President Dr. Jack H. Irving.

[5] PRT Ridership Studies, CDPRT, Volume 1, identified later in presentation.

[6] J. E. Anderson, *Transit Systems Theory,* Chapter 6. www.advancedtransit.org/library/books.

[7] www.aerospace.org



Here is a photomontage of The Aerospace Corporation PRT system.[8] They laid out a large system for Los Angeles with the properties given in the upper left corner of this picture. A unique feature of this system is that the guideway is narrower than the vehicles. This resulted from their finding that *the minimum weight, minimum cost guideway is narrower than the vehicles*.[9] This finding required the development of a **vertical chassis** and gives minimum visual impact. This system used linear pulsed D.C. motors, which provided consistent **frictionless braking.**

Minnesota Senate:
1973: Hearings & Field Trips.
1974: S. F. No. 2703, CHAPTER No. 57:
The Metropolitan Transit Commission (MTC),
an Operating Agency(No R&D), shall "plan an automated, small-vehicle, fixed-guideway system."
MTC had Lobbied against new Technology.
Two proposals: Aerospace & consultant.

The Minnesota Senate formed a Transit Subcommittee, which held hearings at which the Metropolitan Transit Commission (MTC), the Metropolitan Council, and the University Task Force were each asked to answer the same questions. Field trips followed, during which the Subcommittee visited several automated-transit development groups including The Aerospace Corporation at their headquarters in El Segundo, California. Subsequently, the Act defined here was developed and signed into Law by the Governor of Minnesota.

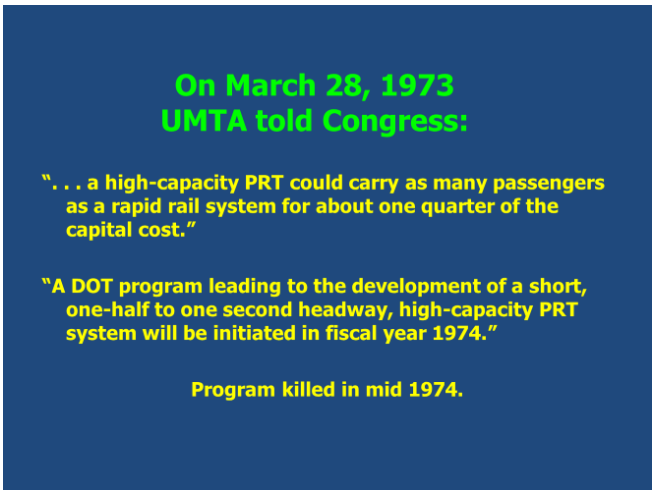
Now I must back up. In the late 1960's the Industrial Engineering Department of the University of West Virginia in Morgantown engaged a consultant, funded by UMTA, to investigate PRT as a means for moving students between campuses of the University of West Virginia. The small town of Morgantown is situated in a mountain valley with almost all the traffic of the city funneled along one U. S. highway. Thus, congestion is as bad as it is in much larger cities. The consultant recommended the Alden StaRRcar, which was being developed in Bedford, Massachusetts, as the PRT system they concluded should be deployed.

[8] Jack H. Irving, Harry Bernstein, C. L. Olson, Jon Buyan, *Fundamentals of Personal Rapid Transit,* 1978.

[9] J. E. Anderson, *Transit Systems Theory,* 1978, Section 10.2, "Optimum Cross Section Based on Bending Stress." Further analysis of the Aerospace guideway shows that once the depth is determined and with it the width required for motors, without increasing the width any further the guideway is sound in a 180-mph crosswind, far more than cities specify. The Aerospace book and my book can be downloaded from www.advancedtransit.org/library/books.

UMTA's report *Tomorrow's Transportation* stated: "A premature rush to demonstrate certain of the new systems and components in urban areas would be uneconomic and wasteful pending further research and development." *But that is exactly what they did*: The Secretary of Transportation determined to use Morgantown as the basis for a national demonstration of the PRT concept. UMTA staff visited Alden StaRRcar at their facility in Bedford and found that it was a group of only six people, much too small they decided to be the basis for a national demonstration. Therefore, UMTA engaged the Jet Propulsion Laboratory (JPL) as the system contractor, Boeing the vehicle designer and builder, Bendix the control engineer, and F. R. Harris the fixed-facility designer and builder. The contracts were let in December 1970 and political UMTA determined that the system had to be in operation by October 1972 in time to help reelect President Nixon. None of these companies had any experience with PRT. JPL soon realized that they were being used only as a "money-pass-through" with no time or budget for the systems engineering in which they excelled. Thus, in August 1971 JPL resigned from the program and Boeing was given the job of project manager. The Alden StaRRcar used six-passenger vehicles. The UMTA Administrator decided, based on no understanding of the PRT concept, that that was too small and ordered that the vehicles have room for 8 seated passengers and 13 standees, resulting in a substantial increase in vehicle weight and size. An F. R. Harris Vice President asked UMTA what vehicle weight they should assume as the guideway design load. He was told to assume the vehicles would weigh as much as rapid-rail vehicles, whereas the basic idea of PRT is to use vehicles small enough and light enough to minimize the weight of the guideway. This and other decisions increased system cost so much that Congress lost interest in PRT.[10]

Notwithstanding the substantial knowledge The Aerospace Corporation had developed in PRT and the very detailed proposal they submitted to the MTC, non-R&D MTC selected a consultant that had no experience with PRT. That consultant was aware of the Morgantown program, in which the system was called "PRT." They laid out guideways for the Twin Cities based on Morgantown "PRT," producing the obvious result that for Minnesota, "PRT" was declared too expensive and not worth considering.

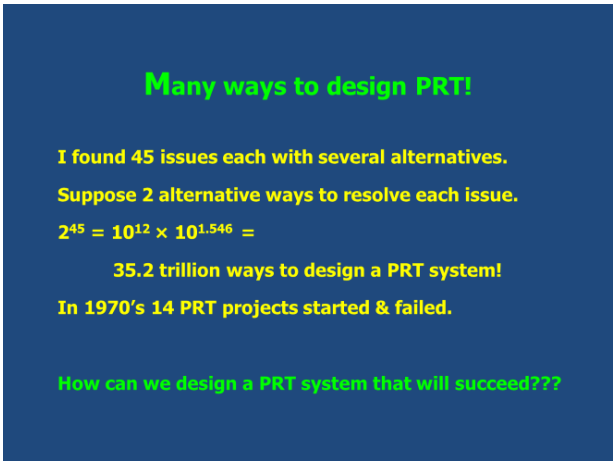


In 1971, the Office of Science and Technology in the Executive Office of the President got interested in PRT after hearing presentations by Dr. Jack Irving and me. The result was that in the January 1972 State of the Union Message, published on the front page of the January 21, 1972 issue of the *New York Times*, President Nixon announced a program of new technology initiatives, the lead of which was "*the development of a system of small vehicles running at close spacings in a network of guideways to carry people nonstop from origin to destination in cities.*" After much negotiation, and notwithstanding the Morgantown program, UMTA announced the program given in this slide. By mid-1974, heavy lobbying killed it. It was lobbied to death by two groups:

[10] Years later, an Alden StaRRcar Vice President told me that an UMTA engineer told him that they were going to design the Morgantown system in such a way that it would kill the idea of PRT once and for all – non-R&D people in this part of UMTA!

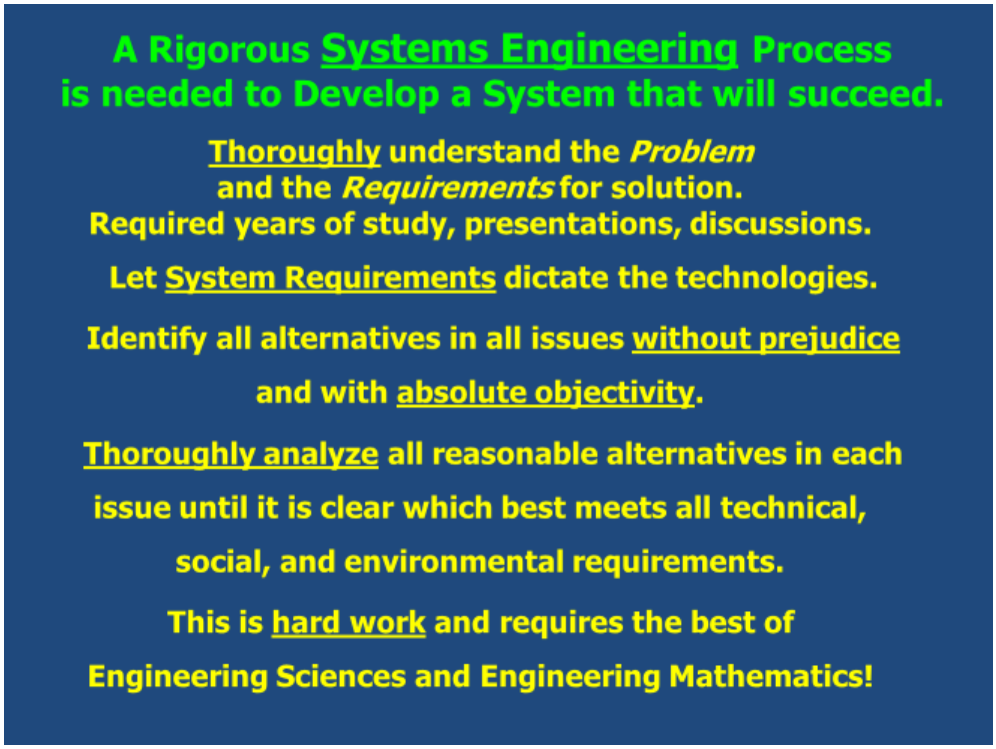
Transit operators and companies developing automated transit systems that would lose their market share if high-capacity PRT were to be developed.

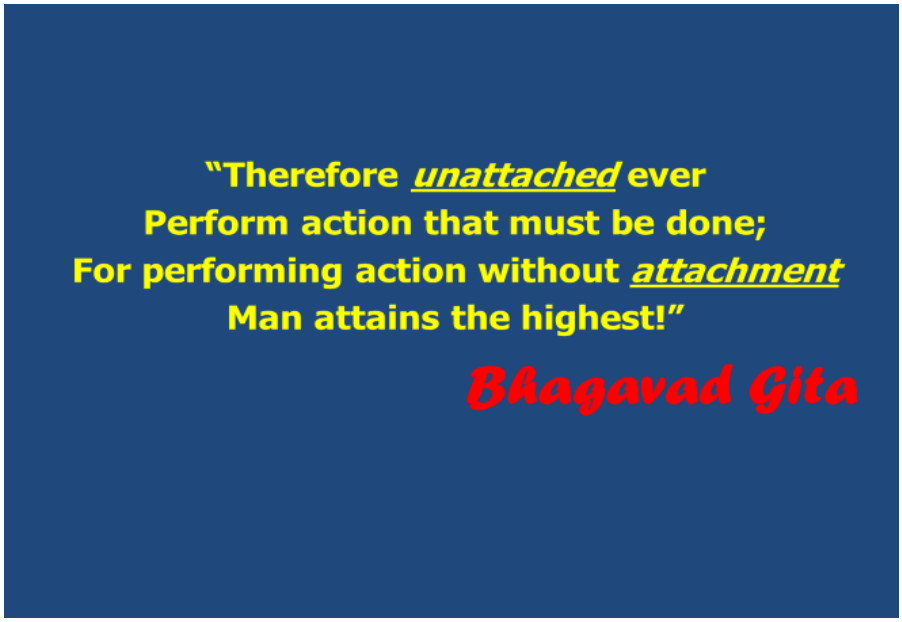
PRT Conference Proceedings.[11]



I initiated my PRT design project in 1981 in the only way I could – as a senior mechanical-engineering design project. Having by that time 13 years of experience in PRT, feedback from hundreds of presentations I gave in the US and abroad, under no serious time pressure, and aware of 14 PRT projects that no longer existed, I resolved to apply systems-engineering principles to the design of a PRT system that could win.[12] I followed rigorously the procedure shown on the next two slides.

[11] Conference Proceedings: *PRT, PRT II, PRT III*, Published at the University of Minnesota, 1972, 1974, 1976.
[12] The 45 issues are given in http://faculty.washington.edu/jbs/itrans/jea2.gif





I particularly like this statement from the Bhagavad Gita, written over 2500 years ago, because the word "unattached" sums the idea that in the design process we must follow the *requirements*[13] objectively and without prejudice, not pet ideas we had become attached to about how things should be done. Every PRT system that was designed to someone's pet ideas failed![14]

[13] Requirements, CDPRT pages 126-130, see page 12.
[14] Rules of Engineering Design, CDPRT pages 89-91.

The Design Advances

`82: $100,000 Patent-Development Grant.

`83: Company formed, Directors invest $120,000.

`84 – `85: Davy McKee Engineering Company invests $700,000 in services to refine the design, find suppliers, prepare proposals.

`86: I move to Boston University.

`87-`89: Engineers from Raytheon, U.S. DOT, General Electric assist on free time in advancing the design and working with potential applications.

Illinois Legislative Act of late 80's established the Regional Transportation Authority (RTA),

directed that the RTA shall "encourage experimentation in developing new public transportation technology."

`89: We met the RTA Chairman – he went to work!

`90: RTA Requests Proposals for 2 parallel PRT design studies @$1.5 M each to lead to a test program.

`91: Our system selected w/ Stone & Webster prime.

`93: Our system selected for test program, w/ Raytheon prime!

In 1991, our $1.5M PRT study for the RTA was initiated with Stone & Webster Engineering Company as prime contractor and finished in 1992. The illustration shown here was developed by RTA staff and was shown in several of their publications. It clearly shows the narrow-guideway design that I had adopted from The Aerospace Corporation PRT work.

Stone & Webster could not supply the $20M needed to match the same amount from the RTA for the test-track program. Raytheon Company stepped in and agreed to match funds provided by the RTA to design, construct, and operate a test system consisting of a third-mile guideway, one station and three vehicles. New management came in, locked all prior work in a file drawer, and decided that they could come up with a better design in a year using their radar engineers. In such a rush and with no prior experience in PRT they more than doubled the guideway width and depth, and quadrupled both the weight of the vehicle and the system cost developed under Stone & Webster. The result was that the RTA dropped the program and said no more about PRT.

A tragedy! Publicity about the RTA program, however, caused other groups to initiate PRT planning and development work.

One of the new PRT design groups was Woo Bo Engineering Company of Seoul, Korea. I worked with them and they developed the video introduced here, which in the presentation is a movie of the operation of a PRT system visually like the system my team had designed. Their work was later taken over by Posco, a very large steel company, who like Raytheon increased the cost of the design to the point that it has found no market.

Issues — Tradeoffs?

1. Dual Mode vs. Single Mode
2. Switch: On Board or at Wayside
3. Vehicles: Supported or Hanging
4. Chassis: Horizontal or Vertical
5. Suspension: Sled runners, Air, Maglev, Wheels
6. Propulsion: Rotary, Air, Cable or Linear (LIM)
7. LIMs: On Board or at Wayside
8. Power Source: On Board or at Wayside
9. Control: Synchronous, Quasi-synchronous, Asynchronous, Trans-synchronous
10. Control: Car Following, Point Following

2 · 2 · 2 · 2 · 4 · 4 · 2 · 2 · 4 · 2 = 8192 designs

35 more issues!

I have mentioned that I found 45 issues that needed to be considered, of which the 10 most important are shown here. Each of the issues was subjected to a detailed tradeoff analysis, which resulted in selection of the alternatives shown in white. The reasons for the selections made in these issues can be found in papers included in Volume 1 of my book, which is announced in the next slide.

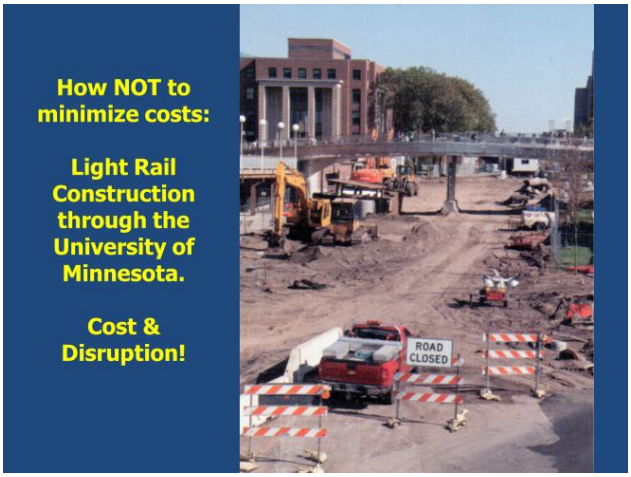
Details in my new Book:

Contributions to the Development of Personal Rapid Transit

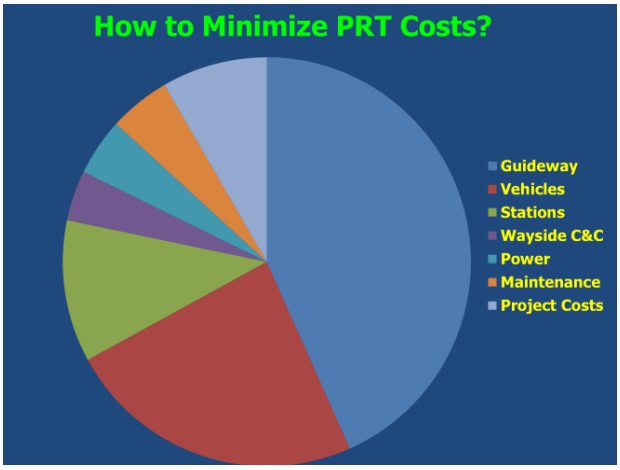
1500 pages in 3 Volumes

Volume #1 can be downloaded from
www.advancedtransit.org/Library/Books

In Volume 1 of my book (CDPRT), pp. 131-207, you can find analyses of the first 10 key issues in sufficient detail to justify the selections.



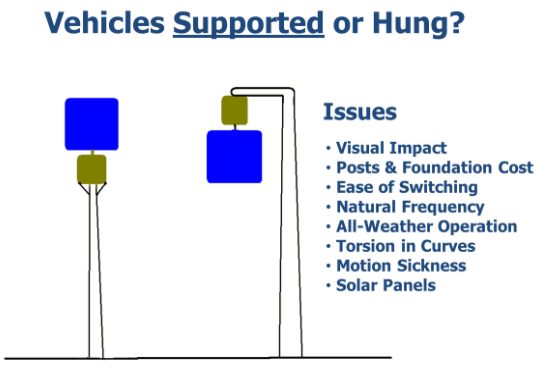
In contrast, I show here the University Avenue light-rail system while under construction through the University of Minnesota. Such scenes could be witnessed along the entire 10-mile length of this system, where construction resulted in many businesses being forced out of business. This is exactly what we do **not** want to do. This system in operation has resulted in about **a wreck a week**, none of which would have happened with an elevated system.



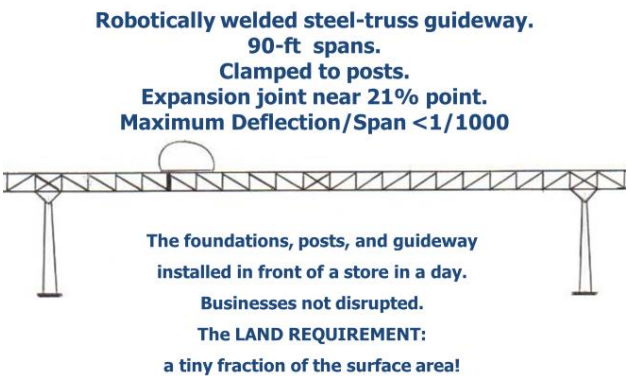
Here is the cost distribution of our system, showing with no surprise that the guideway, being the most expensive component, deserves primary attention.[15] Years before, I found in a surprising number of PRT development programs that the guideway design was taken as an afterthought.

We have already commented that the minimum weight, minimum cost guideway is narrower than the vehicle, thus requiring a unique vertical chassis, as first recommended by The Aerospace Corporation.[16]

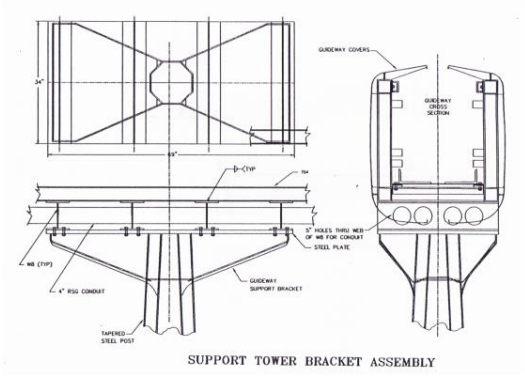
[15] Costs, CDPRT, pages 559-623.
[16] Guideway Design, CDPRT, Task 5, pages 848-1122.



Do we support the vehicles above the guideway or do we hang them below? All-weather operation is a key requirement. With the vertical chassis, we cover the guideway shown on page 16 for nine reasons, which include minimization of penetration of snow. In Volume I of my book, just mentioned, I provide analyses of each of the issues listed on this slide, and show why it is better to support rather than hang the vehicles.[17]



The most economical way to span a distance is with a truss. In a first course in structural analysis the student learns that if the supports of a beam are unconstrained, the maximum deflection under a uniform load is five times as much as if the supports are clamped. This idea was used in the Aerospace PRT design. As shown here and in the next slide, we therefore use a bracket to clamp the guideway to each post. This practice also substantially increases torsional stiffness. In a clamped beam under uniform load, the bending moment is zero near the 21% point. If the necessary expansion joint is placed there, it takes mostly shear and very little bending, which simplifies the design.



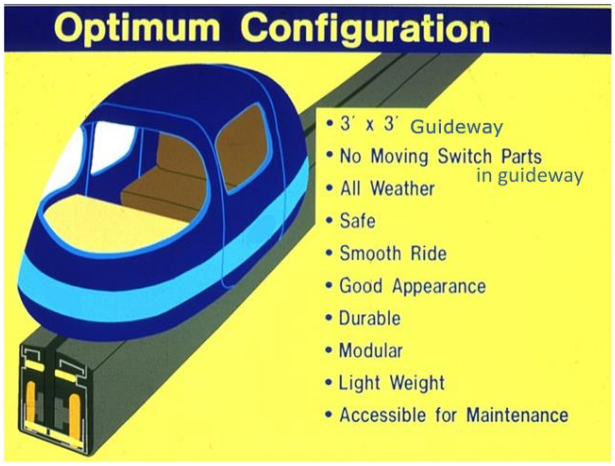
SUPPORT TOWER BRACKET ASSEMBLY

Here is the bracket that was designed during our PRT design study to connect the guideway to the post. It will be subject to detailed finite-element analysis before being released to production.

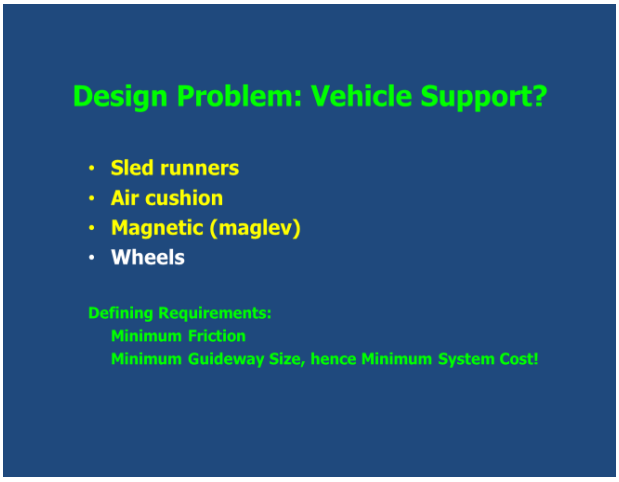
[17] Analyses of Alternatives, CDPRT, pages 131-207.

Computer analysis by Stone & Webster Engineering Company independently confirmed the design of our Guideway.

After the Stone & Webster work on our guideway, we developed a complete analytical analysis of the guideway in both straight and curved sections.[18]

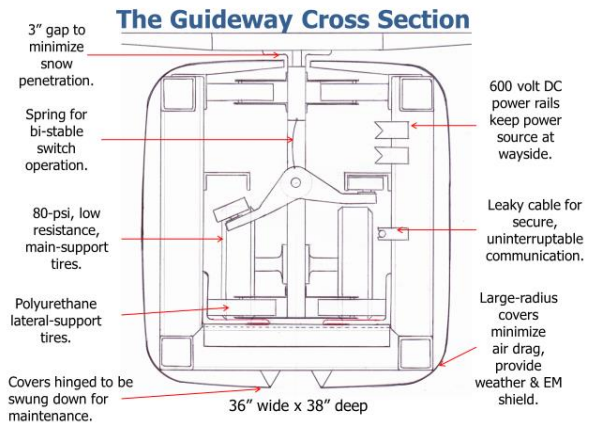


We show here what we found to be the optimum guideway-vehicle configuration with the ten most important requirements. The top requirement is guideway size, and we have shown how we minimize it.



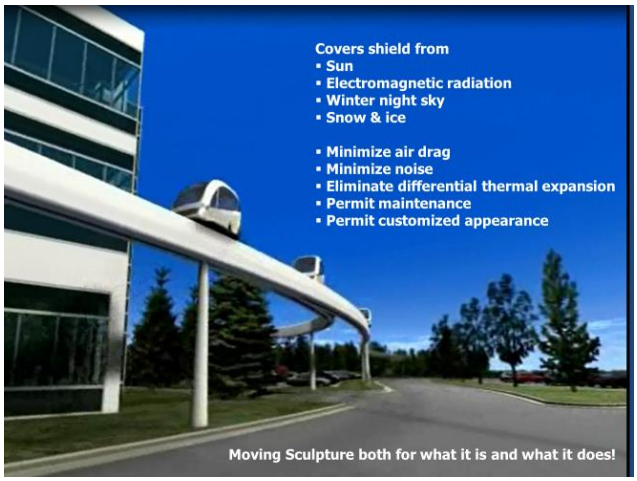
The next design problem is vehicle suspension. Several PRT designers have supported their vehicles on air-cushions. This requires a wide and thus more expensive guideway with greater visual impact. Several companies have used maglev support, mostly because of the attraction of doing something futuristic. But for urban speeds these programs rarely got out of R&D and ended with a guideway wider and more expensive than needed. Wheel support allows the most concentrated loads and thus the narrowest, least expensive guideway.

[18] J. E. Anderson, Structural Properties of the Guideway. CDPRT pages 936-962.
J. E. Anderson, The Polar Moment of Inertia of the Guideway. CDPRT pages 1043-1053.
J. E. Anderson, Deflection of a Curved Guideway. CDPRT pages 1025-1042.



Here is our guideway cross section. Note the narrow vertical chassis. It need be only 2 inches wide and will be fabricated from high-strength steel.[19] The main-support wheels use low-friction, high-pressure tires[20] and run on smooth steel angles with no chuckholes or curbs to run over. Polyurethane-tired wheels provide lateral support. The switch is an arm with a polyurethane-tired wheel on each end, one of which grabs a rail mounted in the merge and diverge sections of the guideway. The guideway cover is made of a thin composite material with aluminum sprayed on the inside to provide electromagnetic shielding. By using a curve radius at the top and bottom of the cover at least one sixth the height of the cover, the drag coefficient to lateral wind loading is only a little more than 0.5, whereas without the covers the drag coefficient goes to 2.[21] Thus the covers reduce the lateral wind loading by a factor of almost four.[22]

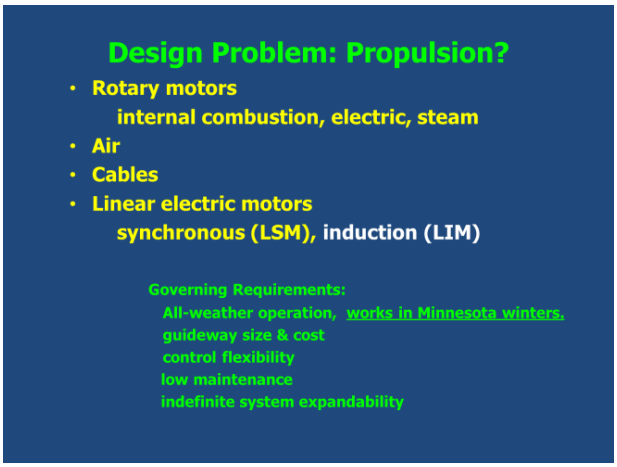
Here is an artist's conception of the system without the necessary guideway-post brackets. The covers satisfy ten requirements:



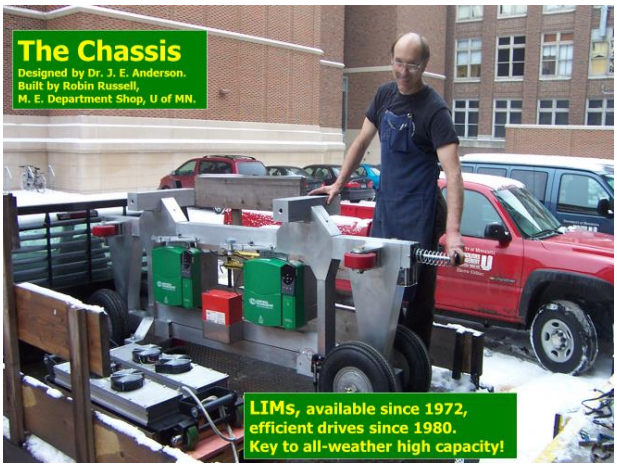
1. They shield the tires from the sun.
2. They provide electromagnetic shielding.
3. Without covers, frost would form on the power rails on clear winter nights.
4. Very little snow and ice can enter the 3 in gap at the top, and the bottom is opened 6 in.
5. Air drag has been mentioned.
6. A sound-deadening material can be sprayed on the inside of the cover.
7. Without the covers, sun shining on one side will heat the steel guideway more than the other side, thus producing differential stresses that the covers eliminate.
8. If necessary, though rarely, the covers can be swung down for maintenance.
9. The covers can be textured and colored to suit the community.
10. Solar panels can be placed on the sides and on almost the entire top. Analyses show that they will provide more than enough power to operate the system.[23]

A Chicago sculptor referred to our system with the statement given at the bottom of the slide.

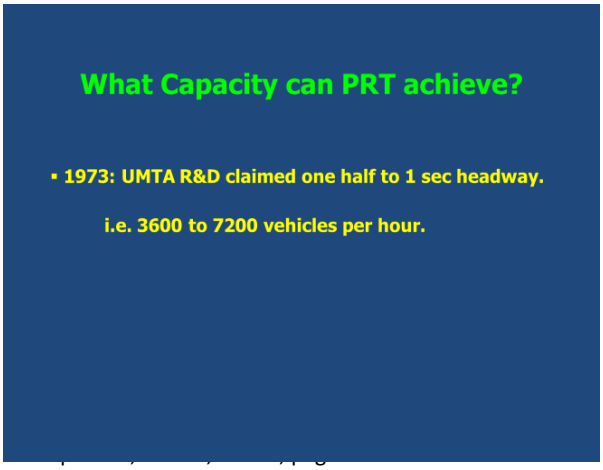
[19] Steel has a fatigue limit while aluminum does not. J. E. Shigley and C. R. Mischke, *Mechanical Engineering Design,* p. 275.
[20] Or the new airless tire with the same cushioning properties as pneumatic tires.
[21] Scraton, C. and Rogers, E. W. E. 1971. Steady and Unsteady Wind Loading. *Phil. Trans. Roy. Soc.* London a. 269:353-379.
[22] Guideway Covers, CDPRT, Task 6, pages 1224-1229.
[23] ITNS, p. 31.



There are many ways to propel PRT vehicles. Most PRT designers selected rotary electric motors with acceleration and braking forces dependent on friction. Two PRT designers used air propulsion, which is very noisy. Cables are practical when the vehicles go only forward and backward on a single section of guideway. Linear synchronous motors are used on very high speed systems and simply don't work at the short headways we need. LIMs provide friction-less operation. They are well developed and provide consistent acceleration and braking in any weather, which is essential for short-headway operation.[24]

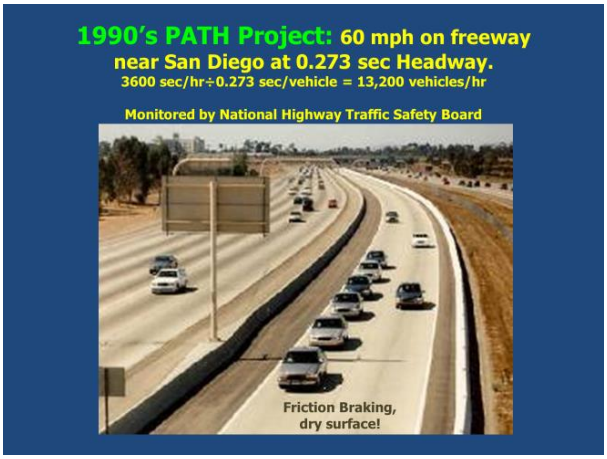


Here is the vertical chassis[25] I designed with the man who built it. It supported the vehicle's cabin 12 hours a day for the 12 days of the Minnesota State Fair with no failures. The LIMs are in the lower left corner not yet installed.[26] Each green box is a variable-frequency drive that drives one of the two motors.[27] To maximize efficiency of LIMs, variable frequency is essential.[28] Note the vertical shear plates that support the bracket attachments to the vehicle's cabin. These brackets have passed careful finite-element analysis. The red box is a battery that provides power for on-board functions.



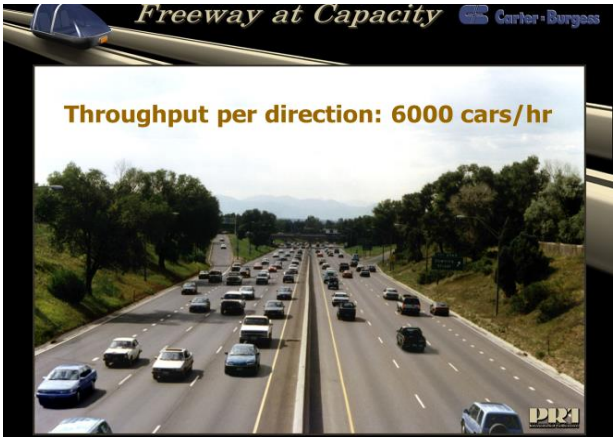
As mentioned on page 8, over 40 years ago UMTA engineers advised their Administrator that they could operate vehicles safely at half-second headways, which implies at most 7200 vehicles per hour.[29] This conclusion assumed use of linear electromagnetic motors. Using propulsion and braking through wheels, operating headway is limited to 6 sec[30] or 1800 vehicles per hour.

[25] Chassis, CDPRT, Task 4, pages 720-847.
[26] They were purchased from Force Engineering, England, www.force.co.uk.
[27] www.emerson.com. Variable-frequency drives were not available until about 1980 – too late for Aerospace PRT.
[28] Properties of a Linear Induction Motor, CDPRT, Vol. 3, pages 1473-1482.
[29] Capacity, CDPRT pages 489-517.
[30] Automated Transit Network Feasibility Evaluation for San Josè Mineta International Airport, San Josè, CA. Aerospace Corporation Report No. ATR-2012(5629)-1, October 19, 2012, Page 76.

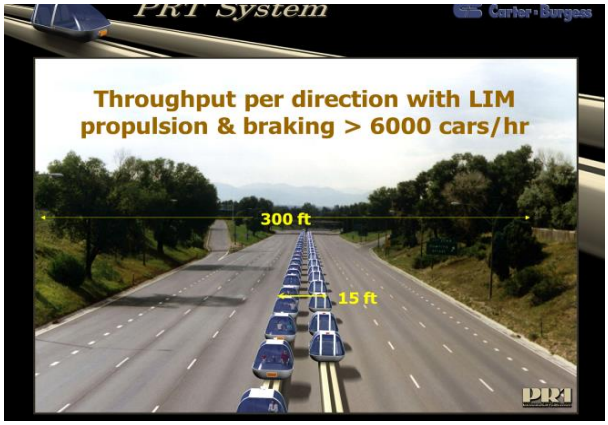


The PATH Project was funded by the U. S. Congress.[31] A series of 17-foot-long Buick LeSabres were operated at a nose-to-tail spacing of 7 ft at 60 mph, corresponding to a headway of 0.273 seconds, a headway believed to be safe in dry conditions. With our 9-foot-long vehicles and the same nose-to-tail spacing, we would achieve a headway of 0.182 sec or 19,800 vehicles per hour, and using LIMs we can do it in winter conditions. Since a freeway lane achieves about 2000 vehicles per hour, this corresponds to almost 10 freeway lanes of travel – far more than required in any but the most extreme situations.

6000 vehicles per hour is adequate for a wide variety of applications.



This sequence shows first a three-lane freeway (the 4th lane is an acceleration lane) operating on the left at close to capacity. The second illustration shows the people in the cars, the third shows them moved to the center, and the fourth shows them in PRT vehicles. With LIM propulsion, our system easily handles that flow in the presence of snow and ice, and reduces the land requirement by a factor of 20:1!



[31] PATH video, available upon request.

This illustration shows a major advantage of an elevated PRT system using a narrow guideway. The guideway can barely be seen from the air, yet using LIMs it can move many times the flow on the arterial streets below.

The land requirement for our elevated PRT system is tiny, whereas the automobile system requires a large fraction of the surface area of a city. This huge land use is the reason the automobile system produces **CONGESTION**.

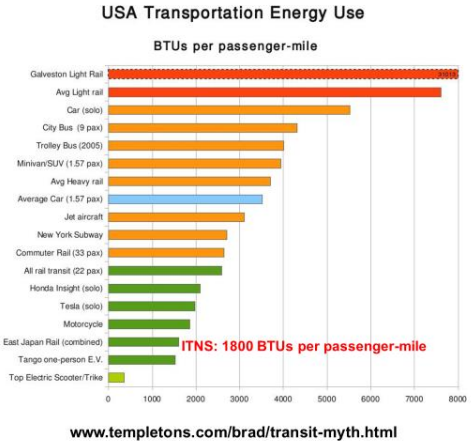
ITNS,[32]

[32] CDPRT, pages 260-288.

Design Problem:
How to Minimize Energy Use?

- **Run vehicles only when needed.**
- **Eliminate intermediate stops.**
- **Lower maximum speeds.**
- **Use each vehicle over and over again.**
- **Use very light-weight vehicles.**
- **Use smooth, stiff tires for low road resistance.**
- **Streamline for low air drag.**
- **Design for efficient propulsion.**

Using off-line stations, our system agrees immediately with the first four of these recommendations. By proper design of the remaining four, one has a system that is as energy efficient as possible. [33]



Brad Templeton wondered how much energy various means of travel use per passenger-mile. He mined federal data to find out, and summarized his results on this chart. To his surprise light rail topped the list. Why? 1) Because of inherently low occupancy averaged over a day.[34] 2) Because, to maximize average speed and thus ridership, planners of surface-level rail systems like to place the stations at least a mile apart and accelerate the trains up to 60 mph between stations. A three-car train weighs empty about 330,000 lb. The peak kinetic energy of such a train, without passengers, is about 15 kW-hr and, because of finite efficiency, the input energy is several times as high. This amount of energy is added and then turned into heat every mile, i.e. approximately every 2 minutes. Assuming an efficiency of 30%, typical of power plants, this is 1500 kW-hr[35] for every operating hour.[36] Some of that energy can be recovered through regenerative braking, but because of finite efficiencies not much! With stations every half mile, the energy use per passenger-mile is even greater. With nonstop trips, attainable with off-line stations, it is not necessary to go to such a high maximum speed. On the same line, 35 mph will achieve a higher average speed. Moreover, every quantity that increases with speed increases as the square of speed and $(60/35)^2 = 2.94$.

[33] J. E. Anderson, Transit Energy Use, CDPRT pages 530-552.

[34] The Director of Transit Development for the MTC in the late 1970's told several of us that the daily average occupancy of their 60-passenger buses was only 2.5 people per vehicle – shockingly low! This is a load factor of only 2.5/60 = 4.2%

[35] The average U. S. household uses about 31 kW-hr per day.

[36] See the Appendix.

Design Problem: How to Achieve High Reliability & Safety?

- Exclusive guideway.
- Few moving parts.
- No safety-critical moving parts in the motors.
- Friction-free acceleration and braking via LIMs.
- No moving track parts in the switch.
- Dual motors, sensors, and power supply.
- Checked Dual Duplex computers.
- Fault-tolerant hardware and software.
- Independent emergency braking.
- *Result:*
  - *Chance of injury close to zero!*

The features shown here are designed into ITNS. Checked Dual Duplex computers and fault-tolerant design are explained with the next slide.[37]

The Key to Safety

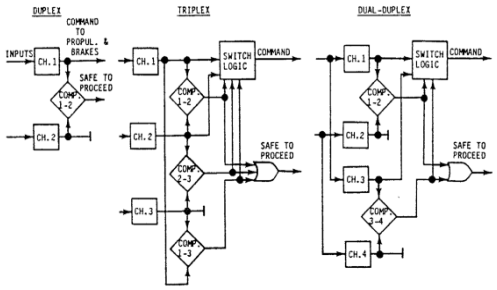


FIGURE 3: MICROPROCESSOR REDUNDANCY CONFIGURATIONS

This diagram was taken from a Boeing report[38] on a study of automated transit for UMTA. On the left is a pair of identical microprocessor control systems, each capable of operating a vehicle. A safe-to-proceed signal is obtained when the two microprocessors agree on a schedule of between about 100 and 200 milliseconds. During that interval, a command to apply the brakes is given, which must be canceled by the safe-to-proceed signal. (This procedure is an example of fault-tolerance, and is used wherever possible.) If the two microprocessor control systems do not agree, the vehicle is commanded to stop. Not liking this result, both Boeing and Honeywell engineers considered triplex and dual-duplex configurations. In the Boeing paper, the selection of dual-duplex is explained.

ITNS Mean Time Between Unsafe Failures

Source: "Failure Analysis in ITNS."

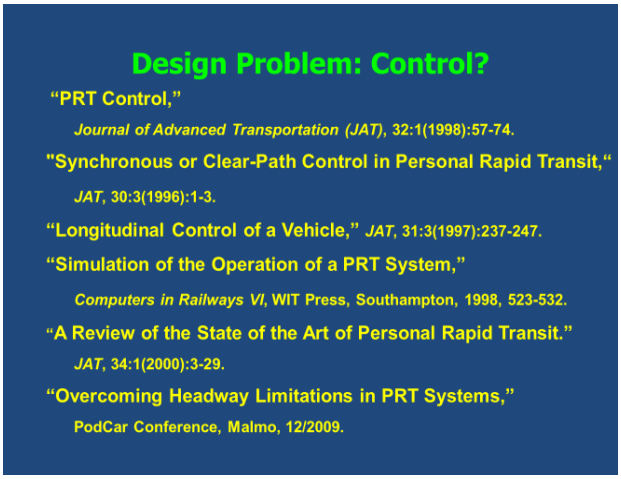
Type of Failure	MTBUF, years
On-Board Computer System	4(10)^20
Communications System	137,000
On-Board Encoder System	214,000
On-Board Propulsion System	700,000
Vehicle Incapable of moving	75,000
Pushing incidents w/ 1000 vehicles	75
Zone Controller	30(10)^18
Vehicle-to-vehicle Collision	10^12
Merge Collision	10^13
Lifetime of Universe	14(10)^9
Auto/ITNS Potential Accident Rate	20(10)^12

Based on the method of calculation given in Boeing reports, in the paper "Failure Analysis in ITNS"[39] I calculated the Mean Times Between Unsafe Failures shown here based on a microprocessor MTBF of 10,000 hours, which was achieved in the early 1980s. People often ask how often it might be necessary to push a vehicle. This analysis found that in a fleet of 1000 vehicles a pushing incident may occur in about once in a lifetime. In the bottom line, I divided the auto accident rate taken from a federal report by the reciprocal of the system MTBUF. We found a ratio of 20 trillion to one!

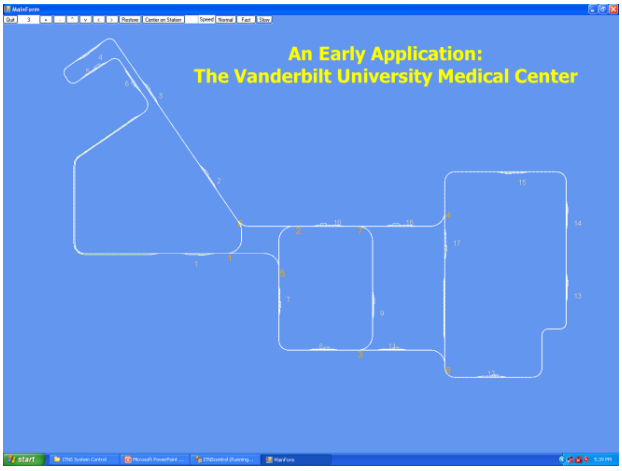
[37] Safety & Reliability, CDPRT, pages 624-681.

[38] R. C. Milnor & R. S. Washington, 1984. "Effects of System Architecture on Safety and Reliability of Multiple Microprocessor Control Systems," IEEE Conference Paper. Today, we do much better than in 1984.

[39] CDPRT, Vol. 2, pages 642-668.

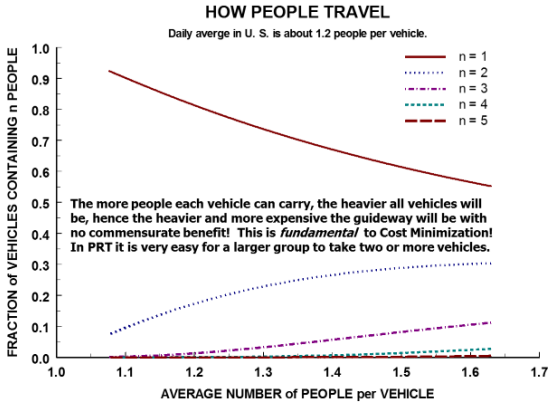


The ITNS control system is based on the papers shown here. [40] Control analysis has been performed by more analysts in more places than any other feature of ATN.[41] Four basic strategies for control have been studied: Synchronous, quasi-synchronous, asynchronous, and trans-synchronous. Asynchronous control has been analyzed with car following, whereas Aerospace Corporation developed quasi-synchronous with point following. Point following means that each vehicle follows a trajectory calculated in the vehicle computer. After extensive simulation work, I found that the best approach is asynchronous point following.

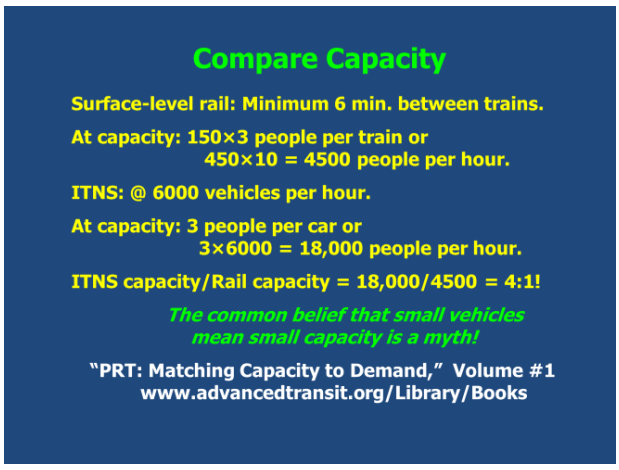


For many years, I have worked with transportation planners at the Vanderbilt Medical Center in Nashville, Tennessee. The area around the ITNS guideway layout shown here is the site of many medical facilities on streets too narrow for large regional buses. These planners would like to have the buses that pickup patients from many sites in Tennessee dropped off in a park in the upper left corner of this diagram, and from there take ITNS to the desired medical facility. They laid out this network and I have used it as a basis for debugging the control system.

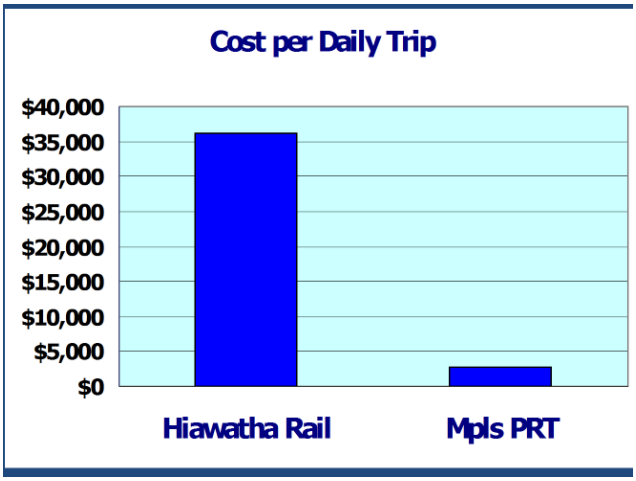
Cabin Design.[42]



[40] Control, CDPRT, Task #7, pages 1230-1454.
[41] J. E. Anderson, "The Future of High-Capacity PRT," References, CDPRT, pages 231-233.
[42] Cabin Design, CDPRT, Task # 3, pages 682-719.



Metro Transit said that the Hiawatha Rail Line cost about $720,000,000 and carries about 20,000 riders a day, giving about $36,000 per daily trip. We laid out an 8-mile ITNS to serve Downtown Minneapolis and estimated its cost to be about $100,000,000. Since it has not been built yet, assume its cost is



$200,000,000. An independent consulting firm estimated ridership to be about 74,000 rides a day. Dividing 200,000,000 by 74,000 gives $2700 per daily trip, lower than the rail line by a factor of more than 13!

Revenue on ITNS can be from
Passenger movement +
Freight movement +
Focused Advertising.
Costs include Cost of Land.

Conventional Transit:
Revenue covers
30% of Operating Costs,
0% of Capital Costs.

ITNS:
In many applications,
Revenue will cover all Costs.

Verification of the costs and revenue of ITNS requires a detailed analysis of a specific system based on a layout like the one given above for the Vanderbilt Medical Center. Such an analysis can be based on our papers on PRT Network Economics.[43]

Results of Systems Engineering

	Conventional Surface Rail	ITNS	ITNS/Rail
Ridership	3%	30%	10/1
People/Hour	4500	18,000	4/1
Cost, $/Pass-mi	$2.05	$0.19	0.09/1
Energy Use, BTU/Pass-mi	7600	1800	0.24/1
Land Use, sq-ft/mile	60,720	2140	0.035/1

[43] CDPRT, Vol. 2, pages 559-607.

Summarizing our findings, we get the results shown on this slide.

We have studied all the types of applications shown here. For example, the Manager of Parks Operations Research at Disney World near Orlando, Florida, visited me when I was teaching at Boston University. He had heard a presentation of my work in Orlando, based on which he mentioned numerous applications of my system at Disney World. He had a long list of questions, the last of which was "Who will build it?" We did not have an answer at that time. They are still waiting.

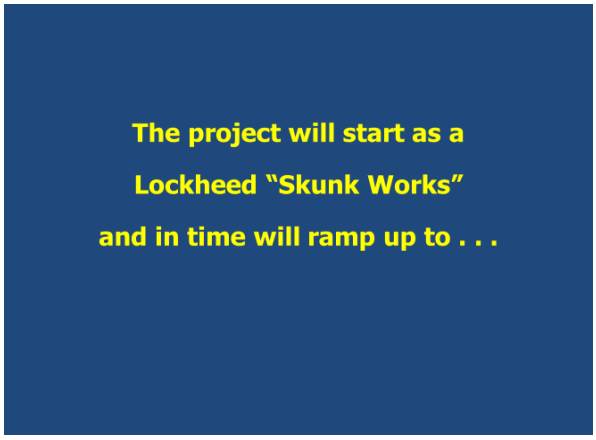
For an application to be profitable, it must be laid out carefully in an area of sufficient population density, and there must be enough riders, which must be estimated by a detailed ridership analysis.[44]

NEXT STEP:

[44] Planning, CDPRT pages 1510-1535.

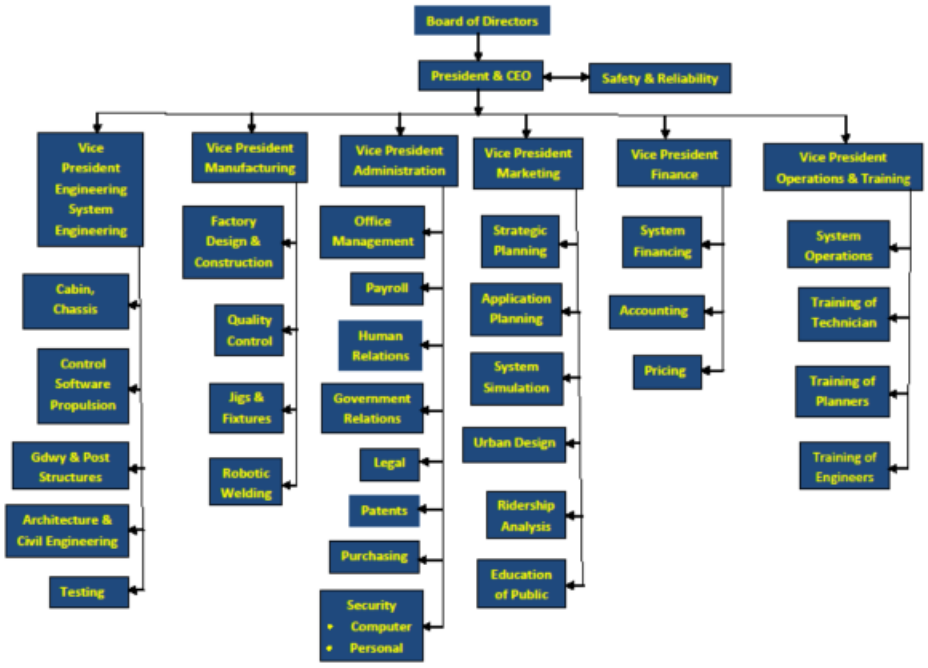
Engineering Program.[45]

Detailed information needed to define and direct each of these tasks can be found in our Business Plan, which is included in Volume 1 of *Contributions to the Development of Personal Rapid Transit.*[46]



[45] Engineering Program, CDPRT pages 1495-1509.

[46] CDPRT pages 333-417.



Market:

Requirement: No Controversy!

Dozens of such applications above $200,000,000 each are available that can be financed privately !

The Vision . . .

Hundreds of Applications like these:


Thanks to Chiphol Forward,
Amsterdam!

Appendix

Light-Rail Energy Use

W_t = 3-car Train Empty Weight, lb = 330,000 lb

W_p = Average person weight, lb = 140 lb

p_t = Average number of people in each train = 21.4[47]

C_{train} = Train capacity, people = 180(3) = 540 people

Load Factor = $\frac{p_t}{C_{train}} = \frac{21.4}{540} = 4.0\%$

V_{max} = Maximum speed of train, mph = 60 mph = 88 ft/sec

V_{ave} = Average speed of train, mph

$g = 32.2\ ft/sec^2$

A_{max} = Maximum acceleration of train, ft/sec^2 = $\frac{1}{8}g$

T_{ss} = Station-to-Station time, sec

T_{dwell} = Dwell time, sec = 20 sec

L_{sta} = Distance between stations, 1 mi = 5280 ft

L_{trip} = Trip distance, assume 4 mi

ϵ = Propulsion efficiency = 0.3

KE_{max} = Maximum kinetic energy of the train

1 kW-hr = 2.655(10)^6 ft-lb = 3412 Btu

$$KE_{max} = \frac{1}{2}\left(\frac{W}{g}\right)V^2$$

For this example, assume 3-car train:

$$W = W_t + p_t W_p = 330{,}000 + 21.4 \times 140 = 333{,}000\ lb$$

$$V_{max} = 88 ft/sec$$

Then

$$KE_{max} = \frac{333{,}000}{64.4}(88)^2 = 40.04(10)^6\ ftlb \times \frac{1\ kWhr}{2.655\ (10)^6 ftlb} = \ 15.08\ kWhr$$

Distance between stations: $L_{sta} = V_{max}\left(T_{ss} - T_{dwell} - \frac{V_{max}}{A_{max}}\right)$

[47] To result in about 8000 Btu per passenger-mile, as used by the Galveston LRT.

$$T_{ss} = \frac{L_{sta}}{V_{max}} + \frac{V_{max}}{A_{max}} + T_{dwell}$$

For this example, assume stops once every mile:

$$T_{ss} = \frac{5280\ ft}{88\ ft/sec} + \frac{88\ ft/sec}{0.125g} + 20\ sec = 101.86\ sec = 1.698\ min$$

$$Stops\ per\ hour = \frac{60\ min/hr}{1.698\ min/stop} = 35.34$$

$$Energy\ Input\ per\ hour\ per\ train = \frac{KE_{max}}{\epsilon} \times\ Stops\ per\ hour = \frac{15.08\ kWhr}{0.3} \times 32.34$$
$$= 1626\ kWhr/hr$$

$$Average\ speed\ of\ train = V_{ave} = \frac{L_{sta}}{T_{ss}} = \frac{1\ mi}{1.698\ min} \times \frac{60\ min}{1hr} = 35.34\ mph$$

$$Trip\ Time = \frac{L_{trip}}{V_{ave}} = \frac{4mi}{32.34\ mph} \times 60\frac{min}{hr} = 7.421\ min$$

$$Energy\ input\ per\ trip\ per\ train = \frac{1626\ kWhr}{hr} \times \frac{7.421}{60} = 201\ kWhr$$

$$Energy\ per\ passenger - mi = \frac{201\ kWhr}{(p_t\ passengers)(4\ mi)} = \frac{201}{21.4 \times 4} = 2.348\ kWhr \times 3412\frac{Btu}{kWhr}$$
$$= 8012\frac{Btu}{PassMi}$$

Note that with 21.4 people per train, or a load factor of 21.4/540 = 4.0%, the energy use per passenger-mile is about the same as the energy use of 8000 Btu per passenger-mile given by Brad Templeton for the Galveston LRT system. This load factor is slightly lower than for the Twin City bus system. These numbers reflect the huge inefficiency of transit operations with on-line stations. With off-line stations, the average load factor is about 20% − five times higher! Why is it so difficult to switch to off-line stations, minimum-sized vehicles, minimum-sized elevated guideways, and automated control? These technologies are easily available, and extremely reliable.

Tradition has dominated, even at great expense!

J. Edward Anderson, BSME, Iowa State University; MSME, University of Minnesota; Ph.D. in Aeronautics and Astronautics, Massachusetts Institute of Technology.

Following his undergraduate work, he developed methods of structural analysis of supersonic-aircraft wings (NACA Report No. 1131) at the Structures Research Division of NACA (now NASA), and contributed to the design of the F-103 wing. He then moved to the Honeywell Aeronautical Division where his first assignment was to design aircraft instruments, one of which included the first transistorized amplifier used in a military aircraft and won the *Aviation Age* Product-of-the-Month Award. He was then assigned to the Aircraft Dynamics Group in the Research Department where he performed computer analysis of autopilots for military and space applications, and later managed a group of 15 Research Engineers in the advanced design of the F-100 and F-107 autopilot systems. He was then assigned to the Inertial Navigation Group where he invented and led 20 Research Engineers in the development of a new type of inertial navigator now used widely on military and commercial aircraft.

In 1959 he received a Convair Fellowship under which, with a half-salary grant from Honeywell, he went to M. I. T. to study for a Ph. D. degree. He became fascinated with magnetohydrodynamics and wrote a thesis entitled *Magnetohydrodynmaic Shock Waves*, which was the only M. I. T. Ph.D. thesis that year out of 200 that was published by M. I. T. Press. It was later reprinted by the University of Tokyo Press, translated into Russian and published by Atomizdat in Moscow in 1968 at a time he was in the Soviet Union on an exchange visit sponsored jointly by the National Academy of Sciences and the Soviet Academy of Science. It is currently used by physicists who study magnetic containment of high-temperature plasma and still receives royalties.

After returning to Honeywell in 1962 he was sent to Cape Canaveral where he was able to show NASA engineers that erratic behavior in the gyro signals on Col. Glenn's space flight were not due to a malfunction of the Honeywell attitude-control system. He directed a team of 24 engineers in the advanced development of a solar-probe spacecraft and in August 1963, following a briefing he gave with his staff to officials at NASA Ames Research Center, NASA informed Honeywell that they were equal in capability with its two funded contractors on the solar-probe effort. He had written a report justifying the solar-problem mission, which was used in 1964 by NASA personnel in testimony to Congress.

In September 1963 Dr. Anderson joined the Mechanical Engineering Department at the University of Minnesota and later directed its Industrial Engineering Division. In 1968, after returning from 10 months in the Soviet Union, he became interested in Personal Rapid Transit (PRT) as a necessary technology for a sustainable world. At the same time, he was invited to join a group of physics professors dedicated to stopping the Safeguard Anti-Ballistic Missile system; which led to chairmanship of a Symposium on the Role of Science and Technology in Society; which led to leading an Honors Seminary called "Technology, Man, and the Future;" which led to initiating, managing and lecturing in a large interdisciplinary course "Ecology, Technology, and Society," which was taught every quarter from 1970 through 1988 to over 4000 students from 100 departments in the University with support of the Deans of the Institute of Technology, Liberal Arts, and Agriculture. Simultaneously, he coordinated a 15-professor Task Force on New Concepts in Urban Transportation and chaired three International Conferences on Personal Rapid Transit (PRT), following which he was elected first president of the Advanced Transit Association. In 1972 he briefed NASA Headquarters on PRT in relation to a "NASA Advanced PRT Program" and in December 1972 was asked by a NASA official to chair a National Advisory Committee on the NASA PRT Program.

During the 1970s, Dr. Anderson consulted on PRT planning, ridership analysis, and design for the Colorado Regional Transportation District, Raytheon Company, the German joint venture DEMAG+MBB, and the State of Indiana. For several years he was a Regional Director of the American Institute of Aeronautics and Astronautics, and one of its Distinguished Lecturers. He lectured widely on new transit concepts and was sponsored on several lecture tours abroad by the United States Information Agency and the United States State Department. In 1982, as a result of having given 180 lectures over a three-year period in opposition to the MX missile program and other aspects of preparation for nuclear war, he was presented with the George Williams Fellowship Award sponsored by the YMCA and presented for public service, and the MPIRG Public Citizen Award. Partly because of his arguments, the Reagan Administration canceled the MX program.

In 1978 he published the textbook *Transit Systems Theory* (D. C. Heath, Lexington Books), which he has used many times in his course "Transit Systems Analysis and Design." In addition to engineering students, enrollment in this course has included professional transportation engineers from across United States as well as from Sweden, Korea, and Mexico. In 1981 he initiated and led the development of a new High-Capacity PRT system (now called an Intelligent Transportation Network System) through five stages of planning, design and costing. He developed computer programs for vehicle control, station operation, operation of many vehicles in networks, calculation of guideways curved in three dimensions to ride-comfort standards, study of the dynamics of transit vehicles, economic analysis of transit systems, and calculation of transit ridership.

In 1986 he was attracted to the Department of Aerospace and Mechanical Engineering at Boston University where he taught mechanics, engineering design and transit systems analysis and design; and where he organized, coordinated and lectured in an interdisciplinary course "Technology and Society." On his own time, he organized a team of a half-dozen engineers and managers from major Boston-Area firms to further develop High-Capacity PRT. In May 1989, the Northeastern Illinois Regional Transportation Authority (RTA) learned of his work together with Raytheon Company and, as a result, initiated a program to fully develop PRT. This led to a $1.5M PRT design study led by Stone & Webster Engineering Corporation, followed by a $40M joint development program funded by Raytheon Company and the RTA. While at Boston University, he developed the Maglev Performance Simulator used by the National Maglev Initiative Office, U. S. Department of Transportation, to study the performance of high-speed maglev vehicles traveling within ride-comfort standards over the curves and hills of an interstate expressway.

Following the RTA program, Dr. Anderson gave courses on transit systems analysis and design to transportation professionals, and engaged in PRT planning studies. In 1992 his PRT system was selected unanimously by a 17-person steering committee over bus and rail systems for deployment at the Seattle-Tacoma International Airport. In 1996 he chaired an international conference on PRT and related technologies in Minneapolis. In 1998 his work led to acceptance of his PRT system out of over 50 similar systems as the preferred technology promoted for the Greater Cincinnati Area by a committee of Forward Quest, a Northern Kentucky business organization.

In the period 2000-2002 he led the design and construction supervision of a full-scale vehicle that operated automatically on a short segment of guideway for thousands of error-free rides, many as an exhibit at the 2003 Minnesota State Fair. This system worked exactly as intended.

For his patents on PRT, the Intellectual Property Owners Foundation named Dr. Anderson an Outstanding American Inventor of 1989. In 1994 he was Distinguished Alumni Lecturer at North Park University in Chicago. In 2001 he was elected Fellow of the American Association for the Advancement of Science for his work on PRT. In 2008 he was named Honorary Lifetime Member of the Advanced Transit Association. In 2010 the Minnesota Federation of Engineering, Scientific, and Technical Societies granted him its Charles W. Britzius Distinguished Engineer award. In 2013 The Aerospace Corporation granted him its “Technical Achievement Recognition for lifelong dedication to the advancement of transportation technology.” In 2018 the Advanced Transit Association awarded him for “Outstanding Contributions to Advanced Transit.”

He is a registered professional Engineer in the State of Minnesota, has authored over 100 technical papers and three books, is listed in 36 biographical reference works including *Who’s Who in America* and *Who’s Who in the World,* and is the son of Missionary parents with whom he spent years one through nine in China.

For his complete bibliography, go to Wikipedia, J. Edward Anderson, Reference 21.

Aerospace Corporation interest in my work

Following is the program for a workshop held on June 28, 2013 at The Aerospace Corporation in El Segundo, CA, just south of the Los Angeles International Airport.

The Aerospace Corporation had finished a $1 M study of PRT technology for San Jose the previous fall, in which they studied all PRT systems, not by name but by characteristics. Because all the then operational PRT systems used rotary motor propulsion, they were all rejected for application at the San Jose airport because of the long headway that had to be specified for a system that depended on friction at the running surface for braking. Headway is the time between vehicles, thus long headway means low capacity in vehicles per hour.

Note in the program that I was the only representative of a PRT company that was invited. Moreover, I was given an award!

Public Sector Innovation Workshop

"Technology and a New Urban Environment"

The Aerospace Corporation, El Segundo, Calif.

June 28, 2013

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6/24/2013
Date

J. Edward Anderson
Print Name

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Paper Title

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Friday, June 28, 2013 Program at The Aerospace Corporation

7:00 **Registration and Continental Breakfast**

8:00 **Welcome and Opening Remarks**

Jag Soni, Organizational Effectiveness Specialist, The Aerospace Corporation

8:05 **Pursuing Innovation in the Public Sector**

Randy Kendall, Vice President, The Aerospace Corporation

Rod Diridon, Sr., Executive Director, Mineta Transportation Institute

Mark Pisano, Fellow, National Academy of Public Administration

8:15**Technology and a New Urban Environment**

Hans F. Larsen, City of San José, Department of Transportation

Morning Topic:

Institutional Innovation: If We Can Go to the Moon, Why Can't We…?

8:30 **Overview**

Tom Paige, The Aerospace Corporation

9:00 **The Nature of Innovation**

Lin Midkiff, The Aerospace Corporation

9:20 **What We Have, What We Need**

Mark Pisano, National Academy of Public Administration

9:40 **Frameworks for Action: Governing Structures**

James Kelly (SCE, Retired)

10:10 **Frameworks in Action: The Development Process**

Dave Bearden, The Aerospace Corporation

10:40 **Break**

11:00 **Panel: Organizing and Financing Innovation**

Hans F. Larsen, City of San José Department of Transportation (moderator)

Michael Boyle, General Counsel, Higgins Law Firm

Dr. Catherine Burke, Professor Emerita, University of Southern California

Dr. Richard Geddes, Associate Professor & Director of Infrastructure Policy Program, Cornell University

John Serafini, Vice President, Allied Minds

12:00 **Lunch**

Afternoon Topic:

Technical Innovation: The Example of ATNs

1:00 **The City of San José ATN Evaluation Experience**

Laura Stuchinsky, City of San José Department of Transportation

1:15 **ATNs: Disruptive Technology of Bust?**

Part 1: Nuts & Bolts

Tom Paige, Lin Midkiff, The Aerospace Corporation

Part 2: The Big Picture

Tom Paige, The Aerospace Corporation

2:30 **Break**

2:45 **ATNs: Costs, Risks, and Opportunities Now and in the Future**

William Baumgardner, Arup International

3:15 **Panel: Next Steps for ATNs**

Laura Stuchinsky, City of San José Department of Transportation (moderator)

Dr. J. Edward Anderson, Chief Engineer, PRT International

Steve Artus, Program and Project Supervisor, California Public Utilities Commission

Matthew Lesh, Transportation Program Specialist, Federal Transit Administration

Christer Lindstrom, Founder, Institute for Sustainable Transportation

4:15 **Next Steps: Call to Action**

James Kelly (SCE, Retired)

4:25 **Closing Remarks**

Randy Kendall, Vice President, The Aerospace Corporation

4:30 **Adjourn**

Travel Assistance

5:30 ***Optional Reception and Dinner***

Keynote Speaker: Rod Diridon, Sr., Executive Director, Mineta Transportation Institute

From: Wollman, Neil <[redacted]>
To: MBX OSTP PCAST <MBX.OSTP.PCAST@ostp.eop.gov>
Sent: Tuesday, 5/18/2021 1:21 PM
Subject: Institute government infrastructure to ensure evidence based policymaking

Any promotion of our proposal with the Administration or members of Congress is appreciated. It could happen as a part of the current infrastructure bill, as proposed below, or as a bill on its own.
==========

The National Prevention Science Coalition (NSPC) along with our partner organizations recommend that the Biden Infrastructure Bill be modified to include the creation of an ***automated clearinghouse*** to enable the type of evidence-based policymaking that the Administration and bipartisan members of Congress are calling for. The proposed clearinghouse will serve the needs of governing bodies and constituent groups by providing a sophisticated data platform for ready access to information across diverse policy areas.

We are not requesting funds for NPSC. Rather, after decades of work in communities and with local, state and federal agencies, we are aware of the lack of well-tested resources to guide decision-making around selection and implementation of evidence-based programs and policies (EBPPs). Our intention is to facilitate the uptake and utility of existing programs and policies shown to produce significant benefits.

The initial step would involve the development of a **health care-relevant clearinghouse** that will address the objectives of the Evidence-Based Policy Act by providing infrastructure for rigorously evaluated EBPPs shown to reduce or prevent problems, such as mental health disorders, drug addiction, academic failure, criminality, and health care disparities. Once well-tested for feasibility and utility, the platform can be expanded to cover additional areas of governmental operations, from budget deliberations to environmental protection and national security.

The Clearinghouse will meet the needs of policymakers and agencies responsible for executing the mandate of the Act by organizing the large reserve of data on EBPPs across policy areas. The platform is also amenable to uptake by a wide range of end-users, such as community stakeholders, military personnel, economic analysts, and educators, to inform decision-making.

After initial outlays, money saved by implementing best practices and policies will result in a stronger economy with considerable savings for the government over time.

Please take a moment to review our proposal for the initial step of the automated clearinghouse and indicate your interest and/or thoughts about its utility by clicking **here**. The NPSC stands ready to advise or guide the initial development of this clearinghouse with respect to health-related concerns, with about 800 members across the nation who have a vast range of expertise representing numerous disciplines, universities and national and community organizations.

Contact us for additional information on the Clearinghouse. We'd like to hear from you if you have any comments or suggestions for promoting its inclusion as an integral component of the Infrastructure Bill. Thank you!

Dr. Diana Fishbein, Co-Director of the National Prevention Science Coalition to Improve Lives, [redacted] and Dr. Neil Wollman, Senior Fellow at Bentley University and former Co-Director of the National Prevention Science Coalition to Improve Lives, [redacted]

An Automated Clearinghouse to Improve Usability and Reach of Evidence-Based Strategies

The Evidence-Based Policy Act (EBPA) reinforces the need to infuse scientific evidence into the decisions of policy-makers and the utility of that information for communities. The Act will lead to the formulation of a protocol to effectively design policies that improve our lives while not wasting taxpayer money on unproven strategies.

The National Prevention Science Coalition to Improve Lives (NPSC) proposes the construction of an automated Clearinghouse that will broadly address the objectives of the Act by providing infrastructure for rigorously evaluated programs and policies shown to reduce problems (e.g., mental health disorders, adverse childhood experiences, delinquency, interpersonal violence, addiction) and promote positive outcomes in our communities. Until now, many strategies we invest in either have not been evaluated or have not produced sufficient effect sizes to justify their implementation or continuation. The proposed Clearinghouse will meet the needs of policymakers and agencies responsible for executing the mandate of the EBPA by organizing the large reserve of data on evidence-based programs and policies (EBPPs) within a platform amenable to uptake by a range of end-users (e.g., community stakeholders, practitioners, policymakers, governmental agencies, etc.).

There are several sources of existing data available to populate a Clearinghouse of this sort, with a clear path to selection, implementation, evaluation, and sustainment of EBPPs. Registries have been developed to provide end-users with detailed information on hundreds of EBPPs that have been evaluated and found to have evidence (rated on their level of effectiveness) to support their implementation. Additionally, a wealth of data has been collected by the federal government and other agencies and organizations reflective of a broad range of phenomena, from physical health to child maltreatment and criminal justice. These data can be used to determine whether existing strategies have exerted a beneficial effect in the localities where they have been implemented. This information can also help to identify the location and source of problems in our communities that require further investment.

Current data reserves, however, do not tend to be structured in a way that is accessible and usable for most end-users (see the Bridgespan Report for a detailed evaluation). An NPSC affiliate (RPC) conducted a survey of federal legislative offices and found that 52% do not use existing registries and 23% do so "rarely" because they are not aware of them. A user-friendly platform and a dissemination plan are needed to increase the uptake of these data. We recommend a means to facilitate the process of organizing the data for greater accessibility and instructiveness, thus improving policy decisions and investments. Our proposal is highly compatible with the mandate of the EBPA by incorporating federal agency and other data, as well as methodological components that will be readily accessible and understandable to those who stand to benefit. Ongoing conversations

lead us to believe there will be widespread support from Congress, the White House, OMB and federal agencies. And a growing number of national and local organizations have expressed an interest in evidence-based policy-making.

Preliminary Description of Automated Clearinghouse

We propose the development of a system—the "National Automated Clearinghouse for Evidence-Based Programs and Policies" (NACEPP)—that will provide comprehensive information on a range of evidence-based strategies for end-users; e.g., researchers (who populate the database), policy-makers (who need to know what to legislate and fund), and community organizations, practitioners and government agencies (that need to identify best practices). The data populating this clearinghouse will provide parameters needed to readily map available EBPPs to existing needs, whether that be to select the most effective violence prevention practices for any given community or to enact policies with greatest potential to reduce poverty. Also needed is the flexibility to include innovative, promising or budding programs that have yet to be subjected to rigorous evaluation but are in the database denoted by their stage of development and need for further study (as per the mandate of the EBPA).

Parameters will be intuitively searchable and fields will be delineated by relevant characteristics; e.g., outcome of interest (e.g., diabetes, addiction, academic failure); setting (e.g., school, family, community, national); target population (e.g., special needs children, parents, community stakeholders, minorities); intervention selection and detailed implementation protocols and frameworks (costs, timeline expectations to achieve impact, strategies to shift resources from existing to promising or evidence-supported approaches); pertinent literature and resources on assessing and utilizing research; cost-benefit analyses; and other information deemed helpful. The goal is to provide a comprehensive, one-stop resource that is more user-friendly and searchable on dimensions that are not currently available and/or comprehensible to the user, providing an efficient and valid method to guide policy-makers, community stakeholders, practitioners and others who stand to benefit from the resource.

The primary advantage of this Clearinghouse over others is that it would be both iterative and interactive and, thus, of greater utility to end-users. At all stages of navigation, weblinks would lead the user to external reference materials and databases and, when needed, will refer to experts or other users with relevant experience. For example, a user may require additional information on how to most effectively and cost-efficiently implement a particular program in their community, requiring more in depth guidance and delineation of the pitfalls or barriers, along with recommended solutions. In effect, the search engine would provide for the type of interaction via an artificial intelligence software that might occur in a conversation, where one statement or query leads to a more personalized, informative and instructive response. And with permission of experts, contact information could be provided to more intensively address concerns raised by users.

The need for implementation support is undoubtedly the most formidable obstacle to adopting EBPPs and proper installation protocols that ensure feasibility, fidelity, acceptability, appropriateness, reach and sustainability in any given community. All the best evidence shows that training, dissemination, and information alone, even with incentives and funding, typically results in 5-15% uptake. To address this pervasive issue, the Clearinghouse will offer a platform for contextual follow-up, implementation support/help, and recommendations for training, coaching and workforce development for end users and/or policymakers seeking to select, adopt/adapt, and inject

chosen EBPPs into policy. These capabilities remain a translational need unmet by other registries. The infrastructures and resources to support development, delivery and accountability aspects of this work are a critical component of this developmental work.

And finally, tor researchers inputting data into the Clearinghouse and/or partnering with end-users, there would be guidance on design, methods, statistical techniques, evaluation protocols, and strategies for translation. The Clearinghouse would also provide a searchable methodology section for researchers to fill in or update database gaps.

Proposed Demonstration

As mentioned, there are several existing registries populated by hundreds of programs, interventions and policies that have been subjected to evaluation (e.g., Blueprints for Healthy Youth Development, Child Trends - What Works, What Works in Social Policy, Results First Clearinghouse Crime Solutions. Unfortunately, in large part, they are not readily usable by most end-users without significant research training, nor are many end-users aware of these registries. The Clearinghouse described herein combines the strengths of these available databases within a user-friendly infrastructure and clearly delineated mechanism for mapping community needs to available evidence-based strategies. Uniform criteria and thresholds for designating programs and policies as evidence-based would be used, not only relative to the statistical findings from RCTs and other ratified research designs, but also the population significance of those results (e.g., how broadly are effects achieved?).[1]

As a first step toward these goals, the framework and platform would be constructed by engineers and programmers for housing well-tested interventions and applying rigorous scientific standards for certification. Working from existing registries will substantially reduce costs, expedite the development process, and provide instant recognition and legitimization. The project will enhance and improve upon the features built into existing registries, drawing on the Bridgespan study of the "What Works Marketplace," which provided key recommendations to enhance the demand for and use of evidence by key agency and community decision-makers when reviewing and selecting programs (Neuhoff, Axworthy, Glazer, & Berfond, 2015). The Bridgespan Group conducted interviews on both the supply and demand sides of preventive interventions and identified six gaps impeding the implementation of evidence-based knowledge:

- **Gap 1: Comprehensiveness**. Decision makers want information on a broader range of interventions with varying levels of effectiveness. They also want to know which interventions have not been reviewed or rated.
- **Gap 2: Implementation**. Decision makers want information about interventions beyond evidence of impact—including peer experience implementing the intervention—to help them make informed decisions. Few clearinghouses provide this level of information.
- **Gap 3: Guidance**. Decision makers are looking for guidance and support in selecting and planning to implement the appropriate intervention. Clearinghouses, however, are not set up to provide this, and the intermediaries in this space are still relatively limited.

[1] In cases where there are inconsistencies across registries, a Bayesian Cost-Benefit Model can be applied to resolve the conflict using meta-analysis.

- **Gap 4: Synthesis**. Decision makers are looking for more than just interventions. They also are looking for information on policies and management decisions, as well as synthesized findings and best practices. This information is not available systematically and can be difficult to find, even where it does exist.
- **Gap 5: Usability**. Users do not find clearinghouses easy to use, nor do they understand the differences between them.
- **Gap 6: Awareness**. Decision makers receive information about interventions from purveyors and peers, but they do not receive information about evidence in a systematic or effective manner.

NACEPP would fill each of these gaps by providing:

Gap 1 - Comprehensive information on a broad range of problems and corresponding interventions that policy makers and other constituents require to make informed decisions and implement solid programs that work. Ratings will be included to indicate whether interventions have been evaluated or not, and which have been shown to be either ineffective, "promising" or effective.

Gap 2 – Clear guidelines on the process of implementation, from general guidance on best practices, pitfalls and barriers, solutions and problem-solving, and researcher-community-government collaborations, to specific guidance for each EBPP.

Gap 3 – Step-by-step processes for identifying and selecting EBPPs that are most appropriate for any given purpose (e.g., tailored for specific community characteristics or decisions regarding state-level funding).

Gap 4 – Information on the need for particular policies and management systems to be in place for EBPPs to exert the greatest benefits, as well as a synthesis of the research in nontechnical terms and descriptions of best practices known to effectively target problems at hand.

Gap 5 - Understandable, concise, and unbiased information on EBPPs available in existing registries and databases that applies uniform "standards of evidence" criteria agreed upon in the field, thus avoiding the need for explanations of how they differ.

Gap 6 – An outreach campaign that will ensure all relevant constituents are aware of the NACEPP and its value-added to their individual mandates (see below).

Additional attributes include the following:

- In addition to covering a wide range of health outcomes, the platform for NACEPP could be readily expanded to include additional domains and outcomes such as environmental concerns, national security, the economy and most operations of government where evidence is available.
- Critical to its functionality and relevance to policy concerns is that legislative offices, administrative agencies and other users will have input into what policy areas to cover.
- Within the system, links will be provided to: (a) policy papers and briefs relevant to the topic, (b) organizations that are working on or interested in policies relevant to the topic and (c) legislative and agency offices with relevant policy objectives.
- When searching on a particular issue, once programs are recommended, a text box will automatically appear for additional information about relevant policy aspects for that program and issue (like addiction or specific juvenile justice concerns).
- And critical to this effort, to ensure its usability and utility, input will be sought from all potential end-users working in concert with experts on an ongoing basis.

These objectives for a clearinghouse can be accomplished with sufficient funding and commitment, as well as by calling upon the expertise of evidence-based policy-making organizations, academics,

researchers, current registry experts, federal government database keepers, implementation scientists, methodologists, computer scientists, and statisticians.

Once operational, a protocol will be established to ensure wide-scale awareness of the resultant clearinghouse, familiarizing potential end-users (e.g., policy-makers, agencies, community stakeholders, practitioners, foundations, think tanks, etc.) with its utility, in effect, advancing the uptake of EBPPs. It will also be important to end-users to provide information that is locally relevant (e.g., responsive to health surveillance data). A rigorous and well-tested marketing methodology for this protocol will determine resonance of messaging frameworks with different audiences for further refinement and targeting, and construction of an effective delivery vehicle. The NPSC has an extensive network of thousands of constituents (organizational and individual), as well as government administrators and policy-makers. Channels of communication will include the news media, social media, issue and policy briefs, one-on-one meetings with, for example, policy-makers or agency administrators, and workshops/seminars.

Policy Benefits

This undertaking will significantly benefit evidence-based policymaking by enabling our nation to more effectively deal with pressing policy questions, such as: (1) how to best educate and re-skill our young people to ensure successful futures; (2) what are best practices to prevent violence in society, (3) how do we promote population-level mental and physical health, and (4) what strategies hold the most promise of uplifting the most vulnerable and deprived in our nation. Answers to these questions will be facilitated by using an automated clearinghouse that builds on past efforts, is comprehensive, can be easily navigated, and is responsive to specific user needs.

The automated clearinghouse we propose would be designed to provide various constituencies with the means to more expeditiously and effectively make decisions that will benefit their work, outcomes of policies formulated, operations of government, and ultimately society as a whole. For example:

1. *Researchers* can readily access the available evidence, identify the gaps requiring further research and continuously add to the database of effective interventions and policy options.
2. *Policymakers* at all levels of government can more readily determine what are the best and most effective programs and policies to legislate and fund, calling upon relevant existing federal databases to aid in decision-making.
3. *Agencies* at all levels of government and community organizations can put into practice the most effective and cost saving programs and policies available, utilizing relevant databases that are incorporated into the clearinghouse.

After initial outlays, money saved by implementing best practices and policies shown to be impactful in reducing and preventing future problems can be used to support additional research needed to establish effects, track outcomes, support the clearinghouse and fund new legislation. Ultimately, such savings have potential to eventually make for a stronger economy and more effective government operations.

Summary

The following prescriptions, suggested by the Office of Management and Budget, are specifically well aligned with our above proposal:

- The creation of private-public partnerships that capitalize on the innovations in research and practice generated by national foundations (e.g., William T. Grant, Laura and John Arnold, Annie E. Casey, Robert Wood Johnson) and a social impact bonds approach that builds resources from both sectors, eventually leading to benefits that exceed the costs. Such collaborations will bring together experts in disciplines ranging from economics, computer science, design thinking and many others to employ a creative, data-driven, interdisciplinary approach to realizing new possibilities in how citizens and government can interact.
- More emphasis on applied research that improves citizen services and stewardship of public resources.
- Engaging academics, non-profits, private industry, data science and user-centered design applications that can feed this dynamic clearinghouse.
- Serving Americans in the Digital Age to maximize the benefits of having information at our fingertips.
- Rethinking delivery of citizen services and data, including IT investment and innovative and more utilitarian applications of data systems.
- Translating and increasing relevance of this clearinghouse from federal government usages to state and local applications.
- Possibly through federal government or foundation seed funding, identifying other sources of funding from the private sector have potential to increase investments and, again, support sustainable innovations.
- Test and learn how to apply innovative approaches to meeting the mission, service, and stewardship needs of the 21st century.

The clearinghouse will facilitate the achievement of these objectives and, in the process, address citizen needs through services and public resources that can be more effectively targeted, implemented and monitored.

This proposal is reflective of what policy-makers, practitioners, stakeholders and others need to make informed, adequately justified, and effective decisions when identifying EBPPs that will serve communities and the nation. We have outlined a general roadmap for the creation of a clearinghouse with details to be fleshed out after thorough discussion and consultation. Our hope is that the agencies authorized to execute the various mandates of the EBPA will include such a plan that will bring to fruition their charge to design a data infrastructure and incorporate results from existing and newly conducted studies. There is potential to greatly improve the operations of government, the services provided to citizens, and their financial impact.

Diana H. Fishbein PhD is Co-Director of the National Prevention Science Coalition to Improve Lives *and Professor of Human Development and Family Studies at The Pennsylvania State University in State College, PA.*
[redacted]

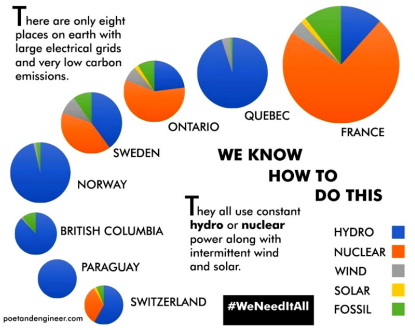
Neil Wollman PhD is Senior Fellow at Bentley Service-Learning Center, Bentley University in Waltham, Mass and former Co-Director of the National Prevention Science Coalition to Improve Lives. [redacted]

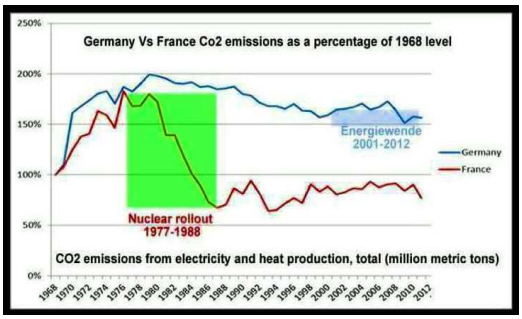
12 August 2021

Dear Mr. President, Energy Secretary, Presidential Advisors and members of Congress:

Upon reviewing your bipartisan infrastructure bill we applaud your efforts and we have suggestions on its implementation, the first being to engage far more substantial, prompt support for, and expansion of, nuclear power.

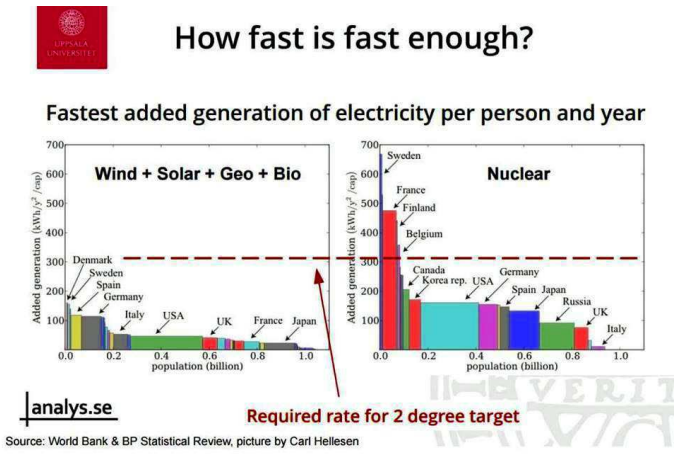
The very recent IPCC report and the UN's environmental warning are no surprise. And, we've known what to do to thwart global warming, ocean acidification, extinctions and so on since 1962, because a President took time to find out even before Ma Nature knocked us off the couch (http://tinyurl.com/6xgpkfa). We were on track to deploy 1GWe (~1 million homes) of clean electricity each week by 1980. Other countries and provinces have even shown us the way since…





Some, like Germany (above right) have gone wrong, despite others' clean, reliable power successes. The infrastructure bill's apparent $6B to rescue commercial nuclear plants from the unrealistic position we've saddled them with is not enough – they've no credit for their cleanliness, safety and reliability. Yet, we've allowed combustion/wind/solar generators to hide their human and environmental costs in subsidies, allowances, emissions forgiveness, overlooked pollution and poor performance.

The World Bank warns that only nuclear-power can be deployed quickly enough to meet even the modest IPCC target of 2 degrees centigrade rise in global warming…



And, the associated economic/environmental warning is eye-opening – huge amounts of raw materials mining, processing, fabricating of often critical materials to support low-energy density wind/solar are already distorting world markets, hurting emerging economies and threatening human rights. DoE has already documented the huge excess of materials needed by wind/solar power relative to nuclear* -- >10 times more to build wind generation; >16 times more to build solar PV, even apart from the massive space demands of a wind/solar kW.

Add to that the growing dependence on natural gas to back up unreliable ('renewable') energy sources, plus untamed methane leakage from the combustion industry, and we see now that natural gas's leakage alone has added about 160ppm CO_2-equivalent GHG to the present~415ppm of actual atmospheric CO_2. This is obviously unsustainable and warming has already entered a dangerous positive-feedback realm -- natural sinks have been warmed and stimulated by our past emissions to add ever more emissions, even outside our control. To the extent wind/solar are backed up by natural gas, they increase our emissions footprint. Nuclear power avoids that and so deserves greater support.

The infrastructure plan appears to advocate expanding of US wind installations by a large factor. This would be an error. Power systems become less reliable and more expensive to the extent that they expand unreliable generation. For example, the latest NREL (LA100) report for Los Angeles' low-emissions future fails when presented with real California historical data because: **a)** it uses an unrealistic data-modeling procedure (ReEDS); and **b)** the analysis avoids incorporation of adequate clean baseload generation (e.g., hydro/nuclear/geothermal): https://tinyurl.com/b35f33uk

Solar PV degradation due sunlight's ultraviolet energy and wearout of wind-generator components already have created poorly-addressed materials-recycling burdens. And pollution due to materials extraction and processing for wind/solar fabrication are significant.** A fundamental reality is that wind/solar installations have relatively short lifespans and severe vulnerabilities to weather, as illustrated by Puerto Rico's and other locales' loss of electric generation in wind/rain/hail/ice/snow…
https://tinyurl.com/y83g6htx

Texas' experience this past February illustrates why generation reliability in the face of serious events is so important – lives were lost. While wind/solar output was lacking, and gas systems suffered from inadequate planning, Texas' nuclear sites continued operating, as has been the case in hurricanes, polar vortexes, etc. around the US. A nuclear plant can even run beyond its fueling schedule, again saving lives...

9 Sep. 2015, "*Planned Maintenance at Diablo Canyon Unit 2 Delayed to Meet State Energy Needs During Heat Wave* CAISO *Requests Both Units Operate at Full Power".*
http://tinyurl.com/zha8dba

Expansions of wind/solar systems will not improve US power reliability, cost, emissions, or materials consumption, pollution and recycling efforts. It will, however, damage the environment. For instance, relaxation of the migratory-bird protections from wind-power

deployments was a mistake in the Obama administration. It and other wind/solar concessions should be reversed before any wind/solar additions are considered.

If we are to preserve economic and national security, as President Kennedy was so concerned with in 1962, and if we are to make effective inroads on environmental threats today, then, as much of the world already knows from direct experience, nuclear power protection and expansion are essential.

We must not only increase R&D on new designs, but treat existing plants as we do other clean electricity sources – if intermittent sources receive subsidies, then so should reliable nuclear, and so on. A simple suggestion appears here: https://tinyurl.com/2pbr8zje

In addition, the US already has large nuclear plants capable of large emissions reductions and power-system reliability gains just sitting idle or in need of repair or completion. Examples are: San Onofre, Bellefonte, VC Summer, Indian Point, Pilgrim, Seabrook, Oyster Point, Kewaunee, VT Yankee and others threatened with closure for various counter-factual reasons. Each site may also be rejuvenated with new designs, such as SMRs… All offer increased power reliability, reduced emissions, high-quality jobs and revenue delivered to their jurisdictions. Just restoring such plants is equivalent to building over 10,000, 5MW wind generators, plus batteries costing over 10 times more to make up for US wind output that's available irregularly under ½ the time. No wind/solar/battery deployments can compete, honestly, economically, socially or environmentally, with nuclear power. Our world competitors know this too.

Our national policy today can indeed make wise choices for our descendants.

Sincerely,

Corey Barcus, 98365
Dr. Stephen Boyd, 11030
@ Dr. Alexander Cannara, 94025
Dr. George Erickson, 55734
Dr. Michael Carey, 94025
Dr. Philip Carlson, 22406
Rodney Coenen, 54915
Thomas Golodik, 07624
Dr. Mary Holzer, 94303
Joseph & Mary Ivora, 93455
James Kennedy, 63141
John Kutsch, 60033
Dr. Ripudaman Malhotra, 97034
Dr. Timothy Maloney, 48144
Dr. Ralph Moir, 94550
Dr. Gene Nelson, 93420
Dr. Michael Pelizzari, 95035
Keith Rodan, 10036
Dr. Leonard Rodberg, 10024
Stan Scott, 94025
Dr. Darryl Siemer, 50317
Robert Springer, 94590
Rudy Stefenel, 95035
Stephen Stearns, 94040
Dr. Richard Steeves, 53719
Gene Summerville, 94070
Ray Sundby, 95035
Matthew Wilkinson, 94559

@ Correspondence contact, [redacted]

Useful links…

Preserving existing nuclear power: https://tinyurl.com/2pbr8zje
Letter to Green New Deal sponsors: http://tinyurl.com/y65belox
A Canadian perspective (25 min in): https://www.youtube.com/watch?v=cu1GIxigNyc
A scientific 'renewables' perspective: https://tinyurl.com/yxw8fqez
...and: https://youtu.be/0NUe-pUVEm8
Oceanic threats: https://tinyurl.com/yafgmlmd
Nuclear safety: https://tinyurl.com/yy2puqbz
Nuclear waste: https://tinyurl.com/3vgfsx9e
Tutorial for MD Clean Energy, etc.: www.humanists.org/blog/2020-11-22
Analysis and critique of NREL's faulty "LA100" report alleging "100% renewable" power for Los Angeles by 2050: https://tinyurl.com/3s9wya7z
…and: https://tinyurl.com/b35f33uk

*** DoE Quadrennial Review** – materials consumed per TWatt Capacity…

Materials: Fig. 10.4, DoE 2015 Quadrennial Review: **https://tinyurl.com/y8xecbz2**

Table 10.4 Range of materials requirements (fuel excluded) for various electricity generation technolo **Tons/TW Capacity**

CF= .91 CF = .31 & .22

Materials (ton/TWh)	Generator only				Upstream energy collection plus generator			
	Coal	NGCC	Nuclear PWR	Biomass	Hydro	Wind	Solar PV (silicon)	Geothermal HT binary
Aluminum	3	1	0	6	0	35	680	100
Cement	0	0	0	0	0	0	3,700	750
Concrete	870	400	760	760	14,000	8,000	350	1,100
Copper	1	0	3	0	1	23	850	2
Glass	0	0	0	0	0	92	2,700	0
Iron	1	1	5	4	0	120	0	9
Lead	0	0	2	0	0	0	0	0
Plastic	0	0	0	0	0	190	210	0
Silicon	0	0	0	0	0	0	57	0
Steel	310	170	160	310	67	1,800	7,900	3,300

Key: NGCC = natural gas combined cycle; PWR = pressurized water reactor; PV = photovoltaic; HT = high temperature

930 10,260 16,447 **--Totals**

The red totals show nuclear consumes <1/10 the materials demanded by either wind or solar generation – many such materials for wind/solar are 'critical' and market-dominated by foreign sources such as China, with associated human-rights challenges.

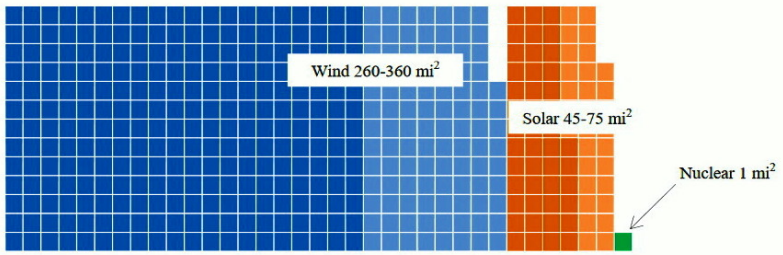
The World Bank estimates that attempting to build out wind/solar around the world as a dominant power source will about triple worldwide mining/refining/fabricating operations, triple materials costs, especially hurting young economies, and increase pollution and other social/environmental threats.

Land/sea consumption is another order of magnitude less for nuclear…

http://tinyurl.com/jcn2pjj

Technology	Capacity Factor, %	Square Miles Needed for 1,000 MW
Wind	32-47	260-360
Solar	17-28	45-75
Nuclear	90	1.3

The table summarizes the approximate land required by wind and solar technologies to match the electricity produced annually by a 1,000-MW nuclear power plant.



https://www.TinyURL.com/WindOrNuc

**** Solar/Wind/Battery Materials…**

https://tinyurl.com/n3frxms
https://tinyurl.com/ybwpgzvu
https://tinyurl.com/z97vxqc
https://tinyurl.com/y9p45ujn
http://tinyurl.com/ycg32mbt
https://tinyurl.com/j38as7g
https://tinyurl.com/yb2ewy74
https://tinyurl.com/y7byyqmt
https://tinyurl.com/ydggt3rp
https://tinyurl.com/y6pv8egy

Combustion Industry 'Renewables' Subsidy & Backup Exploitation…

BP, Chevron, etc. exploit subsidized wind/solar investment to secure income now and future combustion-product sales...

Gas, Wind & Solar

Share of fuel 1990-2030
(% shares of world energy use)

	1990	2030
Renewables*	0.4	6.3
Nuclear	5.6	6.0
Hydroelectric	6.0	6.8
Coal	27.3	27.7
Natural gas	21.8	25.9
Oil	38.9	27.2

*Renewable energy includes biofuels

bp

Wind turbines are flying high. But how do you keep the lights on when the wind stops blowing? At BP, we see a simple answer: We see cleaner-burning natural gas. It's a perfect partner to renewables.

From: 10043.org <[redacted]>
To: MBX OSTP PCAST <MBX.OSTP.PCAST@ostp.eop.gov>
Sent: Wednesday, 9/15/2021 10:10AM
Subject: Joint Letter on Revocation of P.P.10043 from Chinese student

Dear President, Director, and PCAST:

We are writing on behalf of over 1000 Chinese international students whose academic careers are being destroyed by Trump's Presidential Proclamation 10043 (P.P. 10043). We come from 50 US universities; the full list is showed at the end of this email.

P.P. 10043, "Suspension of Entry as Nonimmigrants of Certain Students and Researchers From the People's Republic of China," ostensibly aims to target Chinese students and scholars who are associate with the PRC's "military-civil fusion strategy (MCF)". However, the proclamation was written and applied in an extremely vague way and broad fashion. The proclamation is being used to deny and revoke the legitimate student visas of thousands of Chinese students pursuing higher education in the US:

1. revoke visas of current students who have been studying in the US for years.

2. students are getting blanket visa rejections regardless of their lack of meaningful connection to the Chinese military, what they studied previously, or what they intend to study in the US.

At its core, the proclamation denies a visa to someone who studied at a particular university whether or not any negative information exists on the individual.

The broad application of Presidential Proclamation 10043 so far seen in practice has been effectively labelling all Chinese international students from some of China's top tier technical schools as "spies." So far, this has been causing huge delays, if not outright ending, students' previously promising academic careers and contributions to humankind. Students being impacted by the proclamation are unable to go back to school for the upcoming academic year, a devastating realization for many of us who have worked so hard and sacrificed so much for this opportunity.

P.P. 10043 has created a new racist, discriminatory, and politically motivated restriction on who can become a part of the US higher education system and has made thousands of students suffer as political pawns. P.P. 10043 has even damaged the cooperative spirit of the international scientific community and promoted an atmosphere of distrust in US universities, where now close colleagues are treated with undue suspicion. The affected proportion among STEM students is 16-27% according to February 2021 CSET Issue Brief. Furthermore, students funded by the China Scholarship Council (CSC) are also affected by this EO. The estimated 26,000 scholars funded by CSC during the 2017–18 academic year (source: CSET), with the 1,000+ students whose visas were revoked in 2020, and the 3,000-5,000 students who are directly targeted by this EO yearly (source: CSET), amount to over 30,000 scholars unable to obtain or renew their visas due to P.P. 10043. In fact, 30,000 is a number that would surely be expanded if this EO is not revoked or (at least) revisited.

We, as many rejected Chinese international students and scholars are just as qualified, intelligent, and hard-working as any other applicants admitted into higher education programs in the US. The majority

of us major in STEM, with the earnest wish to join the world's most prestigious academic community, to fulfil our dreams.

We hope OSTP and PCAST to stand with us against this unjust proclamation and urge the Biden administration to end the P.P10043 proclamation as soon as possible. More and more US universities and higher education organizations are also voicing their objection against the restrictions. We must see the reversal of this policy if we hope to maintain a robust global academic community that can promote collaboration across borders and protect the opportunity of all people to participate in this community.

Thank you very much for your time and attention. We look forward to your reply.

Sincerely,

Sicheng Chen from University of Minnesota, Twin Cities

and

Minxin Guo on behalf of 8 students from Boston University
Xida A on behalf of 70 students from Carnegie Mellon University
Zixuan Zhang on behalf of 55 students from Columbia University in the City of New York
Jixing Liu on behalf of 17 students from Cornell University
Xiaotong Li from Case Western Reserve University
Xiangyu Duan on behalf of 4 students from Dartmouth College
Yuezhang Chen on behalf of 21 students from Duke University
Xiaoyu Sui on behalf of 4 students from the Georgia Institute of Technology
Minyue Liu from Georgia State University
Guangya Zhu on behalf of 2 students from Harvard University
Kai Fu from The Indiana University Bloomington
Ziyin Liu on behalf of 18 students from Johns Hopkins University
Ximeng Lin from Kansas State University
Fan Liu on behalf of 6 students from the Massachusetts Institute of Technology
Ella Xu on behalf of 5 students from North Carolina State University
Han on behalf of 3 students from the University of Notre Dame
Zeyu Liao on behalf of 36 students from Northeastern University
Yutong Sheng on behalf of 12 students from Northwestern University
Manjun Wen on behalf of 34 students from New York University
Haohe Liu on behalf of 3 students from Ohio State University
Yihang Yin on behalf of 7 students from The Pennsylvania State University
Banghua Zhao on behalf of 4 students from Purdue University
Xingjian He on behalf of 3 students from Rice University
Zhaoyi Wan on behalf 3 students from the University of Rochester
Xijia Feng on behalf of 5 students from Rutgers, The State University of New Jersey
Xin Zhang on behalf of 6 students from Stony Brook University

Fangzhou Xiong on behalf of 5 students from Stevens Institute of Technology
Aoyu Gong on behalf of 11 students from Stanford University
Fengshuo Lang on behalf of 11 students from Tufts University
Ziyi Zhou on behalf of 22 students from the University of California, Berkeley
Zhifei Yang on behalf of 4 students from The University of Chicago
Ling Li on behalf of 12 students from the University of California, Los Angeles
Qi Ge on behalf of 18 students from the University of California, San Diego
Guanhua Zhang on behalf of 1 student from the University of California, Santa Barbara
Siyue Zhang on behalf of 8 students from the University of Florida
Dayou Zhang from the University of Georgia
Ruiyu Shan on behalf of 22 students from the University of Illinois at Urbana-Champaign
Hao Cheng on behalf of 5 students from the University of Maryland
Ge Zhang on behalf of 27 students from the University of Michigan
Zhijie Xu on behalf of 21 students from the University of Pennsylvania
Nisha Qiao on behalf of 11 students from the University of Pittsburgh
Mofan Deng on behalf of 39 students from the University of Southern California
Zhiqiang Zang on behalf of 33 students from The University of Texas at Austin
Yani Ping on behalf of 6 students from the University of Virginia
Yingke Ding on behalf of 4 students from the University of Washington
Ziqi Zhang on behalf of 4 students from Vanderbilt University
Junyu Zhao on behalf of 2 students from the University of Wisconsin-Madison
Xinyu Qian on behalf of 3 students from the College of William and Mary
Ruijie Shi on behalf of 18 students from Washington University in St. Louis
Yuchen Yang on behalf 3 of students from Yale University
Feng Hu from Texas Tech University (TTU) - National Wind Institute (NWI)
Shimeng Yu from the University of Texas at Dallas
Meng Fang from University of North Carolina, Chapel Hill
Tong Ren from the University of Illinois at Chicago
Liu Antai from the University of California Santa Cruz
Biwei Li from Colorado school of mines
Zixuan Jiang from California College of the Arts
ZhangHongrui on behalf of 2 students from Rensselaer Polytechnic Institute

From: Buchanan, Michelle (EXT) <[redacted]>
To: MBX OSTP PCAST MBX.OSTP.PCAST@ostp.eop.gov
CC: Kung, Harriet [redacted]; Streiffer, Stephen [redacted] Walck, Marianne Carol [redacted]
Sent: Wednesday, 9/29/2021 4:16 PM
Subject: Public Comment re: DOE National Virtual Biotechnology Laboratory

As part of the President's Council of Advisors on Science and Technology (PCAST) open meeting held on September 28 and 29, there was a public session moderated by PCAST co-chair Dr. Frances Arnold on "The State of US Preparedness and Public Health as Revealed by the Pandemic." Relevant to this session, I would like to bring to the attention of the PCAST members a recent effort conducted by the National Virtual Biotechnology Laboratory (NVBL). Funded by the 2020 CARES Act, the NVBL was established by the Department of Energy (DOE) Office of Science in March 2020 to rapidly address key challenges associated with the COVID-19 crisis. Through the NVBL, DOE combined the collective power of thousands of expert scientists and engineers and its world-leading facilities, including the world's most powerful computers, light and neutron sources, and nanoscience and genomics centers, into a key asset for the Nation in the fight against COVID-19.

The NVBL focused on research in five topic areas: manufacturing to address supply chain shortages; developing novel COVID-19 testing; modeling disease epidemiology; understanding viral transport in the environment; and supporting the design of medical therapeutics. In just a few months, NVBL developed new manufacturing approaches to address shortages in N95 masks, test kit supplies, and ventilators, creating over 1000 new jobs; supported development of all three vaccines currently used in the U.S. with structural studies at DOE light sources; provided projections of disease spread under various scenarios to local and state decision makers; identified potential antiviral drug candidates using DOE's high-performance computers and light and neutron sources; and defined the spread of the virus in buildings to develop mitigation strategies. NVBL efforts have also supported efforts of other Federal agencies, such as CDC (epidemiology), FDA (testing), and DHHS (antivirals), as well as various state, regional, and city decision makers.

The DOE national labs have a long history of responding to national emergencies, putting their groundbreaking discoveries and innovations to work to solve the Nation's most challenging problems—that is what national laboratories were designed to do. I invite you to learn more about NVBL in the attached document, as well as view the short video, "Labs in the Fight," on the NVBL website at >https://science.osti.gov/nvbl/Labs-in-the-Fight-Against-COVID<.

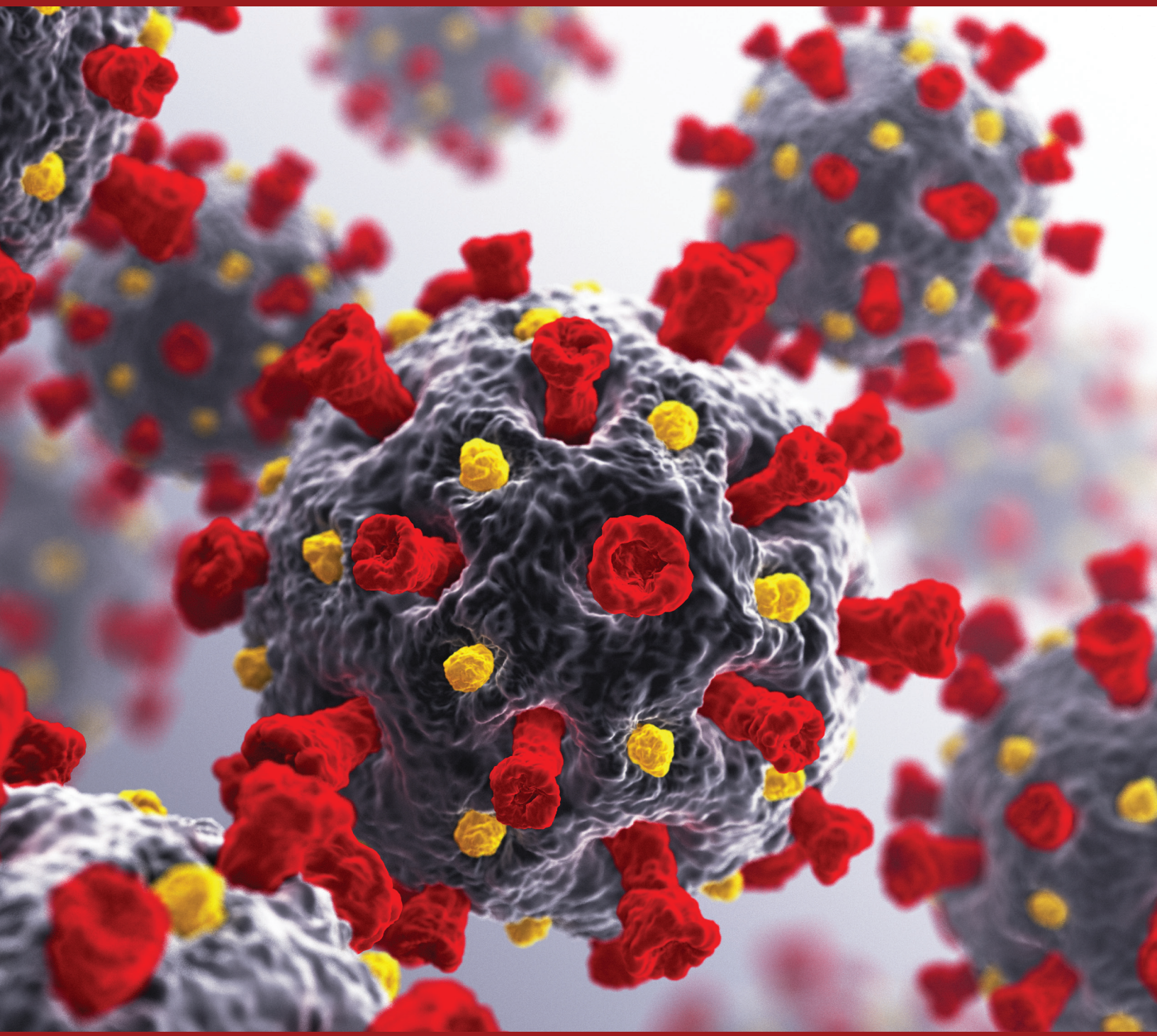
Sincerely,

Dr. Michelle V. Buchanan
Senior Technical Advisor to the
Deputy Director for Science Programs
Office of Science
Department of Energy

U.S. Department of Energy

National Virtual Biotechnology Laboratory

R&D for Rapid Response to the COVID-19 Crisis



U.S. DEPARTMENT OF ENERGY | Office of Science

January 2021

National Virtual Biotechnology Laboratory

A Game-Changing Framework for Responding to the Nation's Needs

With funding from the CARES Act, the U.S. Department of Energy (DOE) established the National Virtual Biotechnology Laboratory (NVBL) in March 2020 to address key challenges associated with the COVID-19 crisis. The NVBL brought together the broad scientific and technical expertise and resources of DOE's 17 national laboratories to address medical supply shortages, discover potential drugs to fight the virus, develop and verify COVID-19 testing methods, model disease spread and impact across the nation, and understand virus transport in buildings and the environment. National laboratory resources leveraged for this effort include a suite of world-leading user facilities broadly available to the research community, such as light and neutron sources, nanoscale science research centers, sequencing and biocharacterization facilities, and high-performance computing facilities.

Within just a few months, NVBL teams produced innovations in materials and advanced manufacturing that mitigated shortages in test kits and personal protective equipment (PPE), creating nearly 1,000 new jobs. They used DOE's high-performance computers and light and neutron sources to identify promising candidates for antibodies and antivirals that universities and drug companies are now evaluating. NVBL researchers also developed new diagnostic targets and sample collection approaches and supported U.S. Food and Drug Administration (FDA), Centers for Disease Control and Prevention (CDC), and Department of Defense (DoD) efforts to establish national guidelines used in administering millions of tests. Researchers used artificial intelligence and high-performance computing to produce near-real-time analysis of data to forecast disease transmission, stress on public health infrastructure, and economic impact, supporting decision-makers at the local, state, and national levels. NVBL teams also studied how to control indoor virus movement to minimize uptake and protect human health.

Through its NVBL framework, DOE has contributed significantly to the nation's COVID response, demonstrating in only a few months the critical impact of the national laboratories. The NVBL serves as an outstanding model for developing and sustaining capabilities to respond to future national needs or emergencies. Examples of NVBL COVID-19 accomplishments are outlined below, and more details are available at science.osti.gov/nvbl.

NVBL Accomplishments

Materials and Manufacturing for Critical Supplies

- Designed a system for mass producing N95 filter media, enabling Cummins Filtration (Nashville, Tenn.) to produce material for more than 3 million masks per day, and worked with DemeTech (Miami Lakes, Fla.) to convert the N95 material to masks and respirators, creating over 1,000 new manufacturing jobs.
- Worked with the U.S. Department of Health and Human Services and Coca-Cola (Atlanta, Ga.), which produces 2 billion bottle preforms per week, to evaluate the use of these preforms to alleviate shortages of test tubes used to collect nasal swab samples.

Materials and Manufacturing for Critical Supplies. NVBL teams developed a mechanism to 3D print the tooling needed to mass produce sample collection tubes for COVID-19 test kits. [Courtesy Thermo Fisher Scientific Inc.]

- Developed an approach to 3D print the tooling needed to produce over 8 million sample collection tubes weekly by Thermo Fisher Scientific, Inc. (Lenexa, Kan.), creating more than 300 jobs.
- Developed a new low-cost ventilator with BioMedInnovations (Denver, N.C.) that received FDA Emergency Use Authorization approval.

Molecular Design for Medical Therapeutics

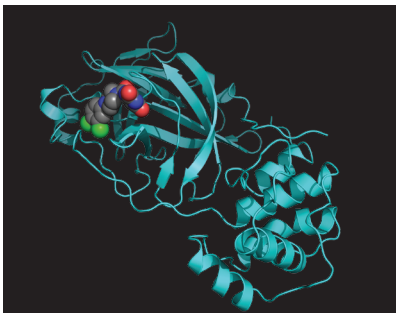
- Used artificial intelligence methods to computationally screen 10^{40} possible antibody variations, identifying the best hits that could be used as an antiviral against the Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) spike protein.
- Computationally screened tens of millions of small molecules against SARS-CoV-2 viral proteins and then experimentally evaluated top hits, greatly accelerating the search for antiviral therapeutics.

Development and Evaluation of COVID-19 Testing

- Collaborated with DoD, CDC, and FDA to provide experimental data in support of national testing guidelines, assessing potential contamination in commercial kits, evaluating sample pooling approaches, examining viral transport media and protocols, and evaluating virus inactivation and extraction methods to assure test efficacy and protect frontline health care workers.
- Developed analysis tools to assess global evolution of the SARS-CoV-2 RNA genome, as it relates to nucleic acid–based assays.
- Identified distinguishing signatures in the SARS-CoV-2 RNA genome that can be used to rapidly detect this pathogen and other co-infecting pathogens in multiplexed assays.
- Developed a small nucleic acid test instrument to rapidly detect SARS-CoV-2 with high sensitivity.

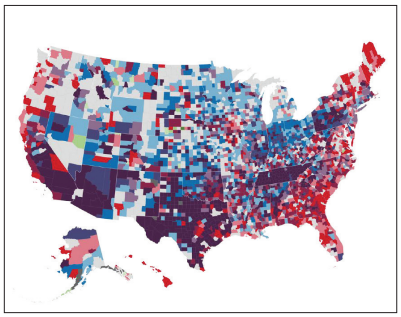
Epidemiological Modeling

- Created an approach to forecast COVID-19 case counts at state, county, and metropolis scales using data-driven statistical models, enabling short-term planning of contact tracing, staffing, and testing capacity needs.
- Created the ability to perform longer-term, scenario-based analysis and mitigation planning to support decision-makers with information on effects of interventions before they are implemented.



Molecular Design for Medical Therapeutics. Scientists used computational modeling and simulation approaches as well as molecular dynamics to design and optimize small molecules that are experimentally confirmed to inhibit viral proteins, such as the 3CLpro cysteine protease shown here. [Courtesy Oak Ridge National Laboratory]

Development and Evaluation of COVID-19 Testing. NVBL researchers provided experimental data that helped inform national guidelines used in millions of tests. [Courtesy Los Alamos National Laboratory]

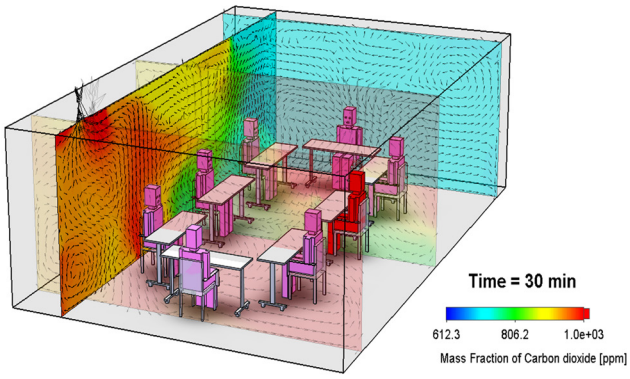


Epidemiological Modeling. Data scientists developed tools to forecast and visualize in near-real time COVID-19 transmission rates and dynamics at the county level. [Courtesy Oak Ridge National Laboratory]

- Produced a platform with comprehensive data access and visualization capabilities to process near-real-time, multi-modal, and multi-source data to support informed decision-making and monitor potential recovery efforts.
- Collected and curated disease data, creating a unique national data resource to support epidemiological and pandemic modeling, including assessment of the impact of human dynamics on infection spread and location and the availability of critical infrastructure.
- Developed an approach to assess mobility behavior changes in response to COVID-19 using cellular phone- and vehicle-derived data to reveal travel patterns for commercial activity by type and across industries, including bars and restaurants, as well as passenger, fleet, and heavy-duty vehicles.
- Established a novel epidemiological modeling approach to quantify contact tracing, testing, and vaccination strategies in resource-constrained environments and to help identify optimal vaccination strategies for states and large metropolitan areas.

Viral Fate and Transport

- Provided critical information about how behavioral, environmental, and operational conditions affect the risk of airborne virus transmission indoors, such as in classrooms, offices, and conference rooms, to mitigate viral spread in enclosed spaces.
- Designed new antiviral materials that can adsorb SARS-CoV-2 virus and deactivate the pathogen.
- Produced and validated models for SARS-CoV-2 fate and transport in wastewater and groundwater arising from seepage of sewer water or septic tanks into groundwater and the associated transport through the subsurface and potential exposure routes and risks to the population.



Viral Fate and Transport. NVBL researchers used computational fluid dynamics simulations to examine airborne transport of the virus indoors. Shown here is a simulation of the airflow and distribution of expelled respiratory aerosols within a classroom or office configuration. [Courtesy Sandia National Laboratories]

Summary

DOE's NVBL has proven to be an exceptionally effective contributor to the nation's COVID response, quickly marshaling unique national laboratory expertise and capabilities to meet the most critical needs. For example, the NVBL supported manufacturers to address key shortages in medical supply chains, creating nearly 1,000 new medical manufacturing jobs. Working closely with other federal agencies and state and regional decision-makers, the NVBL provided solutions across a range of COVID challenges. These accomplishments demonstrate the game-changing resource represented by DOE's 17 national laboratories working together within the integrated NVBL framework. Going forward, the NVBL can bring these resources to bear on future national and international needs and emergencies.

From: Andrea Harless <[redacted]>
To: MBX OSTP PCAST <MBX.OSTP.PCAST@ostp.eop.gov>
Sent: Wednesday, 10/6/2021 1:20PM
Subject: Vaccine Meeting 10/28/21

Hi!
Hope you are doing well. I wanted to send you an invitation to save the date and RSVP for an upcoming briefing on vaccines. We have a panel of very impressive individuals who will be discussing vaccines from all angles: science, policy, and public health and how they meet to take our current pandemic to an endemic and also how we can use this for pandemic preparedness. Please let me know if you have any questions! Thanks!

From Pandemic to Endemic:

How Vaccines are the Nexus for Science, Policy and Public Health in Stopping Pandemics

Thursday, October 28, 2021— noon-1PM EST via Zoom

As we near the two-year mark of the COVID-19 pandemic, many are asking "what's next." While more than half of Americans are fully vaccinated, we are still seeing COVID cases rise. Vaccine hesitancy persists and deaths among the unvaccinated are prevalent and critical. We are continuing to learn best practices to navigate this pandemic, but what steps can we really take to turn this into an endemic? Please join our panel of experts to learn how science, policy, and public health working together is key and how we can use these lessons to prepare for future pandemics.

Experts Will Explain:

- What is the history of vaccines and why are they so important to society?
- Why is surveillance critical to proper vaccine development?
- Why is there vaccine hesitancy and how do we overcome this?
- What is the role of public health and policy in combatting current and future pandemics?
- How can we move this pandemic to an endemic and use innovation for pandemic preparedness?

Speakers:

- **Dr. Michelle Williams** – Dean of the Faculty for Harvard T.H. Chan School of Public Health, and Angelopoulos Professor in Public Health and International Development, a joint faculty appointment at the Harvard Chan School and Harvard Kennedy School
- **Dr. Mark Poznansky** – Director and Research Scholar for the Vaccine and Immunotherapy Center at Massachusetts General Hospital, Attending Physician Infectious Diseases Medicine, Massachusetts General Hospital, and Professor Harvard Medical School
- **Dr. Michael Callahan** – President of United Therapeutics, Researcher for the Division of Infectious Disease at Massachusetts General Hospital, Former COVID Advisor for ASPR at HHS, Former Director for DARPA BioDefense Medical Countermeasures, Former Special Advisor for OSTP/NSC under Presidents Obama and Bush, and Clinical Envoy to Nanjing and Wuhan University Hospital

We welcome you to learn from these experts.

From: Ruch, Bill <[redacted]>
To: Bumb, Ambika EOP/OSTP <[redacted]>
Sent: Friday, October 8, 2021 4:15 PM
Subject: Pandemic Historian from the University of Oklahoma

Good afternoon Ambika,

My name is Bill and the firm I work for represents over 40 universities and research institutions. One of which is the University of Oklahoma. When we sent them our notes from the recent PCAST meeting, some folks from the research leadership suggested that we send along the TIME op-ed below from a historian on campus who covers pandemics over the years in which he discusses the White House's pandemic preparedness plan and addresses the continued need for social and behavioral sciences support. The faculty member also wrote a book on the topic that we'd be happy to send to you and/or Dr. Mazza if you'd like additional historical context on the matter.

What Smallpox Teaches Us About Controlling Future Pandemics | Time

Please let us know if you have any questions and have a great weekend!

Best,

Bill

Bill Ruch
Lewis-Burke Associates LLC

IDEAS • COVID-19

Vaccines Can't End Pandemics Alone—And We've Known That Since We Eradicated Smallpox

BY KYLE HARPER

OCTOBER 5, 2021 4:15 PM EDT

Kyle Harper is the G.T. and Libby Blankenship chair in the History of Liberty at the University of Oklahoma and author of Plagues upon the Earth: Disease and the Course of Human History.

President Thomas Jefferson in 1806 wrote a letter to English physician Edward Jenner. Ten years earlier, Jenner had intentionally infected a boy with cowpox, in order to protect him against the much more terrifying smallpox disease. It worked. Jenner gathered more evidence, and two years later he published his Inquiry into the Variolae vaccinae known as the Cow Pox. News traveled across the Atlantic, and Jefferson was among the first Americans to recognize the revolutionary potential of vaccination. He praised Jenner in lavish terms: "Medicine has never before produced any single improvement of such utility." In fact, Jefferson foresaw an end to a disease that was then the most deadly and most feared affliction in much of the world. "Future nations will know by history only that the loathsome small-pox has existed and by you has been extirpated."

Jefferson was visionary—but too optimistic. Mortality from smallpox declined precipitously as vaccination spread, but progress stalled and at times reversed in the late 19th century. Even at the beginning of the 20th century, there were still thousands of cases of smallpox a year in the United States, and not until the late 1920s was the disease completely eradicated from the country. Globally, progress was even more halting. A massive global health crusade in the 1960s and 1970s finally realized Jefferson's

vision of rendering the disease a thing of the past. The last naturally occurring case of smallpox occurred in 1977—171 years after Jefferson's letter to Jenner imagined a world without the disease.

The example of smallpox elimination is one of many that reminds us the control of infectious disease requires both technical and social adaptations. Jenner's discovery of vaccination ranks as one of the greatest scientific achievements of all time. But technical solutions on their own are never enough. In the U.S., the spread of vaccination required an effective communication campaign, cultural acceptance of vaccines and, above all, changes in the nature and power of the state. Namely, the rise of public health boards, and their ability to mandate vaccination, were necessary to bring the disease completely to heel domestically.

The COVID-19 pandemic has been a painful reminder that confronting the challenge of infectious disease requires both science and social adaptation. The development of multiple safe and highly effective vaccines against COVID-19 in under a year is a marvelous accomplishment. And yet the combination of vaccine hesitancy at home, and vaccine inequity abroad, has let the pandemic surge anew and linger, with no end in sight. Before COVID-19, the U.S. was ranked high on pandemic preparedness. And yet our response has been an embarrassment and a tragedy—as well as a detailed map of our weaknesses, which our nation's enemies are sure to be tracking in detail. Our science was ready, but our society was not.

Read more: The History of Vaccines, From Smallpox to COVID-19

As a historian of infectious disease, who expected that we would face a destabilizing pandemic in our lifetime, I do not find this pattern surprising. But it is concerning that we are not absorbing the lesson. Last month, the

Biden Administration released a preview of its future pandemic preparedness plan. The vision is admirably bold. It proposes a $65 billion investment over 10 years that will be managed "with the seriousness of purpose, commitment, and accountability of an Apollo Program." The plan is motivated by the sober reality that another pandemic is inevitable. Indeed, as the plan states, "There will be an increasing frequency of natural—and possibly human-made—biological threats in the years ahead." And, as it notes, the next one might well be worse. COVID-19 is a severe and deadly disease, but there is plenty of opportunity for a new pathogen that is equally contagious yet more virulent.

President Joe Biden's proposed strategy offers much to like. It promises to make major investments in critical areas where we do not do nearly enough, from surveillance and early-warning systems to real-time tracking of viral evolution. It outlines a path towards even more rapid vaccine development and deployment, as well as fundamental improvements in the treatment of viral diseases. It proposes basic improvements in public health infrastructure domestically and globally.

The problem, however, is that nearly all of the agenda focuses on technical solutions. There are only modest hints of an effort to understand how societies respond to the challenge of pandemics and how we can work to make ourselves more resilient. The plan calls for "evidence-based public health communications," which is laudable, but otherwise there is nothing that matches its scientific aspirations with an equally ambitious call to prepare our society to handle the next threat with greater cohesion and strength. So, two cheers for the Apollo-like vision. But pandemic preparedness is a categorically different project than getting to the moon, because success depends on the behavior of more than 300 million Americans and 8 billion people globally.

It is a disheartening fact that the experience of COVID-19 has rendered our society less ready for the future challenges. The tribalization of our response to masking, vaccines and other mitigation measures has been swift and extreme, and this represents a serious obstacle to preparedness. The reality is that public health is always political. But it is not always bitterly partisan, especially in a polarized society. If anything, we have taken a step backward. Compulsory vaccination, for example, allowed us to conquer smallpox and other menacing diseases, and it became part of our constitutional order and social fabric. In 1905, when a man from Massachusetts protested against a vaccine mandate, saying the requirement violated his individual liberty, the Supreme Court ruled 7-2 that mandatory vaccination was within the power of the states. The majority opinion held that "there are manifold restraints to which every person is necessarily subject for the common good…" On any other basis, organized society could not exist with safety to its members." Some of the constitutional particularities have changed, but the fundamental issues have not. We are relitigating our sense of the common good, at a time when divisiveness and mistrust are at high tide.

The sooner we grapple with that reality, the better prepared we will be. Evidence-based public health communication is a start, but it is far from adequate. A fully-fledged plan should establish an R&D agenda that draws from the social sciences and humanities; it should put in place the framework, resources and incentives to drive forward our knowledge of the determinants of successful public health initiatives. There is a huge amount of ongoing research that is trying to help us understand why countries (and even states) have responded to COVID-19 so differently. It is already evident what a complex question this presents, involving both apparently fixable variables like good leadership, but also much deeper, historically-rooted cultural factors. A plan to build resilience will have to

confront the tensions between individualistic values and social cohesion, the decline of public trust in institutions, the poison of polarization, the role of social media in shaping attitudes toward health and medicine, and the structural inequalities that have been so apparent throughout the pandemic. In short, we need a bold, coherent agenda to advance our understanding of the human side of the equation.

The Biden strategy as proposed earns an A on the technical front, but unless its shortcomings are redressed, it will fail on its social-behavioral agenda. We know all too well how that combination has worked – both throughout history and in our present moment.

From: Ryan Colker <[redacted]>
To: MBX OSTP PCAST <MBX.OSTP.PCAST@ostp.eop.gov>
Sent: Tuesday, October 12, 2021 9:51 AM
Subject: International Code Council Comments

The International Code Council is pleased to provide the attached comments in advance of the October PCAST meeting. Please reach out with any questions or if there is anything we can assist with.

Ryan M. Colker, J.D., CAE
Vice President, Innovation
Executive Director, Alliance for National and Community Resilience
International Code Council
[redacted]
>www.resilientalliance.org<

Interested in Community Resilience? Check out *Optimizing Community Infrastructure: Resilience in the Face of Shocks and Stresses*.

Join us November 15-18 for the innovative 4-day online training event, **ICC Learn Live**. Get the latest building safety updates and earn valuable CEUs. Register Today!

October 12, 2021

Dr. Sarah Domnitz
President's Council of Advisors on Science and Technology
Office of Science and Technology Policy
1650 Pennsylvania Avenue
Washington, D.C. 20504

Submitted Electronically

RE: Comments for PCAST October 2021 Meeting

Dear Dr. Domnitz,

As the Administration, federal agencies and PCAST members work to develop coordinated strategies to address climate change, the International Code Council (Code Council) is pleased to share comments on the important role of building codes and how the federal government can support their effective use.

The Code Council is a member-focused association dedicated to helping the building community and the construction industry provide safe, resilient, and sustainable construction through the development and use of model codes (I-Codes) and standards used in the design, construction, and compliance processes. Most U.S. states and communities, federal agencies, and many global markets choose the I-Codes to set the standards for regulating construction, plumbing and sanitation, fire prevention, and energy conservation in the built environment. The I-Codes are "voluntary consensus standards" under Office of Management and Budget (OMB) Circular A-119 and the National Technology Transfer Advancement Act (NTTAA).

The Code Council is committed to providing communities with solutions they need to achieve their energy efficiency, greenhouse gas (GHG) reduction and climate resilience goals. The I-Codes and supporting resources play an essential role in achieving energy efficiency and GHG reduction goals to meet the United States' Nationally Determined Contributions (NDCs) under the Paris Agreement. Earlier this year, the Code Council Board of Directors released a new framework, Leading the Way to Energy Efficiency: A Path Forward on Energy and Sustainability to Confront Climate Change, leveraging the success of the International Energy Conservation Code (IECC) and International Green Construction Code (IgCC), plus additional resources to help all levels of government advance their climate goals. The framework establishes a new scope and intent for future editions of the IECC that commits to continued improvement and the inclusion of zero energy pathways today and by 2030. The revised scope and intent will permit IECC committees to incorporate additional GHG reduction options. Given buildings account for 40 percent of total energy consumption in the United States, the adoption and effective implementation of building energy codes will play a critical role in advancing efforts to combat climate change and adapt to the associated impacts.

Leveraging the IECC

The Code Council participates in ongoing collaboration with the U.S. Department of Energy (DOE) in advancing content in the IECC to achieve policy priorities and in providing support to state and local governments on the IECC's adoption and administration. The IECC has made significant progress in advancing efficiency. DOE's final determination on the 2021 IECC found a 9.4 percent site energy savings improvement and an 8.7 percent reduction in carbon emissions for residential buildings relative to the 2018 version. The 2021 IECC represents a roughly 40 percent improvement in energy efficiency for residential and commercial buildings compared to the 2006 edition. However, according to the Department, 12 states have adopted codes that are nearly 25 percent less efficient than the latest commercial codes, 14 states have adopted codes that are nearly 20 percent less efficient and 17 states codes that are more than 10 percent less efficient than the latest residential codes, while another 10 states have not adopted a statewide energy code.

Recognizing the importance of adopting the 2021 IECC to achieve increased energy efficiency, GHG reductions, and cost savings, the Code Council recently launched the Code on a Mission Challenge, a campaign to have more than one-third of the U.S. population covered by codes that meet or exceed the 2021 IECC by the end of 2023. Current supporters of the effort include the Northeast Energy Efficiency Partnership (NEEP), National Electrical Manufacturers Association (NEMA), Responsible Energy Codes Alliance (RECA), Institute for Market Transformation (IMT), Energy Efficient Codes Coalition (EECC), Architecture 2030, American Council for an Energy Efficient Economy (ACEEE), Polyisocyanurate Insulation Manufacturers Association (PIMA), New Buildings Institute (NBI).and the American Chemistry Council The campaign includes a toolkit to help support adoption, including references to resources developed by DOE and the national labs.

As DOE establishes its building energy code focus for the current Administration, we strongly encourage the Department to prioritize resources and support to (1) encourage the adoption of current energy codes and (2) to ensure those codes are effectively implemented through training and greater code official certification on the energy codes they implement. These investments would provide benefits to significant swaths of the country, therein providing substantial GHG reduction benefits.

Leveraging the IgCC

The IgCC is a collaborative effort of the Code Council, ASHRAE, Illuminating Engineering Society and the U.S. Green Building Council to provide adoptable code language for communities that want to go beyond requirements contained in base codes. It is ideally positioned to serve as a stretch code, building off the existing code infrastructure to deliver increased energy and water savings. The IgCC provides the design and construction industry with the single, most effective way to deliver sustainable, resilient, high-performance buildings. The continued goal of the IgCC is to build and provide criteria for energy efficiency, resource conservation, water safety, land use, site development, indoor environmental quality and building performance that can be adopted broadly.

The Code Council urges adoption and compliance with the IgCC to support further climate mitigation and adaptation throughout the built environment. Federally developed and supported technical analysis, compliance support tools, technical support and training resources on the IgCC would help accelerate communities' efforts to becoming more energy efficient, meeting GHG emission reduction targets and enhancing climate mitigation and resilience.

Additional GHG Reduction Resources

In addition to updating the IECC development process, the Code Council's new framework identifies the need for common approaches to energy-related policies that are coordinated with energy codes. This

past month, the Code Council released their first educational resource on electric vehicle (EV) charging infrastructure and building codes, titled Electric Vehicles and Building Codes: A Strategy for Greenhouse Gas Reductions, to support local governments in the adoption of code-coordinated policies that support climate mitigation and the Federal Government's mission to transition towards clean energy. This is the first in a series of resources the Code Council is set to publish with the aim of supporting communities in achieving GHG reduction goals in a safe and efficient manner. The Code Council worked in collaboration with DOE, and other sector stakeholders, to develop the resource and a technical brief on Electric Vehicle Charging for Residential and Commercial Energy Codes produced by the DOE in July 2021. We look forward to continued collaboration with DOE to develop additional resources to support energy efficiency and GHG reductions.

These resources can be incorporated into future editions of the IECC. Initial potential topics include:

- Electrification and decarbonization
- Embodied carbon
- Grid Interactivity/efficiency
- Building Performance Standards

Building Codes Save

Building codes represent a highly cost-effective strategy to help protect communities from the risks posed by natural and man-made events. The Code Council's collaboration with the Federal Emergency Management Agency (FEMA) continues to highlight the role up-to-date building codes play in supporting safe, sustainable and resilient communities. A FEMA supported study by the Congressionally-established National Institute of Building Sciences found that the regular adoption of building codes provides an $11 benefit for every $1 invested. The 2020 FEMA study, *Building Codes Save: A Nationwide Study*, found that currently 65 percent of counties, cities, and towns across the U.S. have not adopted modern building codes, only 50 percent of cumulative post-2000 construction adhered to the I-Codes, and 30 percent of new construction is occurring in communities with no codes at all or codes that are more than 20 years outdated. These are alarming statistics in light of the increasing frequency and magnitude of hazard events across the country. The FEMA study also found that the I-Codes could help communities avoid $132 billion to $171 billion in cumulative losses through 2040 and save more than $600 billion by 2060 if all new buildings across the U.S. were built to modern editions of the I-Codes.

Given these significant benefits, FEMA should continue and even enhance its prioritization of code adoption and administration activities under its Hazard Mitigation Grant Program (HMGP) and Building Resilient Infrastructure and Communities (BRIC) program. The continued support of building codes as a cost-effective climate mitigation strategy through FEMA's programs is crucial to combat the climate crisis and adapt to the changing climate. The Code Council seeks continued collaboration with FEMA to enhance the adoption and compliance of modern building codes as a key mitigation mechanism.

We commend FEMA's establishment of an agency-wide Building Codes Working Group to coordinate code related initiatives and policies and look forward to its expansion to all agencies that use codes and standards to support their missions. Full support from the Administration will help assure broad participation and coordination.

Global Resiliency Dialogue

In adapting to the impacts of climate change, the Code Council recognizes that the risks the built environment will face in the future are different than those of the past. Codes, standards and the design

process must adapt to recognize these changing risks. Bringing together the latest research and modeling from climate scientists with the data and information needs of building scientists is essential.

The Code Council led establishment of the Global Resiliency Dialogue, a forum of building code developers and research organizations from Australia, Canada, New Zealand and the United States. Established in 2019, the Global Resiliency Dialogue is a joint initiative to inform the development of building codes that draw on both building science and climate science to improve the resilience of buildings and communities to intensifying risks from weather-related natural hazards. In February 2021, the Global Resiliency Dialogue published findings of its first international survey in the report, *The Use of Climate Data and Assessment of Extreme Weather Event Risks in Building Codes around the World*. The second publication is currently underway, which provides a definition for climate resilience in the context of building regulation and analyzes comparative findings on the incorporation of climate change in building codes from a second survey conducted in each member country.

The Global Resiliency Dialogue is in the process of developing international resiliency guidelines through collaborative research efforts that will aid jurisdictions across the globe to better prepare the building stock to withstand the more extreme weather events, including high wind, flooding, and wildfire, that the evidence and science tells us have been and will continue to increase in frequency and duration.

In conjunction with work of the Global Resiliency Dialogue, it is essential for Federal Agencies like the National Oceanic and Atmospheric Administration (NOAA) and National Institute of Standards and Technology (NIST) to help coordinate the effective use of climate science. Engaging private sector Standards Development Organizations (SDOs), like the Code Council, is essential. It is pivotal that standards, especially in the built environment, incorporate climate models and science to adapt to the changing climate, safeguard communities and enhance overall sustainability and resilience. The Code Council, through their work with the Global Resiliency Dialogue urges the Federal Government to engage in these strategic collaborations to assist in aligning expectations for building durability and resilience with the projection of future hazards. It is also crucial for NOAA and NIST to continue developing and deploying messages and resources that enhance understanding of building codes, support a common understanding of risk and communicate the importance of up-to-date building code.

Minimum Design Standards for Federally-Funded Projects

Although the federal government invests billions of dollars in infrastructure annually and requires current codes and standards for its own portfolio, FEMA is the only federal entity that currently requires that federally assisted projects adhere to up-to-date building codes and standards. FEMA has done so to "increase the resilience of communities after a disaster," "protect lives and property," and to "reduc[e] the need for future Federal disaster recovery funding and other assistance." Recognizing the importance of resilient construction, a component of the President's American Job Plan commits to "build back above existing codes and standards" in disaster- prone communities.

Given the heterogeneity in the adoption of hazard resistant codes and standards across our country, we believe federally assisted construction and infrastructure investments should at minimum adhere to up-to-date codes and standards. That position is supported by past FEMA Administrators from both parties, the federal government's National Mitigation Investment Strategy, and the still active Disaster Risk Reduction Minimum Codes and Standards Policy that former FEMA Administrator Fugate put in place.

Schools, hospitals, housing, childcare facilities, airports, and other public buildings and amenities are all pillars of our communities and especially important in meeting the needs of vulnerable populations.

Many of these buildings frequently serve communities as emergency shelters, which requires these facilities be resilient and well maintained. Ensuring they are constructed to modern codes and standards protects the people who use and occupy these structures as well as the federal government's own investment, is consistent with FEMA policy, and follows the federal government's requirements for its own buildings. To do otherwise, locks avoidable risk and inefficiencies into investments with lifetimes spanning 50 to 75 years, or more.

—

Building codes play an essential role in enhancing resilience in response to the changing climate and supporting community needs in achieving their energy efficiency and GHG emission reductions targets. Ongoing support and collaboration of the diverse stakeholder groups the Code Council has and will continue to convene will drive innovation forward and enhance resilience in the development and implementation of future codes. The Code Council calls on the administration to work across the Federal government (DOE, FEMA, EPA, NOAA, NIST, etc.) to prioritize resources and support through their programs to encourage adoption of current codes and their effective implementation as a critical climate mitigation and adaptation strategy. Support of current I-codes through technical resources, transparent technical analysis, training resources, and integration of climate science is essential to achieving future energy efficiency goals, GHG reduction targets and climate resilience.

The Federal Government, through PCAST and other Agency work, should enhance participation in and support for the I-Codes like the IECC and its new framework, and expand its support for the IgCC to support climate mitigation. Continued collaboration between the Code Council and these Federal Agencies is critical to support standardized approaches to policy implementation that advance energy efficiency and GHG reductions to enhance national resilience.

Sincerely,

Ryan M. Colker, J.D., CAE
Vice President, Innovation

Gabe Maser
Deputy Senior Vice President, Government Relations

Energy Sciences Coalition Statement to the
President's Council of Advisors on Science and Technology
On the Critical Role the Department of Energy Office of Science Plays in Responding to the Climate Challenge and Clean Energy Transition

October 13, 2021

Dear Members of the President's Council of Advisors on Science and Technology (PCAST):

On behalf of the more than 100 member organizations of the Energy Sciences Coalition (ESC), we thank you for your public service. As you prepare policy and funding recommendations for the Biden Administration related to combatting and adapting to climate change and achieving net zero emissions by 2050, **ESC urges you to include the Department of Energy (DOE) Office of Science as one of the leading federal science agencies to achieve ambitious climate and clean energy goals**.

The DOE Office of Science is a critical part of the nation's innovation ecosystem and is the nation's largest funder of the physical sciences. Among its core mission objectives is conducting fundamental science to deliver solutions and technologies to address climate change, clean energy, and environmental sustainability. Scientific breakthroughs and energy technology innovation are still necessary to decarbonize the U.S. economy and mitigate the worst effects of climate change. Office of Science-supported fundamental research forms the foundation for future energy technologies. The current imperative—energy systems that meet our energy security, economic, and environmental challenges—requires continued, robust investments in all areas of fundamental research to advance all energy systems, including energy storage, negative emission technologies, advanced nuclear, hydrogen, fusion, renewables such as wind and solar, carbon capture, storage and utilization, and next-generation fuels. We encourage you to bring the programs, capabilities, and expertise of the Office of Science to bear in all these areas.

The DOE Office of Science is unique among federal science agencies, supporting the network of 17 DOE national laboratories—the crown jewels of the nation's research and innovation ecosystem— and directly stewarding ten of them. Over 300 universities and other research institutions across all 50 states are also supported by over $1 billion in Office of Science research funding annually. One of the greatest strengths of the national laboratories and their partnerships with academia and industry is science at scale, which will be required to find solutions to climate change and help deploy clean energy technologies and ensure environmental sustainability and equity.

The DOE Office of Science has a long history of combining the talent and capabilities of the national laboratories' unique science facilities, the country's research universities, and industry to bring together multi-disciplinary teams to tackle fundamental science, energy, environmental, and national security grand challenges. The most recent examples are the bioenergy research centers, national quantum information science research centers and the nation's response to COVID-19. The DOE Office of

Science already supports the country's leading scientists at national laboratories and research universities to address climate change. For example, researchers are developing predictive models of climate change as well changing interactions among climate, water, and energy to help decision makers understand impacts on ecosystems and human well-being and develop strategies to mitigate or adapt to change. Fundamental, use-inspired research in novel materials at the national labs in collaboration with industry and academia is speeding the delivery of solutions at scale and scope for carbon capture and long duration, grid-scale energy storage.

The DOE Office of Science is also the nation's steward of the most sophisticated, world-class scientific user facilities used by research universities, industry and most federal agencies to advance their scientific and technology goals and objectives. Conceived of, built and managed by Office of Science national laboratories and universities across the country these 27 large scale and world leading include particle accelerators, experimental reactors, X-ray synchrotron and free-electron laser light sources, leadership-class supercomputers and other high-precision instruments – tools that provide unprecedented access to molecular, microbial, atomic, and subatomic structures and chemistry. Annually, more than 36,000 researchers from academia, industry and federal agencies use these facilities to support their pursuits in science and engineering. Other federal agencies involved in addressing climate change rely on access to these facilities, including the National Aeronautics and Space Administration, the National Oceanic and Atmospheric Administration, the National Science Foundation, and the Environmental Protection Agency. As an example related to climate, DOE has operated the Atmospheric Radiation Measurement (ARM) user facility for over 30 years, the country's leading ground-based measurements tools, especially for clouds and aerosols, located in different geographic regions around the world. ARM data has been critical in expanding scientific understanding of atmospheric processes and improving global-scale weather and climate models.

Equally important, the Office of Science prepares the next generation of American scientific and engineering talent. To be world leaders in addressing climate change and transitioning the economy to clean energy requires additional investments in STEM workforce and education programs. Through competitively awarded grants, Office of Science supports approximately 22,000 Ph.D. scientists, engineers, graduate students, undergraduates and technical personnel at more than 300 institutions across all 50 states and the District of Columbia. DOE-funded research and education programs strengthen our nation's scientific knowledge base and prepare the next generation of scientists and engineers by providing hands-on experience for students. ESC urges you support expanding successful education programs, such as the Office of Science Graduate Fellowship Program, to support the best and brightest students from multidisciplinary areas of research in pursuing their advanced degrees. ESC also urges the creation of new workforce development programs to increase diversity, equity, and inclusion of STEM professionals working in DOE mission-relevant disciplines, and significantly broaden recruitment pools to leverage existing domestic talent.

The DOE Office of Science plays a pivotal and leading role in addressing this country's climate, energy, national security, and environmental challenges. ESC again urges you to prioritize and fully leverage DOE Office of Science capabilities and expertise to address these challenges.

Sincerely,

Leland Cogliani
Co-chair
[redacted]

Carina Márquez-Oberhoffner
Co-chair
[redacted]

APPENDIX I. ESC MEMBERSHIP

American Association for the Advancement of Science
American Association of Physicists in Medicine
American Association of Physics Teachers
American Astronomical Society
American Chemical Society
American Crystallographic Association
American Geophysical Union
American Geosciences Institute
American Institute of Physics
American Mathematical Society
American Nuclear Society
American Physical Society
American Society for Engineering Education
American Society of Agronomy
Acoustical Society of America (ASA)
American Society of Mechanical Engineers
American Society for Microbiology
American Society of Plant Biologists
American Vacuum Society
Arizona State University
Association of American Universities
Association of Public and Land-grant Universities
AVS – The Society for Science and Technology of Materials, Interfaces, and Processing
Battelle
Binghamton University
Biophysical Society
Boston University
Case Western Reserve University
City College of CUNY
Clemson University
Coalition for Academic Scientific Computation (CASC)
Consortium for Ocean Leadership
Columbia University
Computing Research Association
Council of Scientific Society Presidents
Cornell University
Cray Inc.
Crop Science Society of America
Duke University
The Ecological Society of America
Federation of American Societies for Experimental Biology
Florida State University
Fusion Power Associates
General Atomics
Geological Society of America
George Mason University
Georgia Institute of Technology
Harvard University
Health Physics Society
IBM
IEEE-USA
Iowa State University
Jefferson Science Associates, LLC
Krell Institute
Lehigh University
Long Island University
Massachusetts Institute of Technology
Materials Research Society
Michigan State University
Michigan Technological University
New York University
Northeastern University
Northern Illinois University
Northwestern University
Oak Ridge Associated Universities (ORAU)
OSA—The Optical Society
Pace University
Penn State University
Princeton University
Purdue University
Rensselaer Polytechnic Institute
Rutgers, The State University of New Jersey
Society for Industrial and Applied Mathematics
Soil Science Society of America
South Dakota School of Mines
Southeastern Universities Research Association
SPIE
Stanford University
Stony Brook University
Tech-X Corporation
The Ohio State University
University of California System
University of Chicago
University of Colorado Boulder
University of Delaware
University of Illinois System
University of Iowa
University of Maryland, College Park
University of Michigan
University of Missouri System
University of Nebraska
University of North Texas
University of Oklahoma
University of Pennsylvania
University of Rochester
University of Southern California
University of Tennessee
University of Texas at Austin
University of Virginia
University of Wisconsin-Madison
Vanderbilt University
Washington State University
West Virginia University
Yale University