

Keeping facilities relevant / healthy

Recent context for U Minnesota:

Panel Review of Characterization Facility (CharFac) – (reviewers: 2 external, 2 internal)

What's happened, what's good, what's bad...

1. Current scale, suite of instrumentation
2. Historical recap
 - Funding for instrumentation
 - Growth of research usage, internal/external; and education
3. Problems
 - Staff attrition, etc.
 - Admin difficulties
4. Recommendations by panel

Univ. of Minnesota's Characterization Facility: Overview

Scale

- ~\$18 million replacement value of equipment
- ~10 FTE technical staff
- ~600 total research users per year, ~100 external
- 300-400 new research users per year
- ~400 trainings/year for *research* usage
- ~250 students from 13 *curricular and short courses* in last year
- ~40 UMinn. departments/institutes (incl. biomed)
- ~140 UMinn. faculty research groups
- 40-50 companies in typical year
- ~25 external academic institutions in typical year
- Annual transaction volume: ~15,000 billed sessions, ~3,000 supply sales
- Operations budget ~\$1.5M; \$315k subsidy, not MRSEC

- ❖ **Hard & soft materials, liquids, biological**
- ❖ **Analytical services and training by experts**
- ❖ **Collaborative research; custom methods development**
- ❖ **Curricular courses, short courses, workshops**



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Current CharFac: 40 analytical systems

(not shown: >30 ancillary EM tools)

Shepherd Labs

Nils Hasselmo Hall

Moos Tower

Scanning and Transmission Electron Microscopes (10); service contracts

- JEOL 6500 FE-SEM (BS, EDS, EBSD, cathodolum.)
- JEOL 6700 FE-SEM (high-res.)
- Hitachi S-900 FE-SEM (cryo, in-lens high-res., BS)
- Hitachi S-4700 FE-SEM (cryo, BS)
- JEOL 1200 TEM (biological)
- FEI Titan aberration-corrected TEM/EELS
- Two FEI Tecnai G2 F30 FEG TEMs (EDX, two EELS, STEM, cryo, high-tilt, 3D reconstruction software)
- Two FEI Tecnai T12 TEMs; one EDS; second bio/cryo
- Two full suites of specimen prep tools (SEM/TEM) for hard and soft materials, biological; includes two cryomicrotomes

Proximal Nanoprobes: SPM, nanoindentors & related (10)

- Two Bruker Nanoscope III Multimodes (EFM, MFM, KPFM, FMM, force volume) on Nano-k platforms; nPoint closed loop
- Two Agilent 5500's, one with inverted light microscope; T, RH control, robust liquid cell; digital pulsed force mode, MACIII (multifrequency methods); closed loop
- Custom SPM methods: signal adder, shear modul., LabView
- Probe modification: chemical, metal, colloidal particle
- Hysitron Triboindenter + new transducer, Picoindenter (inside TEM to view deformation/fracture), Triboscope
- Agilent Nanoindenter XP (oscillatory loading, storage/loss)
- Custom-built micromechanical tester (MMT)
- Tencor stylus profilometer (up to 14" wide, 2" thick)

Visible Light Techniques

- Woollam Spectroscopic Ellipsometer (film thickness and optical constant characterization over $\lambda=200-1100$ nm)
- Video and Computer-Enhanced Light Microscopy
- Zygo Optical Profilometer (interferometric)

X-ray Diffraction & Scattering (10)

- Bruker AXS (Siemens) D5005 XRD
- Siemens D500 X-Ray XRD (multi-sample changer)
- Scintag XDS 2000 Theta-Theta XRD; broad temp. control
- Bruker AXS microdiffractometer with 2D detector
- Pananalytical X'pert Pro high-angular resolution XRD
- Bruker D8 XRD with temperature and humidity control
- Bruker D8 microdiffractometer; 2D detector, XYZ sample stage
- 2D SAXS, 2 meter line
- 2D SAXS, 6 meter line; in-line DSC, rheometer, mechanical strain, temp. stage
- Anton Paar SAXSess (wide- and small-angle)

Ion Beam Analysis (elemental composition, depth profiles)

- Rutherford backscattering (RBS); FReS, PIXE/PIGE, NRA
- NEC 5.1 MeV accelerator, He⁺, He⁺⁺ and H⁺ beams
- New DAQ system, three ion, X-ray and γ -ray detectors, goniometer for channeling analysis

Surface analytical (elemental, chemical) and depth profiles

- Two X-ray photoelectron spectrometers (XPS/ESCA), one monochromated/small spot/angle resolved (SSI)
- Auger spectroscopy (AES; scanning and depth profiling)
- Micro contact angle system

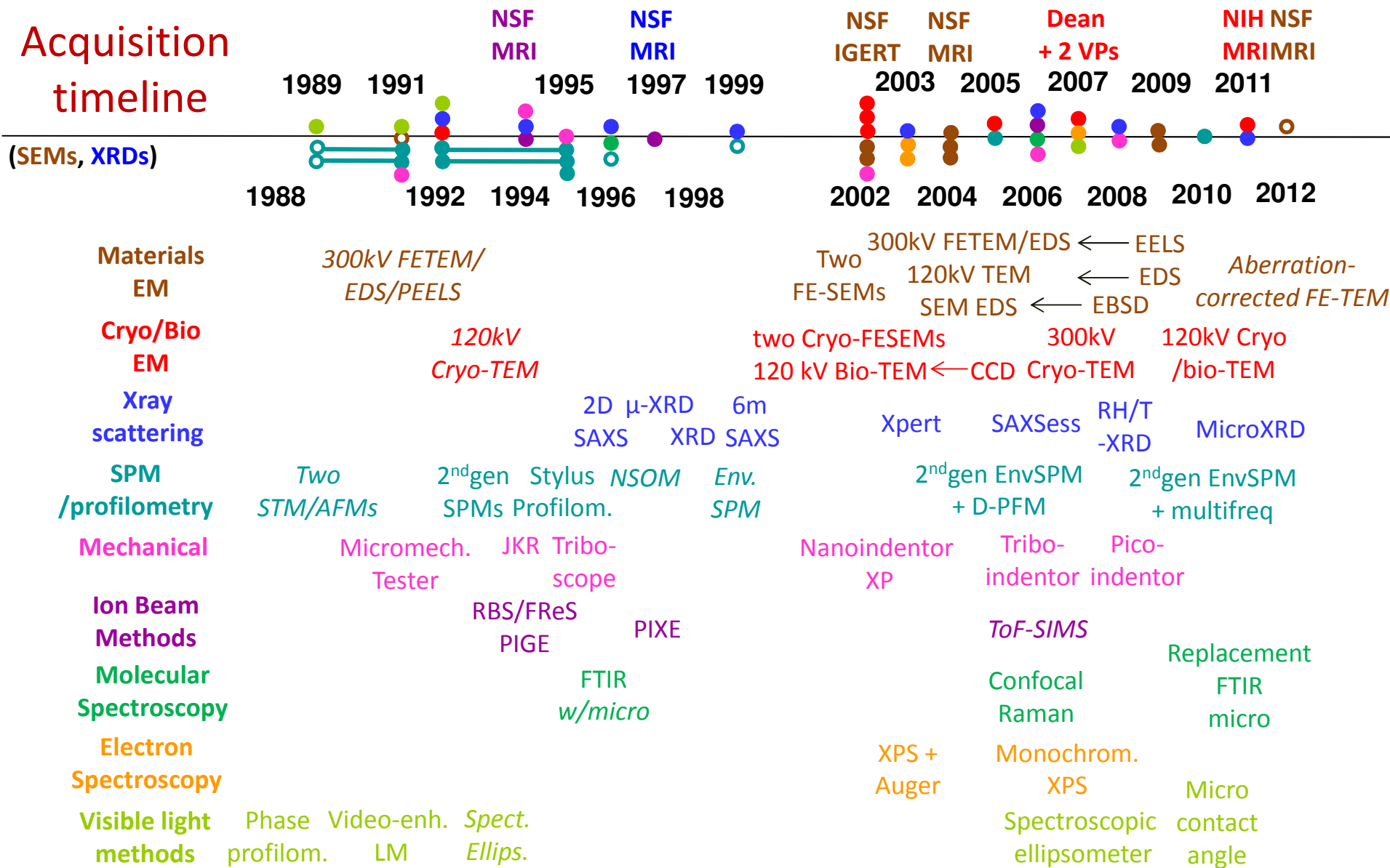
Vibrational spectroscopy (chemical, 3D imaging)

- Thermo FTIR spectrometer (DTGS and MCT detectors), Transm., Refl., ATR, DRIFTS; new microscope
- Witec confocal Raman spectrometer/microscope (514-nm and 752-nm lasers); full spectroscopic imaging in XY and XZ

How did we get here?

NSF-ERC (\$3.5M; ~\$300k/yr + \$200k/2yr beyond) —————
 NSF-MRSEC (\$790k) —————
 Dean's special matching fund (\$280k) —————
 NSF-NNINcap eq match (\$90k) —————
 UMin. Grant-in-Aid program (~\$500k, success:17/20) —————
 Dean's cap eq subsidy (\$1M) —————

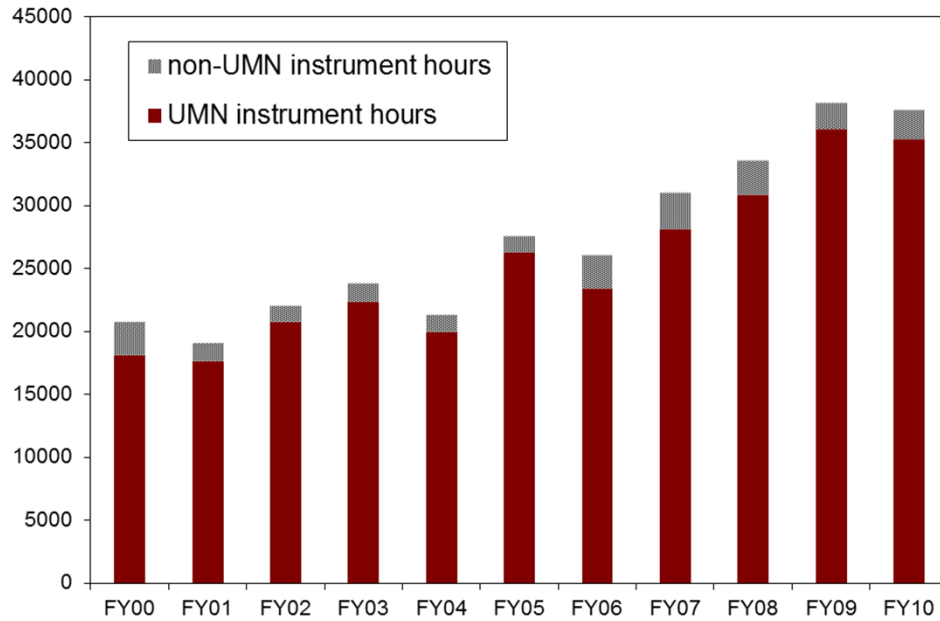
Acquisition timeline



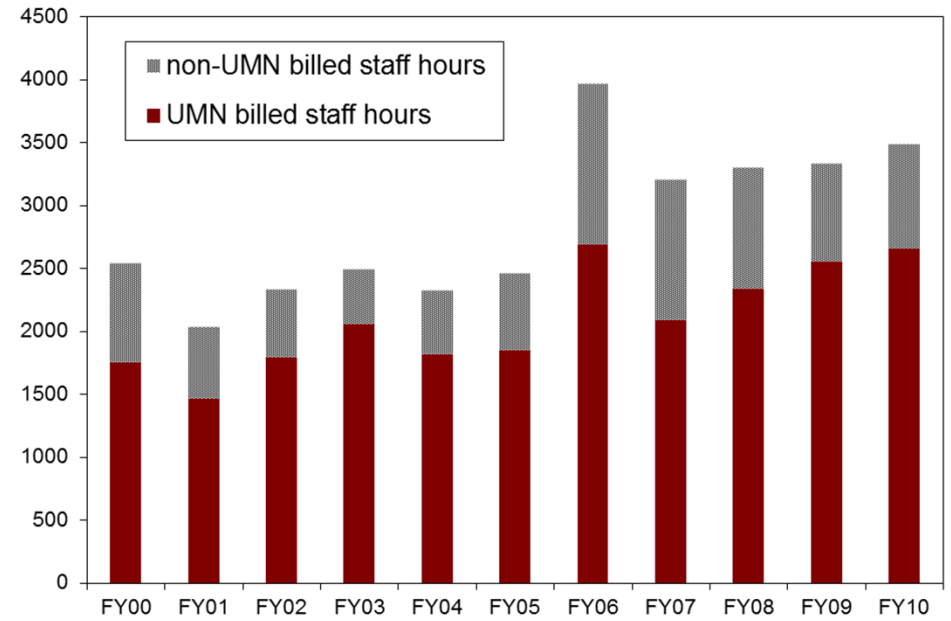
Did usage / user base grow?

Mid 1999 – Mid 2010

Instrument time



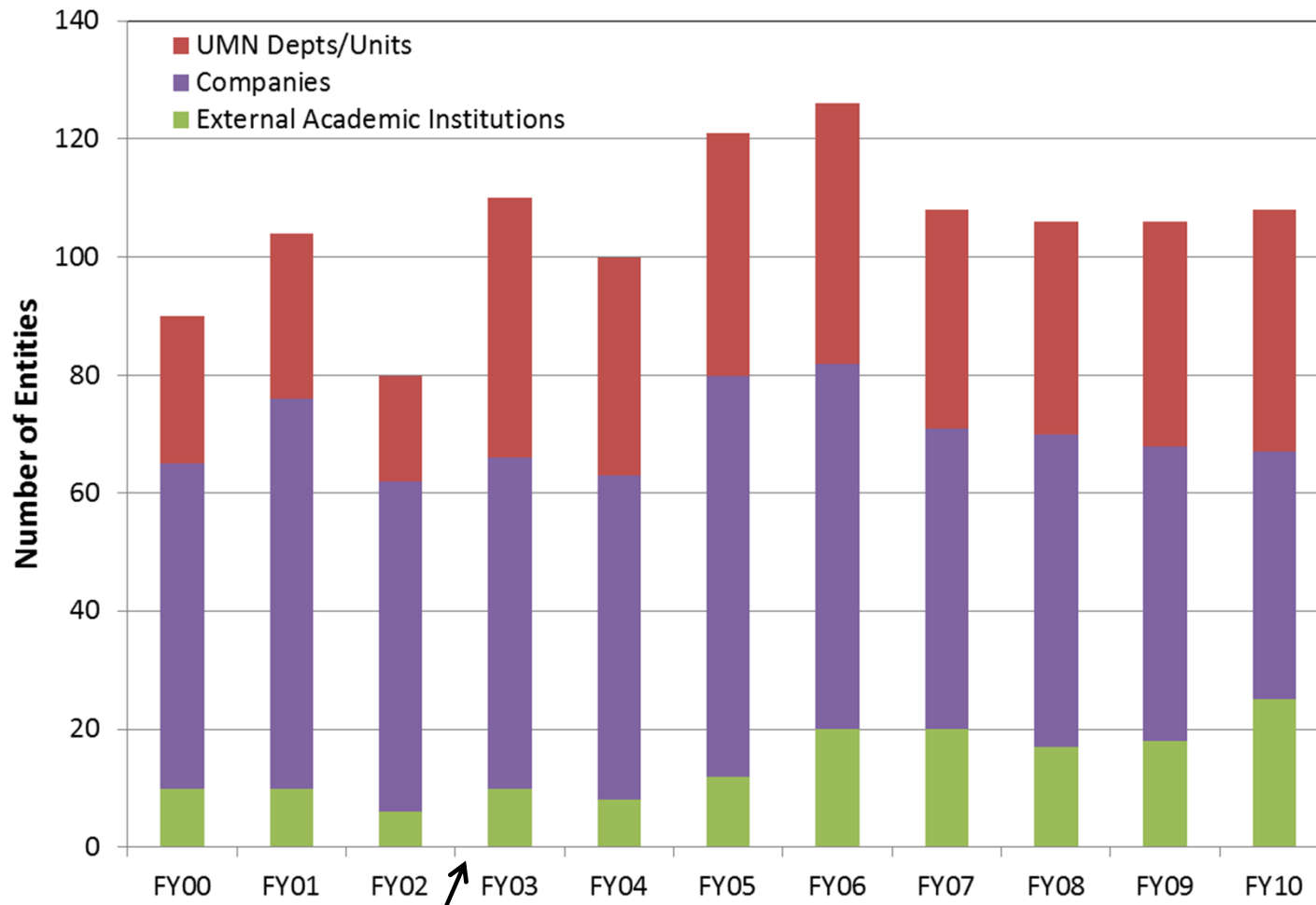
Billed staff time



11-year evolution in **operations** funding

- User fees \$600k → \$1.2M
- Subsidy \$100k → \$315k (3 deans, 1 VP)
(\$140k for two 300kV TEM service contracts; rest for added biomed EM)

Number of user entities by category

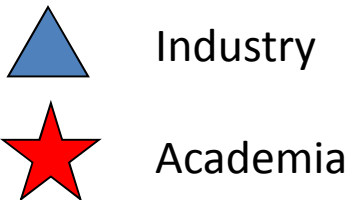
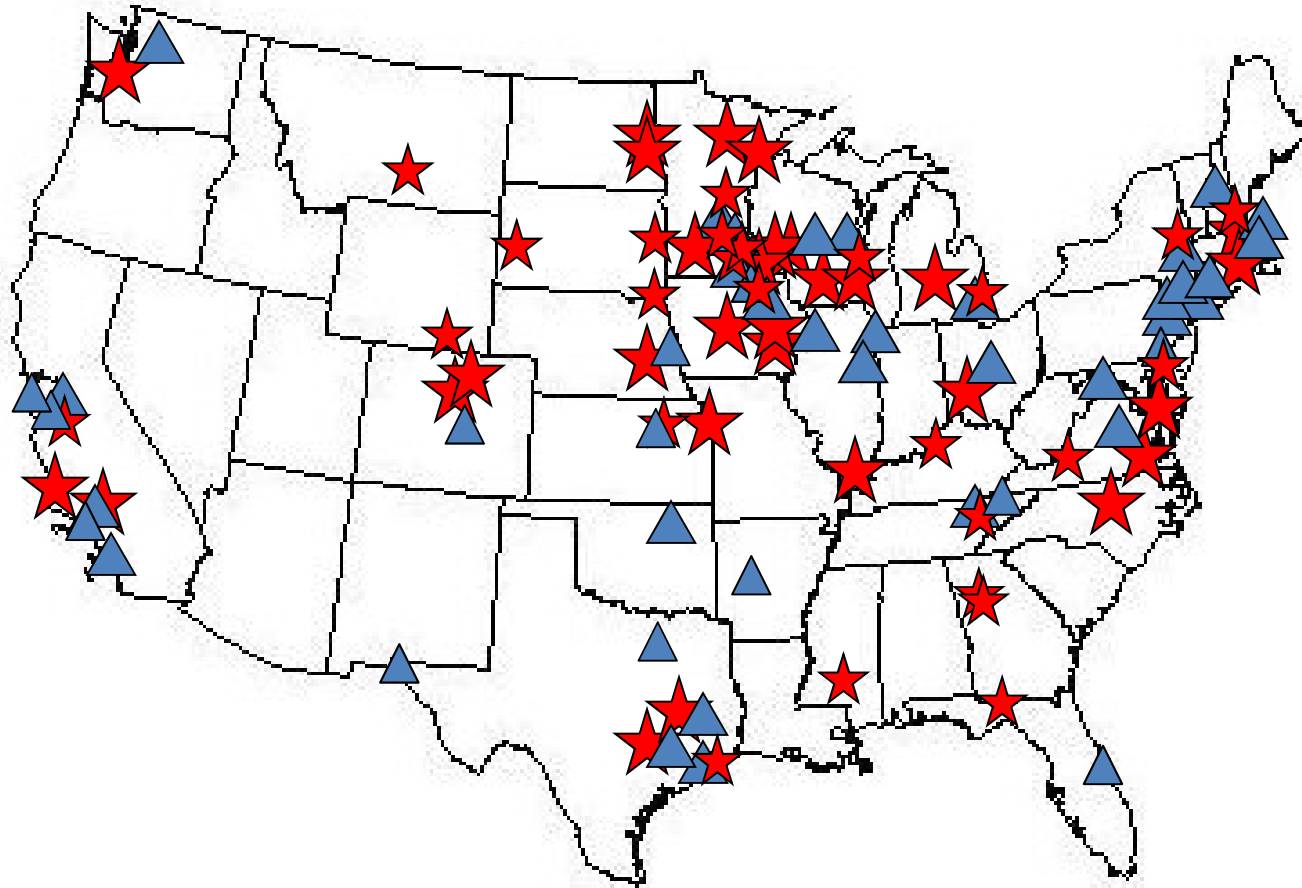


Acquired
biomedical
EM labs

External users:
25-33% of user
revenue

CharFac External User Geography

2004 - 2008 and 2008 - 2011



External Users of Univ. of Minnesota Characterization Facility

July 2008 - June 2011

(12-yr income: \$220-\$370k/year)

77 in 3 years; typically 40-50/year

28 in 3 years; typically 20-25/year

11 in 3 years; typically ~7/yr

Companies			Research Universities	4yr colleges, non-PhD
3M	Donaldson Company	Nature Works LLC	Brown University	Augsburg College
Abbott Vascular	Eastman Chemical Co.	NVE Corporation	Columbia University	Carleton College
Advanced Research	Ecolab Inc.	Paddock Laboratories, Inc.	Emory University	Hamline University
Alcon Research, LTD	Entegris, Inc.	Phygen Coatings, Inc.	Florida A&M University	Luther College
American Preclinical Services	EnteroMedics Inc.	QualiTech, Inc.	Georgia Institute of Technology	Macalester College
Applied Colloids	FSI International	Rushford Hypersonic LLC	Iowa State University	
Aspen Research Corp.	General Mills	SAGE Electrochromics, Inc.	Kansas State University	2yr colleges
ATS Medical	Genesegues, Inc.	Seagate Technology	Leibniz Universitat Hannover	Dakota County Technical College
Aveka, Inc.	Honeywell	Sil-Pro, LCC	Montana State University	Minneapolis Technical and Community College
Avicenna Technology	Huntsman Chemical	Soligie Inc.	North Dakota State University	Nanolink short course - 2yr institution instructors
Becton Dickinson	Hutchinson Technology	St. Jude Medical	Old Dominion University	
Bergquist Co.	Hysitron, Inc.	St. Onge Steward Johnston & Reens	San Jose State University	Non-profits / government
BH Electronics Inc	IFC Medical	Steriluent	South Dakota School of Mines & Technology	Rushford Institute for Nanotechnology
Biothera	Imation	SurModics Inc	South Dakota State University	City of Minneapolis Water Works
Boston Scientific	Innovative Surface Technologies	SVT Associates	Texas A&M University	County of San Diego
Carestream Health, Inc.	Ironwood Electronics	Synovis Surgical Innovations	University of California - Santa Barbara	
Cargill	Johnstech International	Systems Visions LLC	University of Cincinnati	
Chameleon Scientific	Katz Analytical	Tennant Company	University of Colorado	
Cima Nano Tech, Inc.	Kimberly-Clark Corporation	Tepha, Inc.	University of Delaware	
Con Agra Foods	Kroll Ontrack	Unilever	University of Nebraska-Lincoln	
Conopco, Inc. - Unilever	Lion Precision	Upsher-Smith Laboratories	University of South Dakota	
Copytele	Lutonix, Inc.	Valspar	University of Southern Mississippi	
Covidien	Lyotropic Therapeutics, Inc.	Veeco Metrology	University of Tennessee	
Crane Engineering	Medtronic	Vision Ease Lens	University of Texas-Med. Br.	
Cymbet Corp	Minnesota Wire & Cable	White Bear Photonics, LLC	University of Wisconsin-Madison	
DiaSorin	MSP Corporation		University of Wisconsin-Milwaukee	
			University of Wyoming - Laramie	
			Wayne State University	

What about educational users?

Recent-year curricular and short course usage: summer 2010 through spring 2011

Designator	Revenue for CharFac	# of students	Course Name (summer 2010, fall 2010, spring 2011)	Lead instructor or organizer	(other) CharFac staff involvement (co-instr., guest lect., lab demos)
MatS 8995	\$22,400	15	Nanoscale Imaging and Characterization	McCormick	Seaton, Hafner, Zhang, Ugurlu, Frethem, Haugstad, Dong
Chem 5210	---	17	Materials Characterization	Penn	Haugstad, Ugurlu, Nelson
ECE 5657	---	30	Principles of Thin Film Technology	Stadler	Haugstad
BME 5421	---	15	Biomedical Optics	Akkin	Dong
MatS 5517	\$ 3,000	10	Electron Microscopy	Mkhoyan	---
MatS 4221	\$ 1,200	21	Materials Design and Performance	Gerberich	Nelson, Luo
MatS 3801	\$17,200	32	Structural Characterization Lab	Leighton	Seaton, Haugstad, Dong, Luo
MatS 3851	\$ 1,200	29	Properties Characterization Lab	Frisbie	---
MT 3131	\$ 8,000	11	Intro. to Materials Characterization	Hafner	Haugstad, Luo, Dong, Nelson
BME 5151	---	35	Intro. To BioMEMS & Medical Microdevices	Saliterman	Haugstad, Frethem
NSIC	\$ 3,200	17	Summer 2010 short course (week lab)	McCormick	Seaton, Hafner, Zhang, Ugurlu, Frethem, Haugstad, Dong
Nanolink	\$ 1,200	7	Summer 2010 short course (2 days lab)	Haugstad	Dong
Cryo EM	---	11	Summer 2010 short course (2 days lab)	McCormick	Hafner, Zhang, Frethem
Total:	\$57,400	250			

2000: almost nothing for curriculum

Essential to much of the growth in activity: Talented professional staff (mainly post-postdoc)

But... attrition!

Left since 2000: 27 technical staff, 5 admin staff
(not counting contracted admin and students)

- | | |
|-----------------------------|---|
| Admin - Angela Linde | SurfAnal - John Thomas |
| Admin - Assefa Geleta | Tech & XRS - Peter Yurek |
| Admin - Constance Sorenson | XRS - Bryan Wuertz |
| Admin - Lora Witte | XRS - Dave Carr |
| Admin - Sequoia Davis | XRS - Erik Sapper |
| Admin & Tech - Mike Boucher | XRS - Jaidev Tantry |
| EM - Arzu Altay | XRS - Mallika Kamarajugadda |
| EM - David Bell | XRS - Maria Torija |
| EM - Joysurya Basu | XRS - Mike Lund |
| EM - Sam Dong | XRS - Ryan Wold |
| EM - Stuart McKernan | XRS - Smita Debnath |
| EM - Xinren Li | XRS - Tamotsu Harada |
| IBA - Tiffany Shih | XRS - Venu Vangala |
| IBA - Yongqiang Wang | XRS - Wei Fan |
| EM - Ozan Ugurlu | Vibr. Spectr. + SPM - Jinping Dong |

(still contracted: Tech - John Kadlec XRS - Linda Sauer)

August 2011	FTE	responsibilities
Haugstad, Greg	0.85	SPM/IBA/ToF-SIMS/admin
Nelson, John	0.75	SEM/mechan/misc
Dong, Jinping	0.8	Raman/FTIR/SPM/misc
Hafner, Bob	1	cryo-bio TEM
Fretham, Chris	1	SEM NHH
Ressler, Alice	1	admin/client rel./bio NHH
Ugurlu, Ozan Myers, Jason	1	TEM
Manno, Mike	0.5	XRS
Zhou, Fang	1	specimen prep/bioTEM NHH
Luo, Bing	1	Surface Analytical/XRD
Seaton, Nick	0.5	SEM
Zhang, Wei	0.45	cryo-bio TEM NHH
Schafer, John	0.4	IT (JAWS/web)
Low e, Matt	0.4	IT (PCs/networking)
"Front desk"	0.25	first contact / scheduling / admin
Sauer, Linda + Kadlec, John	0.5	contracted services
Joel Overlander	1	accounting + HR

total 11.6

Problems: Administrative Challenges

- New requirements that industrial work be done under Services Agreement with optional Nondisclosure Addendum (Regents level principles, written by Office of General Counsel, overseen by Office of External Sales).
- Once-in-30yr change of University's accounting system: required customization of software systems, just to get billing to run.
- New MN State requirement that all external hands-on users ("rentals") are subject to Sales Tax, retroactive 3 years.
- Three administrative workers become interpersonally problematic; budget cuts justify termination.

Principal recommendations of panel review, May 2011

Mission/scope

- No change. Curricular activity, though an expansion of mission, is worthy.
- Expansion to biomedical clientele is unavoidable.

Administration

- Need good accountant (expensive). Problematic staff can be a HUGE drain.
- Director: Spend less effort on financial issues and managing admin staff, more on technical issues and marketing.

Fee structure

- Need systematic comparison with multiple peer institutions (for internal rates)
- Charge for full staff cost recovery during trainings.

Curricular activity costs

- Need to charge for full staff-time cost recovery.
- Look into institutional mechanisms for support of equipment for curricular activity.
- Because of the opportunity cost, more TA effort should be sought.

Marketing

- Use college for distributable marketing materials.
- Faculty incentives for marketing facility to industry?

Technical staff

- Skepticism that labs can be staffed at BS level. MS may be ok in some instances.
- Continue staffing mostly with “post postdocs”. Attrition will always be a problem.